**Aleena Raza (L1F17BSCS0155)**

**Assignment # 4**

Consider the MIPS processor with the following Specifications;

1. Main Memory 32G Byte
2. Cache 4K Byte
3. The processor can read and write 64 bits at a time.
4. **Draw the Direct Mapping**

* Offset:

System = 64bit = 64/8 = 8 bytes

2^x = 8 = 3 bits

* Index:

Cache = 4kb = (2^2) (2^10) = 2^12 = (2^12)/8 = 2^9 bytes

9 bits = index

* Tag:

Main Memory= 32 GB = (2^5) (2^30) = 2^35 bytes

35-9 -3 =23 bits

23 bits = tag

1. **Draw the Fully Associative Mapping.**

* Offset: System= 64bit = 64/8 =8 bytes

2^x = 8 = 3 bits

* Tag: Main Memory= 32 GB = (2^5) (2^30) = 2^35 bytes =35 -3 = 32 bits

Tag = 32 bits

Cache entries:12 - 3 = 9 bits

1. **Identify the cache Miss/Hit for the following address for both part a and b**
2. 1 00 0000 1111 0000 1010 0000 0000 1010 1111
3. 1 00 0000 1111 0000 1010 0000 0000 1010 1101
4. 1 00 0000 1111 0000 1010 0000 0000 1010 0011
5. 1 00 0000 1111 0000 1010 0000 0000 1011 1111
6. 1 00 0000 1111 0000 1010 0000 0110 1010 1111
7. 1 00 0000 1111 0000 1010 0000 1110 1010 1111
8. 1 00 0000 1111 0000 1011 0000 0000 1010 1111
9. 1 00 0000 1111 0000 1011 0000 0000 1010 1001
10. 1 00 0000 1111 0000 1011 0000 0000 1010 1101
11. 1 10 0000 1111 0000 1010 0000 0000 1011 1111

**Direct Memory**

1. 1 00 0000 1111 0000 1010 0000 0000 1010 1111

* 0000 1010 1=21
* MISS

|  |  |  |  |
| --- | --- | --- | --- |
| **Index** | **TAG** | **Data** | **Valid Bit** |
| 21 | 1 00 0000 1111 0000 1010 0000 | B: 2179022869 W: 0- 7 | 0 |

1. 1 00 0000 1111 0000 1010 0000 0000 1010 1101

* 0000 1010 1=21
* HIT

|  |  |  |  |
| --- | --- | --- | --- |
| **Index** | **TAG** | **Data** | **Valid Bit** |
| 21 | 1 00 0000 1111 0000 1010 0000 | B: 2179022869 W: 0- 7 | 1 |

1. 1 00 0000 1111 0000 1010 0000 0000 1010 0011

* 0000 1010 0=20
* MISS

|  |  |  |  |
| --- | --- | --- | --- |
| **Index** | **TAG** | **Data** | **Valid Bit** |
| 20 | 1 00 0000 1111 0000 1010 0000 | B: 2179022868 W: 0- 7 | 0 |
| 21 | 1 00 0000 1111 0000 1010 0000 | B: 2179022869 W: 0- 7 | 1 |

1. 1 00 0000 1111 0000 1010 0000 0000 1011 1111

* 0000 1011 1=23
* MISS

|  |  |  |  |
| --- | --- | --- | --- |
| **Index** | **TAG** | **Data** | **Valid Bit** |
| 20 | 1 00 0000 1111 0000 1010 0000 | B: 2179022868 W: 0- 7 | 0 |
| 21 | 1 00 0000 1111 0000 1010 0000 | B: 2179022869 W: 0- 7 | 1 |
| 23 | 1 00 0000 1111 0000 1010 0000 | B: 2179022871 W: 0- 7 | 0 |

1. 1 00 0000 1111 0000 1010 0000 0110 1010 1111

* 0110 1010 1=213
* MISS

|  |  |  |  |
| --- | --- | --- | --- |
| **Index** | **TAG** | **Data** | **Valid Bit** |
| 20 | 1 00 0000 1111 0000 1010 0000 | B:2179022868 W: 0- 7 | 0 |
| 21 | 1 00 0000 1111 0000 1010 0000 | B: 2179022869 W: 0- 7 | 1 |
| 23 | 1 00 0000 1111 0000 1010 0000 | B: 2179022871 W: 0- 7 | 0 |
| 213 | 1 00 0000 1111 0000 1010 0000 | B: 2179023061 W: 0- 7 | 0 |

1. 1 00 0000 1111 0000 1010 0000 1110 1010 1111

* 1110 1010 1=469
* MISS

|  |  |  |  |
| --- | --- | --- | --- |
| **Index** | **TAG** | **Data** | **Valid Bit** |
| 20 | 1 00 0000 1111 0000 1010 0000 | B: 2179022868 W: 0- 7 | 0 |
| 21 | 1 00 0000 1111 0000 1010 0000 | B: 2179022869 W: 0- 7 | 1 |
| 23 | 1 00 0000 1111 0000 1010 0000 | B: 2179022871 W: 0- 7 | 0 |
| 213 | 1 00 0000 1111 0000 1010 0000 | B: 2179023061 W: 0- 7 | 0 |
| 469 | 1 00 0000 1111 0000 1010 0000 | B: 2179023317 W: 0- 7 | 0 |

1. 1 00 0000 1111 0000 1011 0000 0000 1010 1111

* 0000 1010 1=21
* MISS

|  |  |  |  |
| --- | --- | --- | --- |
| **Index** | **TAG** | **Data** | **Valid Bit** |
| 20 | 1 00 0000 1111 0000 1010 0000 | B: 2179022868 W: 0- 7 | 0 |
| 21 | 1 00 0000 1111 0000 1011 0000 | B: 2179031061 W: 0- 7 | 0 |
| 23 | 1 00 0000 1111 0000 1010 0000 | B: 2179022871 W: 0- 7 | 0 |
| 213 | 1 00 0000 1111 0000 1010 0000 | B: 2179023061 W: 0- 7 | 0 |
| 469 | 1 00 0000 1111 0000 1010 0000 | B: 2179023317 W: 0- 7 | 0 |

1. 1 00 0000 1111 0000 1011 0000 0000 1010 1001

* 0000 1010 1=21
* HIT

|  |  |  |  |
| --- | --- | --- | --- |
| **Index** | **TAG** | **Data** | **Valid Bit** |
| 20 | 1 00 0000 1111 0000 1010 0000 | B: 2179022868 W: 0- 7 | 0 |
| 21 | 1 00 0000 1111 0000 1011 0000 | B: 2179031061 W: 0- 7 | 1 |
| 23 | 1 00 0000 1111 0000 1010 0000 | B: 2179022871 W: 0- 7 | 0 |
| 213 | 1 00 0000 1111 0000 1010 0000 | B: 2179023061 W: 0- 7 | 0 |
| 469 | 1 00 0000 1111 0000 1010 0000 | B: 2179023317 W: 0- 7 | 0 |

1. 1 00 0000 1111 0000 1011 0000 0000 1010 1101

* 0000 1010 1=21
* HIT

|  |  |  |  |
| --- | --- | --- | --- |
| **Index** | **TAG** | **Data** | **Valid Bit** |
| 20 | 1 00 0000 1111 0000 1010 0000 | B: 2179022868 W: 0- 7 | 0 |
| 21 | 1 00 0000 1111 0000 1011 0000 | B: 2179031061 W: 0- 7 | 1 |
| 23 | 1 00 0000 1111 0000 1010 0000 | B: 2179022871 W: 0- 7 | 0 |
| 213 | 1 00 0000 1111 0000 1010 0000 | B: 2179023061 W: 0- 7 | 0 |
| 469 | 1 00 0000 1111 0000 1010 0000 | B: 2179023317 W: 0- 7 | 0 |

1. 1 10 0000 1111 0000 1010 0000 0000 1011 1111

* 0000 1011 1=23
* MISS

|  |  |  |  |
| --- | --- | --- | --- |
| **Index** | **TAG** | **Data** | **Valid Bit** |
| 20 | 1 00 0000 1111 0000 1010 0000 | B: 2179022868 W: 0- 7 | 0 |
| 21 | 1 00 0000 1111 0000 1011 0000 | B: 2179031061 W: 0- 7 | 1 |
| 23 | 1 10 0000 1111 0000 1010 0000 | B: 3252764695 W: 0- 7 | 0 |
| 213 | 1 00 0000 1111 0000 1010 0000 | B: 2179023061 W: 0- 7 | 0 |
| 469 | 1 00 0000 1111 0000 1010 0000 | B: 2179023317 W: 0- 7 | 0 |

**Fully Associative Mapping:**

1. 1 00 0000 1111 0000 1010 0000 0000 1010 1111 ----------- cache

MISS

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Index** | **TAG** | **Data** | **Valid Bit** | **Dirty Bit** |
| 0 | 1 00 0000 1111 0000 1010 0000 0000 1010 1 | B: 2179022869 W: 0- 7 | 0 | 0 |

1. 1 00 0000 1111 0000 1010 0000 0000 1010 1101 ----------- cache

HIT

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Index** | **TAG** | **Data** | **Valid Bit** | **Dirty Bit** |
| 0 | 1 00 0000 1111 0000 1010 0000 0000 1010 1 | B: 2179022869 W: 0- 7 | 1 | 0 |

1. 1 00 0000 1111 0000 1010 0000 0000 1010 0011 ----------- cache

MISS

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Index** | **TAG** | **Data** | **Valid Bit** | **Dirty Bit** |
| 0 | 1 00 0000 1111 0000 1010 0000 0000 1010 1 | B: 2179022869 W: 0- 7 | 1 | 0 |
| 1 | 1 00 0000 1111 0000 1010 0000 0000 1010 0 | B: 2179022868  W: 0- 7 | 0 | 0 |
|  |  |  |  |  |

1. 1 00 0000 1111 0000 1010 0000 0000 1011 1111 ----------- cache

MISS

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Index** | **TAG** | **Data** | **Valid Bit** | **Dirty Bit** |
| 0 | 1 00 0000 1111 0000 1010 0000 0000 1010 1 | B: 2179022869 W: 0- 7 | 1 | 0 |
| 1 | 1 00 0000 1111 0000 1010 0000 0000 1010 0 | B: 2179022868  W: 0- 7 | 0 | 0 |
| 2 | 1 00 0000 1111 0000 1010 0000 0000 1011 1 | B: 2179022871 W: 0- 7 | 0 | 0 |

1. 1 00 0000 1111 0000 1010 0000 0110 1010 1111 ----------- cache

MISS

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Index** | **TAG** | **Data** | **Valid Bit** | **Dirty Bit** |
| 0 | 1 00 0000 1111 0000 1010 0000 0000 1010 1 | B: 2179022869 W: 0- 7 | 1 | 0 |
| 1 | 1 00 0000 1111 0000 1010 0000 0000 1010 0 | B: 2179022868  W: 0- 7 | 0 | 0 |
| 2 | 1 00 0000 1111 0000 1010 0000 0000 1011 1 | B: 2179022871 W: 0- 7 | 0 | 0 |
| 3 | 1 00 0000 1111 0000 1010 0000 0110 1010 1 | B: 2179023061 W: 0- 7 | 0 | 0 |

1. 1 00 0000 1111 0000 1010 0000 1110 1010 1111 ----------- cache

MISS

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Index** | **TAG** | **Data** | **Valid Bit** | **Dirty Bit** |
| 0 | 1 00 0000 1111 0000 1010 0000 0000 1010 1 | B: 2179022869 W: 0- 7 | 1 | 0 |
| 1 | 1 00 0000 1111 0000 1010 0000 0000 1010 0 | B: 2179022868  W: 0- 7 | 0 | 0 |
| 2 | 1 00 0000 1111 0000 1010 0000 0000 1011 1 | B: 2179022871 W: 0- 7 | 0 | 0 |
| 3 | 1 00 0000 1111 0000 1010 0000 0110 1010 1 | B: 2179023061 W: 0- 7 | 0 | 0 |
| 4 | 1 00 0000 1111 0000 1010 0000 1110 1010 1 | B: 2179023317 W: 0- 7 | 0 | 0 |

1. 1 00 0000 1111 0000 1011 0000 0000 1010 1111 ----------- cache

MISS

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Index** | **TAG** | **Data** | **Valid Bit** | **Dirty Bit** |
| 0 | 1 00 0000 1111 0000 1010 0000 0000 1010 1 | B: 2179022869 W: 0- 7 | 1 | 0 |
| 1 | 1 00 0000 1111 0000 1010 0000 0000 1010 0 | B: 2179022868  W: 0- 7 | 0 | 0 |
| 2 | 1 00 0000 1111 0000 1010 0000 0000 1011 1 | B: 2179022871 W: 0- 7 | 0 | 0 |
| 3 | 1 00 0000 1111 0000 1010 0000 0110 1010 1 | B: 2179023061 W: 0- 7 | 0 | 0 |
| 4 | 1 00 0000 1111 0000 1010 0000 1110 1010 1 | B: 2179023317 W: 0- 7 | 0 | 0 |
| 5 | 1 00 0000 1111 0000 1011 0000 0000 1010 1 | B: 2179031061 W: 0- 7 | 0 | 0 |

1. 1 00 0000 1111 0000 1011 0000 0000 1010 1001 ----------- cache

HIT

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Index** | **TAG** | **Data** | **Valid Bit** | **Dirty Bit** |
| 0 | 1 00 0000 1111 0000 1010 0000 0000 1010 1 | B: 2179022869 W: 0- 7 | 1 | 0 |
| 1 | 1 00 0000 1111 0000 1010 0000 0000 1010 0 | B: 2179022868  W: 0- 7 | 0 | 0 |
| 2 | 1 00 0000 1111 0000 1010 0000 0000 1011 1 | B: 2179022871 W: 0- 7 | 0 | 0 |
| 3 | 1 00 0000 1111 0000 1010 0000 0110 1010 1 | B: 2179023061 W: 0- 7 | 0 | 0 |
| 4 | 1 00 0000 1111 0000 1010 0000 1110 1010 1 | B: 2179023317 W: 0- 7 | 0 | 0 |
| 5 | 1 00 0000 1111 0000 1011 0000 0000 1010 1 | B: 2179031061 W: 0- 7 | 1 | 0 |

1. 1 00 0000 1111 0000 1011 0000 0000 1010 1101 ----------- cache

HIT

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Index** | **TAG** | **Data** | **Valid Bit** | **Dirty Bit** |
| 0 | 1 00 0000 1111 0000 1010 0000 0000 1010 1 | B: 2179022869 W: 0- 7 | 1 | 0 |
| 1 | 1 00 0000 1111 0000 1010 0000 0000 1010 0 | B: 2179022868  W: 0- 7 | 0 | 0 |
| 2 | 1 00 0000 1111 0000 1010 0000 0000 1011 1 | B: 2179022871 W: 0- 7 | 0 | 0 |
| 3 | 1 00 0000 1111 0000 1010 0000 0110 1010 1 | B: 2179023061 W: 0- 7 | 0 | 0 |
| 4 | 1 00 0000 1111 0000 1010 0000 1110 1010 1 | B: 2179023317 W: 0- 7 | 0 | 0 |
| 5 | 1 00 0000 1111 0000 1011 0000 0000 1010 1 | B: 2179031061 W: 0- 7 | 1 | 0 |

1. 1 10 0000 1111 0000 1010 0000 0000 1011 1111 ----------- cache

MISS

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Index** | **TAG** | **Data** | **Valid Bit** | **Dirty Bit** |
| 0 | 1 00 0000 1111 0000 1010 0000 0000 1010 1 | B: 2179022869 W: 0- 7 | 1 | 0 |
| 1 | 1 00 0000 1111 0000 1010 0000 0000 1010 0 | B: 2179022868  W: 0- 7 | 0 | 0 |
| 2 | 1 00 0000 1111 0000 1010 0000 0000 1011 1 | B: 2179022871 W: 0- 7 | 0 | 0 |
| 3 | 1 00 0000 1111 0000 1010 0000 0110 1010 1 | B: 2179023061 W: 0- 7 | 0 | 0 |
| 4 | 1 00 0000 1111 0000 1010 0000 1110 1010 1 | B: 2179023317 W: 0- 7 | 0 | 0 |
| 5 | 1 00 0000 1111 0000 1011 0000 0000 1010 1 | B: 2179031061 W: 0- 7 | 1 | 0 |
| 6 | 1 10 0000 1111 0000 1010 0000 0000 1011 1 | B: 3252764695 W: 0- 7 | 0 | 0 |

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