Indian Institute of Engineering Science and Technology, Shibpur
Five year Dual Degree (B.Tech-M.Tech) 5th Semester Examination 2018
Operating Systems
IT – 502

Full Marks: 70 **Time: 3 Hours**

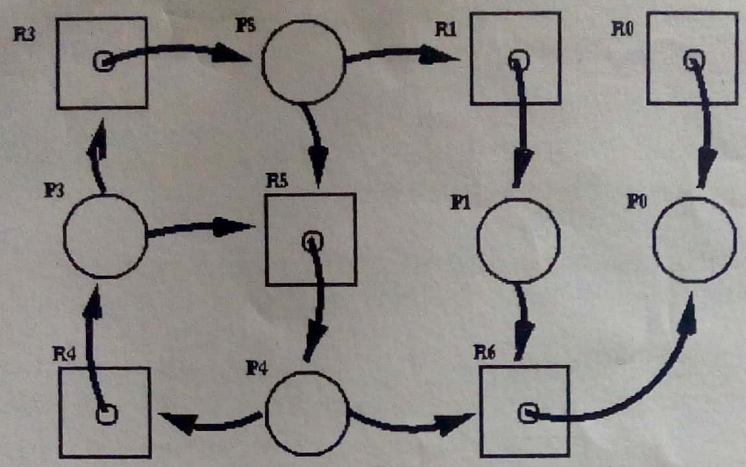
Answer any five questions.

1. a) What is a process table? Some operating systems implement per-user process table instead of system-wide process table. Why? Give reasons in favor of both the implementations. [3]
b) Suppose a system creates 10 processes (P_1, P_2, …, P_{10}) with process ids 1, 2, …, 10 which corresponds to first 10 entries in the process table. Now, P3, P5, and P7 terminates, what changes will be made in the process table? Now, another process P is created by the system, what will be the process id of the new process P? Justify your answer. [3]
c) To which queue a running process P is transferred after its time quantum expires? Explain why there is a need for a separate long-term scheduler? [3]
d) Explain what is meant by cascading termination? Give one disadvantage of cascading termination. [3]
e) What do you understand by an interrupt handler? [2]

2. a) Give two disadvantages of kernel level threads. [3]
b) Explain the Selfish Round Robin scheduling policy. Explain whether a particular process can face the problem of starvation in this policy. [4+2]
c) Prove that, in Lottery Scheduling, a client's throughput is proportional to ticket allocation with accuracy, which improves with $\sqrt{n}$ where n is the number of identical lotteries held. [5]

3. a) Explain how CFS (Completely Fair Scheduler used in Linux), uses Red-Black tree to schedule processes. [4]
b) Explain clearly, with an example, how race condition can occur when two different processes modify a common variable in a system implementing the Round Robin scheduling algorithm. [3]
c) Explain how it will affect the system performance if a solution to the critical section problem does not satisfy the bounded waiting condition? [3]
d) Give and explain the implementation of binary semaphore. [4]

4. a) Define deadlock. What is a circular wait condition? [2+2]
b) Prove that cycle in the Resource Allocation Graph (RAG) is a necessary condition but not a sufficient condition for a deadlock to occur. [3]
c) Explain why we cannot use RAG for deadlock avoidance where there are multiple instances of resource types. [3]
d) Write the advantage of using wait-for-graph as compared to RAG. Draw the wait-for-graph for the following RAG



[4]

5. a) Sketch a memory management system using paging with TLB. Initially when a process starts state the content of the TLB as well as the page table of the corresponding process. Write down the steps to explain how the TLB and page table entries are populated. [3+2]
b) Paging does not solve the problem of internal fragmentation – comment. Also, derive an expression for the expected amount of internal fragmentation in terms of the number of processes and page size. [3+2]
c) Derive and explain the effective access time (EAT) where a two-level paging system with TLB is used. [4]

6. a) Write the different benefits of using demand paging with explanation. [3]
b) Find the number of page-faults when the following page replacement algorithm is used given the page reference string as 1, 2, 3, 4, 1, 2, 3, 4, 1, 2, 3, 4, 5
i) FIFO ii) LRU iii) OPT [6]
c) Explain the NUR (Not Used Recently) page replacement algorithm. Why is it better than LRU page replacement algorithm? [3+2]

7. a) Explain why the size of a working set increases first when the process execution migrates from one locality to another. [3]
b) What is the disadvantage when the directory implementation uses a linear list? [2]
c) Write one advantage and one disadvantage of using indexed disk allocation. [3]
d) Unix uses 9 direct pointers, 1 single indirect, 1 double indirect, and 1 triple indirect pointer in an inode for disk allocation. Explain how are they used. [4]
e) What is the disadvantage of using bit-vector for free space management of disk?[2]

8. a) Explain the following disk scheduling algorithms: i) SSTF ii) C-SCAN iii) C-LOOK. Why is it advantageous to use C-LOOK in place of C-SCAN? [6+2]
b) Why RAID level 0 is not a true RAID level? Why is RAID level one more expensive than others? Explain how block striping can improve the read throughput. [2+2+2]

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Answer any five questions.

1. a) Explain how copy-on-write helps in efficient creation of processes in UNIX. [3]
   b) Write the limitations of user-level threads. [3]
   c) Describe the m-to-n thread model. Describe its advantage over 1-to-1 model. [3]
   d) Draw and explain the process state diagram. [3]
   e) Explain how worker threads can improve the performance of a system. [2]

2. a) Write down the three conditions to be satisfied by a solution to a critical section problem. [4]
   b) Explain the test-and-set instruction. Show how it can be used to solve critical section problem. [3+3]
   c) Let the three processes P, Q, and R has 75, 150, 300 tickets respectively. Let the large number be N=3000. If time quantum q is 100 milliseconds, then find out the average waiting time when stride scheduling is used. [4]

3. a) Define 'safe state' of a system. 'If a system is in unsafe state, it implies a deadlock' – comment. [4]
   b) State the deadlock detection algorithm and explain its time complexity. [6]
   c) Explain how using dynamic loading, better memory utilization is achieved. 'Dynamic linking is useful for libraries' – explain. [4]

4. a) How does paging solve the problem of external fragmentation? Does paging also solve the problem of internal fragmentation? Explain. [3]
   b) Show how the logical address is translated to physical address in paging with TLB. [4]
   c) 'The content of PTBR (Page Table Base Register) does not change during a context switch' – justify. Why some of the entries in TLB are wired down? [4]
   d) Derive the expression for Effective Access Time (EAT) in a system which implements demand paging with TLB and two-level paging scheme. [3]

5. a) Describe the main disadvantage of using inverted page table and provide a solution to overcome it. [4]
   b) Explain the steps of address translation in segmentation with paging with the help of a diagram. [4]
   c) What is a page fault? Write down the steps taken by the Operating System when a page fault happens. [4+2]

6. a) Explain Belady's anomaly. [2]
   b) What is a reference bit? How is it used in the second-chance page replacement algorithm? [2+4]
   c) State the NUR (Not Recently Used) page replacement algorithm. [3]
   d) Give arguments in favor of or against using global page replacement and local page replacement. [3]

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7. a) What is thrashing? Which factors should be considered for deciding the working set window size? [2+3]
   b) Explain the difference between Buddy system allocator and Fibonacci allocator. [3]
   c) Under what condition prepaging can be advantageous and disadvantageous? [3]
   d) Define TLB-reach. Explain how you can support multiple page sizes. [3]

8. a) Explain the linked disk allocation method. What are its advantages and disadvantages? [4]
   b) On a disk there are 200 cylinders (0-199) and the request queue is for the blocks on cylinders 98, 183, 37, 122, 14, 124, 65, 67, currently the R/W head is at the cylinder 53. What is the total number of cylinders travelled when i) FCFS ii) C-SCAN disk scheduling algorithm is used? [6]
   c) Write a short note on FAT (File Allocation Table). [4]