Theory Assignment 1- 2024
Design Principle of Operating Systems (CSE 3249)
Programme: B.Tech. (CSE & CSIT) Semester: 5th
Submission Date: 30 Oct 2024

Course Learning Outcome	*Taxonomy Level
To understand the different components of operating System and various ways of structuring an operating system.	L4
To differentiate the basic design issues involved in creating process and threads.	L4
To analyze the mechanisms involved in handling, scheduling and synchronizing processes.	L4

This assignment is designed to give you practice with the concepts of

- Instruction Execution
- Memory and cache memory
- Uniprogramming and Multiprogramming
- Process creation using fork()
- Process scheduling algorithm
- Synchronization Tool (Semaphore)

Note: All students are requested to follow book of operating systems by William stalling 9th edition. All figure number with page no mentioned in the question are given there.

1. Suppose the hypothetical processor of figure 1.3 (page no 34) also has two I/O instruction:
   0011=Load AC from I/O
   0111=Store AC to I/O
   In these cases, 12-bit address identifies a particular external device. Show the program execution using the format of Figure 1.4 (page no 35) for the following program:
   a. Load AC from device 6.
   b. Add content of memory location 880.
   c. Store AC to device 7.

   Assume that the next value retrieved from the device 6 is 10 and that location 880 contains a value of 8.

2. Consider a hypothetical 64-bit microprocessor having 64-bit instructions composed of two fields. The first 2 bytes contain the opcode, and the remainder an immediate operand or an operand address. What is the maximum directly addressable memory capacity?

3. Suppose that a large file is being accessed by a computer memory system comprising of a cache and a main memory. The cache access time is 50 ns. Time to access main memory (including cache access) is 550 ns. The file can be opened either in read or in write mode. A write operation involves accessing both main memory and the cache (write-through cache). A read operation accesses either only the cache or both the cache and main memory depending upon whether the access word is found in the cache or not. It is estimated that read operations comprise of 70% of all operations. If the cache hit ratio for read operations is 0.9, what is the average access time of this system?

4. Consider a computer with 400Mbytes of available memory (not used by os). Three program, JOB1, JOB2 and JOB3 are submitted for execution at the same time with attribute listed below.

	JOB1	JOB2	JOB3
Type of job	Heavy compute (80% CPU used)	Heavy I/O (10% CPU used)	Heavy I/O (10% CPU used)
Duration	10 min	20 min	15 min
Memory required	100M	150M	125M

For simple Batch environment, these job are executed in sequence JOB1, JOB2 then JOB3. Find out CPU utilization, memory utilization and Throughput in case of uniprogramming and multiprogramming system.

5. In a batch operating system, three jobs are submitted for execution. Each job involves an I/O activity, CPU time and another I/O activity of the same time span as the first. Job JOB1 requires a total of 23 ms, with 3 ms CPU time; JOB2 requires a total time of 29 ms with 5 ms CPU time; JOB3 requires a total time of 14 ms with 4 ms CPU time. Illustrate their execution and find CPU utilization for uniprogramming and multiprogramming systems.

6. Trace the following program segment and determine how many processes are created. Draw a graph that shows how the processes are related.

a. int main( )	b. int main( )

{
  pid_t c1,c2;
  c2=0;
  c1 = fork();
  if (c1 == 0)
    c2 = fork();
  if (c2 > 0)
    fork();
  printf(" 1");
	{
	  pid_t c1=1,c2=1;
	  c1 = fork();
	  if (c1 != 0)
	    c2 = fork();
	  if (c2== 0)
	    fork();
	  printf(" 1");

return 0; }	return 0; }

c. int main( )
  {
   if (fork() || fork())
     fork();
   printf(" 1 ");
   return 0;
}
	d. int main( )
	  {
	   if (fork() && (!fork()))
	     if (fork() || fork())
	        fork();
	   printf("2 ");
	   return 0;
	  }

7. Consider the set of processes with arrival time (in milliseconds), CPU burst time (in milliseconds), and priority (**high number implies high priority**) as shown below.

Process	Arrival time	Burst Time	Priority
P1	0	11	1
P2	0	8	0
P3	12	2	3
P4	2	6	2
P5	9	16	4

Find the average turnaround time, average waiting time and average response time for each of the following scheduling algorithm along with their Gantt chart illustrating the execution of these processes:

➤ FCFS (Consider the order specified in the table),
➤ SJF (Non preemptive),
➤ SRTF,
➤ Non preemptive Priority based scheduling,
➤ Preemptive Priority based scheduling,
➤ Highest Response Ratio Next (Consider the order specified in the table),
➤ Round robin scheduling (quantum =2ms)

Which of the algorithms results in the minimum average waiting time over all processes?

8. Consider the set of processes with arrival time (in milliseconds), CPU burst time (in milliseconds), and priority (**lowest number implies high priority**) as shown below.

Process	Arrival time	Burst Time	Priority
P1	0	4	3
P2	0	2	1
P3	1	3	2
P4	2	2	4

Find the average turnaround time, average waiting time and average response time for each of the following scheduling algorithm along with their Gantt chart illustrating the execution of these processes:

- ➢ FCFS (Consider the order specified in the table),
- ➢ SJF (Non preemptive),
- ➢ SRTF,
- ➢ Non preemptive Priority based scheduling,
- ➢ Preemptive Priority based scheduling,
- ➢ Highest Response Ratio Next (Consider the order specified in the table),
- ➢ Round robin scheduling (quantum =2ms)

Which of the algorithms results in the minimum average waiting time over all processes?

9. Consider the following four processes with arrival times (in milliseconds) and their length of CPU bursts (in milliseconds) as shown below:

Process	Arrival time	Burst Time
P1	0	3
P2	1	1
P3	3	3
P4	4	x

Find the value of x, such that the average waiting time of the processes is 1 millisecond, if the processes execute on a single processor using SRTF scheduling.

10. Consider a multilevel feedback queue scheduling (MLFBQ) with three queues q1, q2 and q3, where q1 has the highest priority and q3 has the lowest priority. q1 and q2 use round robin algorithm with time quantum equal to 3 and 5 milliseconds respectively. q3 uses first-come first-serve algorithm. Assume the arrival time of all processes as 0. A process entering the ready queue will put in queue 0. Processes in queue q1, q2 will be demoted to lower priority queue, if not completed on specified time quantum. Find the average waiting time (A.W.T) and average turnaround time (A.T.A.T) for executing the following process?

process	Burst time
P1	8
P2	22
P3	4
P4	12

11. Two concurrent processes P and Q are executing the following instructions. Synchronize the execution of P and Q with suitable semaphore operations using the two Boolean

semaphores S and T. Also suggest the initial values of S and T such that the execution of the processes will print the sequence 00110011…

Process P	Process Q

While(true)
{
    Print("1");
    Print("1");
}
	While(true)
	{
	    Print("0");
	    Print("0");
	}

12. Two concurrent processes P and Q are executing the following instructions. Synchronize the execution of P and Q with suitable semaphore operations using the two Boolean semaphores S and T and proper initialization of the semaphore values, so that the final outcome will be in the following order:

Process P	Process Q
Print("1"); Print("2");	Print("3"); Print("4");

a) 1 3 2 4   b) 3 1 2 4