**COMPUTER ARCHITECTURE**

**ASSIGNMENT # 02**

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**Question # 1)**

Consider the following code running on a single-issue dynamically scheduled processor without speculation. (Tomasulo Algorithm)

fld F2,0(x1) ; (F2) = X(i)

fmul.d F4, F2, F0; (F4) = a\*X(i)

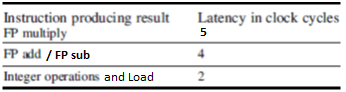
fld F6,0(x2) ; (F6) = Y(i)

fadd.d F6, F2, F6 ; (F6) = a\*X(i) + Y(i)

fsd F6,0(x2) ; Y(i) = a\*X(i) + Y(i)

fsub.d F4, F4,F2 ;

Table below gives the latency of the instructions.



Completely fill the Instruction cycle detail table given below when all instructions are committed

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | issue | exe start | exe end | complete |
| fld F2,0(x1) |  |  |  |  |
| fmul.d F4,F2,F0 |  |  |  |  |
| fld F6,0(x2) |  |  |  |  |
| fadd.d F6,F2,F6 |  |  |  |  |
| fsd F6,0(x2) |  |  |  |  |
| fsub.d F4,F4,F2 |  |  |  |  |

Store can calculate effective addresses still while the value to be written is not available. Also give the, reservation station and FP register status tables when the fsub.d F4, F4, F2 instruction is issued.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  | Reservation Station | | | | | | |
| Name | Busy | op | Vj | Vk | Qj | Qk | A |
| Load1 |  |  |  |  |  |  |  |
| Load2 |  |  |  |  |  |  |  |
| Add1 |  |  |  |  |  |  |  |
| Add2 |  |  |  |  |  |  |  |
| Add3 |  |  |  |  |  |  |  |
| Mult1 |  |  |  |  |  |  |  |
| Std |  |  |  |  |  |  |  |

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Register Status | | | | | | | | | |
| Field | F0 | F2 | F4 | F6 | F8 | F10 | F12 | ..... | F30 |
| Busy |  |  |  |  |  |  |  |  |  |
| Qi |  |  |  |  |  |  |  |  |  |

**Question # 2)**

There are tables given below of correlating predictor (1,2) i.e. it has global history register of size 1 -bit. So there one of the two predictors is selected based on history. Each predictor is a two predictor. So each predictor has 4 states; T, Weakly Taken, Weakly NT and NT. The total no of distinct branches that can be addressed is 4.

|  |  |  |
| --- | --- | --- |
| Total entries | 1st Predictor on each entry  (if History T)  Current state | 2nd predictor on each entry  (if History NT)  Current State |
| 0 | T | T |
| 1 | NT | Weakly Not Taken |
| 2 | Weakly Taken | NT |
| 3 | Weakly Taken | T |

The above table is rearranged in different order below. This format will be used by you to submit the solution.

|  |  |  |  |
| --- | --- | --- | --- |
| Entry No | Branch | Select it when last branch is | Current State of 2-bit predictor |
| 0 | 0 | T | T |
| 1 | 0 | NT | T |
| 2 | 1 | T | NT |
| 3 | 1 | NT | Weakly NT |
| 4 | 2 | T | Weakly Taken |
| 5 | 2 | NT | NT |
| 6 | 3 | T | Weakly Taken |
| 7 | 3 | NT | T |

Assume that last branch executed was T.

Given below is the list of branches to be executed

|  |  |
| --- | --- |
| Branch address | Actual Outcome |
| 234 | T |
| 423 | T |
| 234 | NT |
| 541 | NT |
| 423 | NT |
| 541 | T |
| 440 | T |
| 440 | NT |

To find the branch to which the given branch address will map, simply use the mod function,

i.e. calculate (Branch address) % Total branch entries

Total branch entries are 4 in our example

So 234%4=2.

Hence the predictor selected for 1st branch is 2. To further select one of the two i.e from entries 4 and 5, you have to check the GBH register (1-bit size in this example). Since initial condition is that the last branch executed was T, so entry number 4 will be selected. Its prediction is T and actual branch outcome is also T, so the prediction is true and the predictor is not updated.

Using the procedure described fill the table given below

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Branch Entry No  (0 – 3) | Entry No. of table  (0 -7)  (to identify which one of the two predictors was selected | Prediction | Actual outcome  (It can also serve as GBH. Prior to given code, last branch was true) | Misprediction  (yes/no) | Predictor update |
|
| 234%4=2 | 4 | T | T | No | Change to Taken |
| 423%4=3 | 6 | T | T | No | Change to Taken |
| 234%4=2 | 4 | T | NT | Yes | Change to Weakly Taken |
| 541%4=1 | 3 | NT | NT | No | Change to Not Taken |
| 423%4=3 | 7 | T | NT | Yes | Change to Weakly Taken |
| 541%4=4 | 3 | NT | T | Yes | Change to Weakly NT |
| 440%4=0 | 0 | T | T | No | No Change |
| 440%4=0 | 0 | T | NT | Yes | Change to Weakly Taken |