Computer Science 605.411

Problem Set 6
    Name_____

1. a) (10 On our 5-stage MIPS pipeline system, in which stage of the pipeline will a conditional branch instruction reside when the PC is set to the branch target address, if the branch is taken?

b) (10) In which stage of the pipeline would an unconditional branch or jump reside when the PC is set to the branch or jump target address?

2. Suppose that the following instruction sequence executes on our 5-stage MIPS pipeline system that employs data forwarding and a hazard detection unit that causes stalls when necessary. However, on this system, no action is taken for branch or control hazards (i.e. no flushing of the pipeline is performed).

```
              lui    $8,0x200
              ori    $4,$0,1
              sw     $4,16($8)
    loop:     lw     $9,16($8)
              sll    $4,$4,1
              bne    $9,$0,loop
              nop
              addi   $9,$9,-1
              sw     $9,16($8)
              xor    $9,$9,$9
```

a) (10) Does the code sequence contain an infinite loop?

b) (30) If the code does contain an infinite loop, show the contents of each pipeline stage until the bne instruction completes the write-back stage for the second time. Otherwise show the contents of each pipeline stage until all of the instructions have exited the pipeline.

3. (20) A "data dependency" is said to exist when an instruction uses as input the contents of a register written by another instruction ahead of it in the pipeline. Iidentify all data dependencies in the instruction sequence listed in problem 2 above. A "dependent instruction"is one that uses as input a register value written by another instruction ahead of it in the pipeline.

4. (20) A "data hazard" is said to exist when the result or effect produced by a dependent instruction would be incorrect unless the dependency is resolved.   The result or effect is considered incorrect if it would differ from that obtained on the non-pipelined sequential system. Identify all data hazards in the instruction sequence listed in problem 2 above.