1. A.

and $x5, $x5, $x0

LOOP: sw $x5, 0($x12)

addi $x12, $x12, 4

addi $x5, $x5, 1

bne $x5, $x13, LOOP

jalr $x0, 0($x1)

1. A.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 |
| lw | IF | ID | EX | MEM | WB |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| lw |  | IF | ID | ID | EX | MEM | WB |  |  |  |  |  |  |  |  |  |  |  |  |
| addi |  |  | IF | IF | ID | EX | MEM | WB |  |  |  |  |  |  |  |  |  |  |  |
| bne |  |  |  |  | IF | ID | EX | MEM | WB |  |  |  |  |  |  |  |  |  |  |
| lw |  |  |  |  |  | IF | ID | EX | MEM | WB |  |  |  |  |  |  |  |  |  |
| lw |  |  |  |  |  |  | IF | ID | ID | EX | MEM | WB |  |  |  |  |  |  |  |
| addi |  |  |  |  |  |  |  | IF | IF | ID | EX | MEM | WB |  |  |  |  |  |  |
| bne |  |  |  |  |  |  |  |  |  | IF | ID | EX | MEM | WB |  |  |  |  |  |
| lw |  |  |  |  |  |  |  |  |  |  | IF | ID | Nop | Nop | Nop |  |  |  |  |
| lw |  |  |  |  |  |  |  |  |  |  |  | IF | ID | ID | Nop | Nop | Nop |  |  |
| add |  |  |  |  |  |  |  |  |  |  |  |  | IF | IF | ID | EX | MEM | WB |  |
| addi |  |  |  |  |  |  |  |  |  |  |  |  |  |  | IF | ID | EX | MEM | WB |

B. number of cycle = 9 \* 9,999 + 14 = 90005

Number of instructions = 4 \* 10000 + 2 = 40002

**CPI = 2.25**

1. A.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| I | Branch | State | Predicted | Actual |
| 0 | X | 000 | NT | NT |
| 1 | Z | 000 | NT | T |
| 1 | X | 000 | NT | T |
| 1 | Y | 000 | NT | NT |
| 2 | Z | 001 | NT | T |
| 2 | X | 001 | NT | T |
| 2 | Y | 000 | NT | T |
| 3 | Z | 010 | NT | T |
| 3 | X | 010 | NT | NT |
| 4 | Z | 011 | NT | T |
| 4 | X | 001 | NT | T |
| 4 | Y | 001 | NT | NT |
| 5 | Z | 100 | T | T |
| 5 | X | 010 | NT | T |
| 5 | Y | 000 | NT | T |
| 6 | Z | 101 | T | T |
| 6 | X | 011 | NT | NT |
| 7 | Z | 110 | T | T |
| 7 | X | 010 | NT | T |
| 7 | Y | 001 | NT | NT |
| 8 | Z | 111 | T | T |
| 8 | X | 011 | NT | T |
| 8 | Y | 000 | NT | T |
| 9 | Z | 111 | T | T |
| 9 | X | 100 | T | NT |
| 10 | Z | 111 | T | T |
| 10 | X | 011 | NT | T |
| 10 | Y | 001 | NT | NT |
| 11 | Z | 111 | T | T |
| 11 | X | 100 | T | T |
| 11 | Y | 000 | NT | T |
| 12 | Z | 111 | T | T |
| 12 | X | 101 | T | NT |
| 13 | Z | 111 | T | T |
| 13 | X | 100 | T | T |
| 13 | Y | 001 | NT | NT |
| 14 | Z | 111 | T | T |
| 14 | X | 101 | T | T |
| 14 | Y | 000 | NT | T |
| 15 | Z | 111 | T | T |
| 15 | X | 110 | T | NT |

|  |  |  |  |
| --- | --- | --- | --- |
|  | Number of Predictions | Number of Correct Predictions | Prediction Accuracy |
| Branch X | 100,000 | 33,333 \* 2 – 8 + 3 = 66,661 |  |
| Branch Y | 66,666 | 33,333 (50%) |  |
| Branch Z | 100,000 | 99,996 (only first 4 are wrong) |  |
| total | 266,666 | 199,990 | **~.7499644%** |

1. A.

C = ABS

C = 64K; A = 8; B = 64 bytes

64K = 8 \* 64 \* S

S = 128

**Offset** = log(B) = log(64) = **6 bits**

**Index** = log(S) = log(128) = **7 bits**

**Tag** = 32 – offset – index = 32 – 6 – 7 = **19 bits**