1. Describe what happens with the following instruction executes:
   1. J Loop
   2. LUI $t0, 0xffff
2. Diagram the “stair step” instruction execution for the following instructions. Assume no forwarding:

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | |
| LW $t0, 0($s1) | IF | ID | EX | MEM | WB |  |  |  |  |  |  |  |  |  |  | |
| ADDI $t3, $t0, 1 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | |
| SUB $t2, $t4, $t5 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | |
| SW $t3, 0($s1) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |

1. Diagram the “stair step” instruction execution for the same instructions, but this time, assume forwarding

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
| LW $t0, 0($s1) | IF | ID | EX | MEM | WB |  |  |  |  |  |  |  |  |  |  |
| ADDI $t3, $t0, 1 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| SUB $t2, $t4, $t5 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| SW $t3, 0($s1) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |

1. What is the percent speedup of the execution in problem 3 compared with problem 2?