

First Name: _____ Last Name: _____

- 1) Associate the hazard type with the second instruction of an instruction pair causing a hazard. Move "Start" to the first instruction.

- No hazard
- 2a. MEM/WB.RegisterRd = ID/EX.RegisterRs
- 1a. EX/MEM.RegisterRd = ID/EX.RegisterRs
- 1b. EX/MEM.RegisterRd = ID/EX.RegisterRt
- Start

```
add $1, $2, $3
add $4, $5, $1
add $6, $1, $2
add $8, $9, $1
add $10, $8, $11
```

Refer to the conditions for detecting hazards.

- 2) Which is NOT a condition for setting the the ForwardA mux select lines to 10, causing forwarding of the ALU result in EX/MEM directly to the ALU's top input?
- EX/MEM.RegWrite
 - ID/EX.RegWrite
 - EX/MEM.RegisterRd != 0
 - EX/MEM.RegisterRd = ID/EX.RegisterRs
- 3) If the forwarding unit sets ForwardA to 10, the ALU's top input comes from _____.
- ID/EX
 - EX/MEM
 - MEM/WB

4) If the forwarding unit sets ForwardA to 01, the ALU's top input comes from _____.

- ID/EX
- EX/MEM
- MEM/WB

5) The forwarding unit sets ForwardA to 01 for which type of hazard?

- EX hazard
- MEM hazard

6) Refer to the conditions for detecting hazards.

Match the hazard detection conditions and actions to the corresponding code snippet.

- The register written by the load is read by the next instruction's first operand.
- Inserts a bubble.
- The register written by the load is read by the next instruction's second operand.
- Detects a load instruction.

```
if (ID/EX.MemRead and
((ID/EX.RegisterRt = IF/ID.RegisterRs) or
(ID/EX.RegisterRt = IF/ID.RegisterRt)))
stall the pipeline
```

7) For the code below,

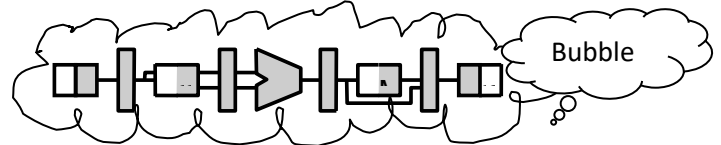
a. On the diagram, mark and identify all the data dependencies in the code given below and identify which dependencies will cause data hazards without forwarding hardware.

```
lw    $t1, 0($t0)
lw    $t2, 4($t0)
add   $t3, $t1, $t2
sw    $t3, 12($t0)
lw    $t4, 8($t0)
add   $t5, $t1, $t4
sw    $t5, 16, $t0)
```

b. Assuming there is no special hardware that is added for forwarding. Add “nop” instructions to the code to avoid the data hazards.

c. How many clock cycles does it take to execute the code in part b.

d. Using forwarding, clearly show how it can be used to resolve data hazards. If a bubble needs to be added, simply make a marking as below. (use the next page for your answer)



e. How many clock cycles does part d take?

f. Indicate what each stage will do during the 5th clock cycle.

g. Assume we can utilize a compiler to reorder the code to remove / minimize stalled cycles. On the updated code, using forwarding, show it be used to resolved data hazards.

