Indian Institute of Technology, Delhi

FALL, 2011

CSL 211: COMPUTER ARCHITECTURE

Minor 2

Time: One and Half Hours

NOTE: – All answers need to be brief and to the point.
– No questions will be answered. Make any reasonable assumptions.

Total Marks: 50
Total Number of Pages : 2

[1,4,5, and 6] have no part marking.

1. Answer briefly (1-2) lines: (10 marks)

(a) Which algorithm is faster, restoring or non-restoring, for integer division?
(b) Why don't we require forwarding from the WB to the ID/RF stage?
(c) How can we stall a pipeline?
(d) What is the difference between data path and control path?
(e) What is the range of positive denormalized numbers?

2. You are given a large binary number. What is a quick way of finding if it is divisible by a number of the form $2^k - 1$. (5 marks)

3. Prove that the non-restoring integer division algorithm works correctly? (5 marks)

4. Answer briefly (1-2) lines: (10 marks)

(a) What is a delayed branch?
(b) What type of predictor would you use to predict the branches in for loops efficiently, and why?
(c) What type of predictor would you use to predict the branches in a sequence of if-else statements, and why?
(d) Among the following predictors: gshare, pap, gselect, tournament, which predictor do you expect to be the most accurate?
(e) Is the following code sequence amenable to branch prediction. Why or Why not?

```
int status = flip_random_unbiased_coin();
if(status == HEAD)
        print("head");
else
        print ("tail");
```

5. Take a look at the code fragment. (10 marks)

```
LD R1, 100(R1)
LD R2, 100(R2)
ADD R4, R3, R2
STR R4, 10(R2)
LD R5, 100(R6)
STR R6, 0(R5)
BEQ R15, R16, <label>
LD R8, 0(R9)
ADD R5, R8, R8
LD R3, 100(R1)
STR R4, 100(R3)
```

(a) Assuming a traditional MIPS pipeline, how many cycles does this code take to execute? Assume that time starts when the first instruction reaches the WB stage. This means that if I had just one instruction, then it would take exactly 1 cycle to execute (Not 5). Assume that there is no forwarding. Assume that the branch evaluates to not taken.

(b) How many cycles will it take to execute this piece of code with forwarding turned on?

(c) How many cycles will it take to execute this piece of code if we assume that branch prediction is perfect and we have forwarding?

(d) Play the role of a compiler. Rearrange this piece of code to make it execute as fast as possible. (Assume forwarding)

6. If I increase the average CPI by 15%, decrease the instruction count by 30%, and double the frequency, what speedup should I expect, if any, and why? (5 marks)

7. We have assumed uptil now that each memory access requires one cycle. Now, let us assume that each memory access takes two cycles. How will you modify the datapath and the control path of the MIPS pipeline in this case. (5 marks)
