**Question 1 (25 Points).**

Consider the following snapshot of a system. There are three types of resources: E, F and G and Four processes P0, P1, P2 and P3.

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Process** | **Allocation** | | | **Max** | | | **Available** | | |
| **E** | **F** | **G** | **E** | **F** | **G** | **E** | **F** | **G** |
| **P0** | 1 | 0 | 1 | 4 | 3 | 1 | 3 | 3 | 0 |
| **P1** | 1 | 1 | 2 | 2 | 1 | 4 |  |  |  |
| **P2** | 1 | 0 | 3 | 1 | 3 | 3 |  |  |  |
| **P3** | 2 | 0 | 0 | 5 | 4 | 1 |  |  |  |

Answer the following questions using the banker's algorithm:

(a) What is the content of the matrix Need? **(5 Points)**

(b) Is the system in the safe state? If yes, write the safe sequence of processes. Show the detailed steps. **(1+2+12 Points)**

(c) If a request from process P3 arrives for (3,3,1), can the request be granted immediately? If the answer is yes then write the reason. If the answer is no, then also write the reason. **(5 Points)**

**Question 2 (30 Points)**. Consider a main memory with five page frames and the following sequence of page references 3, 8, 2, 3, 9, 1, 6, 3, 8, 9, 3, 6, 2, 1, 3.

(a) Calculate number of page faults using Optimal and Least Recently Used (LRU) algorithm. **(14 + 14 points)**

(b) Which algorithm is efficient for this problem? **(2 Points)**

**Question 3 (25 Points).** Suppose, the disk drive has 100 cylinders, numbered 0 to 99. The drive is currently serving a request at cylinder number 49. Calculate the time required to satisfy the following pending disk requests if it takes 2ns/head movements using SSTF disk scheduling algorithm.

20, 34, 12, 50, 24, 44, 65, 78, 33.

**Question 4 (20 Points)**

(a) Consider a page size of 512 bytes. Find the physical address if the logical address is i) 588 and

ii) 1124. Consider the following page table. **(10 Points)**

|  |  |
| --- | --- |
| **Page Number** | **Frame** |
| 0 | 5 |
| 1 | 4 |
| 2 | 6 |
| 3 | 1 |

(b) A counting semaphore S is initialized to 7. Then, 20 P operations and 15 V operations are performed on S. What is the final value of S? **(5 Points)**

(c) Does the following code supports Mutual Exclusion and Progress or not? Let's assume, turn is a Boolean variable randomly initialized. **(5 Points)**

|  |  |
| --- | --- |
| **Process P1** | **Process P2** |
| Entry Section: while(turn == 1);  (critical section);  Exist Section: turn=0; | Entry Section: while(turn == 0);  (critical section);  Exist Section: turn=1; |