**一、虚存（共1小题，每小题10 分，共10 分）**

Virtual memory uses a page table to track the mapping of virtual addresses to physical addresses. The following data constitutes a stream of virtual addresses as seen on a system. Assume 4 KiB pages, a 4-entry fully associative TLB, and true LRU replacement. If pages must be brought in from disk, increment the next largest page number.

2228,48871,34588,13197,4670,49225,12608

TLB

|  |  |  |
| --- | --- | --- |
| Valid | Tag | Physical Page Number |
| 1 | 11 | 12 |
| 1 | 7 | 4 |
| 1 | 3 | 6 |
| 0 | 4 | 9 |

Page table （画出Page Table的最终结果）

|  |  |  |
| --- | --- | --- |
| Index | Valid | Physical Page or in Disk |
| 0 | 1 | 5 |
| 1 | 0 | Disk |
| 2 | 0 | Disk |
| 3 | 1 | 6 |
| 4 | 1 | 9 |
| 5 | 1 | 11 |
| 6 | 0 | Disk |
| 7 | 1 | 4 |
| 8 | 0 | Disk |
| 9 | 0 | Disk |
| 10 | 1 | 3 |
| 11 | 1 | 12 |

Given the address stream shown, and the initial TLB and page table states provided above, show the final state of the system. Also list for each reference if it is a hit in the TLB, a hit in the page table, or a page fault， fill in the following table.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Address | Virtual Page | TLB H/M | TLB | | |
| Valid | Tag | Physical Page |
| 2228  (8B4H) | 0 | TLB miss  PT hit | 1 | 11 | 12 |
| 1 | 7 | 4 |
| 1 | 3 | 6 |
| 1(last access 0 | 0 | 5 |
| 48871  (BEE7H) | 11 | TLB hit | 1(last access 1 | 11 | 12 |
| 1 | 7 | 4 |
| 1 | 3 | 6 |
| 1(last access 0) | 0 | 5 |
| 34588  (871CH) | 8 | TLB miss  PT hit  PF | 1(last access 1) | 11 | 12 |
| 1(last access 2) | 8 | 13 |
| 1 | 3 | 6 |
| 1(last access 0) | 0 | 5 |
| 13197  (338DH) | 3 | TLB hit | 1(last access 1) | 11 | 12 |
| 1(last access 2) | 8 | 13 |
| 1(last access 3) | 3 | 6 |
| 1(last access 0) | 0 | 5 |
| 4670  (123EH) | 1 | TLB miss  PT hit  PF | 1(last access 1) | 11 | 12 |
| 1(last access 2) | 8 | 13 |
| 1(last access 3) | 3 | 6 |
| 1(last access 4) | 1 | 14 |
| 49225  (0C049H) | 12 | TLB miss  PT miss | 1(last access 5) | 12 | 15 |
| 1(last access 2) | 8 | 13 |
| 1(last access 3) | 3 | 6 |
| 1(last access 4) | 1 | 14 |
| 12608  (3140H) | 3 | TLB hit | 1(last access 5) | 12 | 15 |
| 1(last access 2) | 8 | 13 |
| 1(last access 6) | 3 | 6 |
| 1(last access 4) | 1 | 14 |