1. Suppose the time to service a page fault is on the average 50 milliseconds, while a memory access takes 70 microsecond. Calculate average memory access time if system maintains 75% hit ratio?
2. A CPU generates 32-bit virtual addresses and 64 bit physical address. The page size is 4 KB. Calculate
    a. Total number of bits needed to address a page in virtual address
    b. Total number of bits needed to address a frame in physical address
    c. Size of the physical address space
    d. Size of the virtual address space
3. Consider Peterson's algorithm for mutual exclusion between two concurrent processes i and j. The program executed by process is shown below.

```
repeat
  flag [i] = true;
  turn = j;
  while ( P )
      do no-op;
  Enter critical section
      perform actions
  exit critical section
  flag [i] = false;
  Perform other non-critical section actions.
until false;
```

What should be the value of predicate P in the while loop for the program to guarantee mutual exclusion? How this predicate P ensures mutual exclusion?

4. Consider the following memory address references:

    0347, 0732, 0679, 0732, 0642, 0478, 0425, 0324, 0368, 0841, 0974

    What will the reference string corresponding to the addresses given above (assuming page size is 100 bytes)? How many page faults will occur with this reference string assuming that the process can have only one frame?
5. Consider a disk system with 120 cylinders. The requests to access the cylinders occur in following sequence:

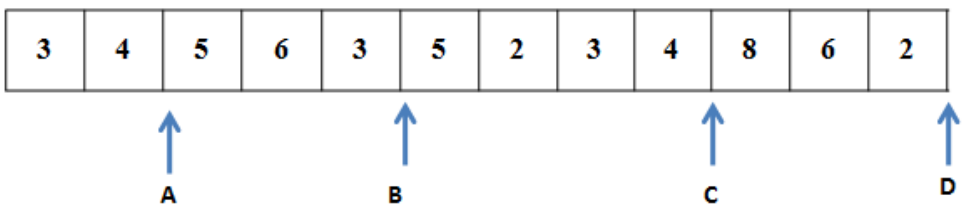
    7, 19, 73,14, 2, 15, 6, 20, 25, 4, 34, 10.

    Assuming that the head is currently at cylinder 46, what is the total head movement to satisfy all requests in queue using:
    a. Shortest seek time first
    b. LOOK
6. Suppose there is a system with 130 KB of memory with no memory initially allocated. Given the following sequence of requests by the processes, show the

memory layout at intermediate stages for first best fit and worst fit allocation algorithm

Process No.	Nature of request	Amount of memory requested in KB)
P0	Allocation	25
P1	Allocation	30
P2	Allocation	15
P3	Allocation	50
P0	De-allocation	
P2	De-allocation	
P4	Allocation	12
P5	Allocation	22

7. Assuming a 1-KB page size, what are the page numbers and offsets for the following address reference (provided as decimal numbers):
   a. 2378
   b. 19360
8. Consider a paging system with the page table stored in memory.
   (i) If a memory reference takes 200 nanoseconds, how long does a paged memory reference take?
   (ii) If we add TLBs and 80% of all page table references are found in the TLBs, what is the effective memory access time? Assume that the time taken to access a TLB is 20nanoseconds.
9. Consider two concurrently running processes P1 with a statement s1 and P2 with a statement s2. Suggest a solution to the synchronization problem using Semaphores so that s2 be executed only after s1 has completed.
10. Consider a page reference string as below and number of page frames given to the process = 3



Show the content of stack at location A, B, C, D, if stack maintains the most recent page references?

11. Consider the following code fragment executed by a process of PID=1055.

```
int main()
{
```

```
int a=5;
if (fork() == 0)
  { a = a + 5;
    b= getppid();
    printf("%d, %d \n", a, b);
  }
else
  { c = a - 5;
    d= getpid();
    printf ("%d, %d \n", c, d);
  }
return 0;
}
```

Write the output of a, b, c, d?

12. Consider a disk drive has 200 cylinders numbered from 0 to 199. The request for 62 is being serviced and is moving towards track 99 and the disk request queue contains read/write requests for the sectors on tracks 184, 55, 103, 96 and 197, respectively. What is the total number of head movements needed to satisfy the requests in the queue using:
    i. FCFS
    ii. SCAN
    iii. LOOK