

# EGC442

## Class Notes

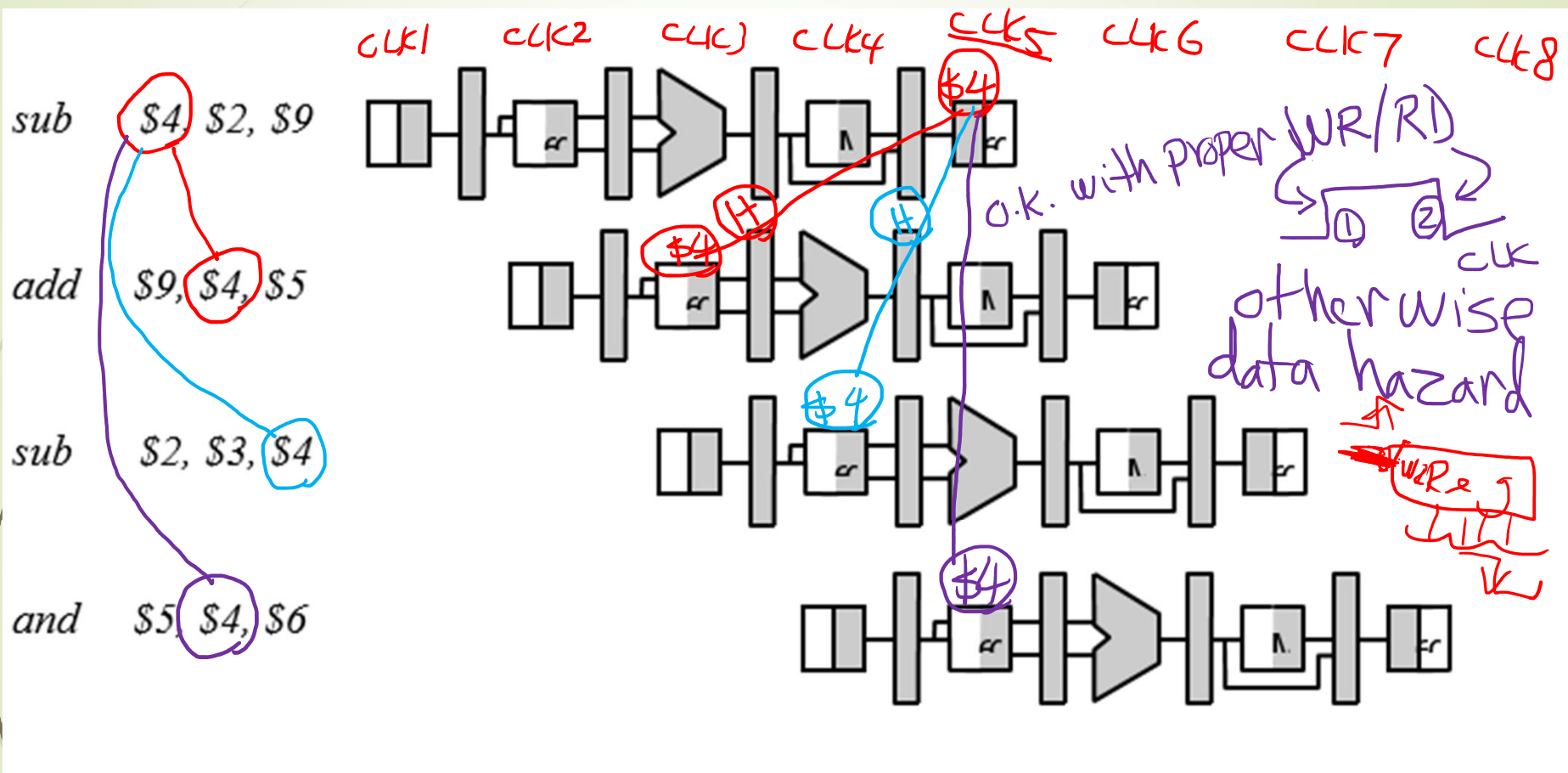
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5 a. On the diagram, mark and identify all the data dependencies in the code given below and identify which dependencies will cause data hazards without forwarding hardware.



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

```

sub    $4, $2, $9
nop
nop
nop
add    $9, $4, $5
sub    $2, $3, $4
and    $5, $4, $6
  
```

with  
no  
hardware  
support  
at all

```

sub    $4, $2, $9
nop
nop
add    $9, $4, $5
sub    $2, $3, $4
and    $5, $4, $6
  
```

with CLK

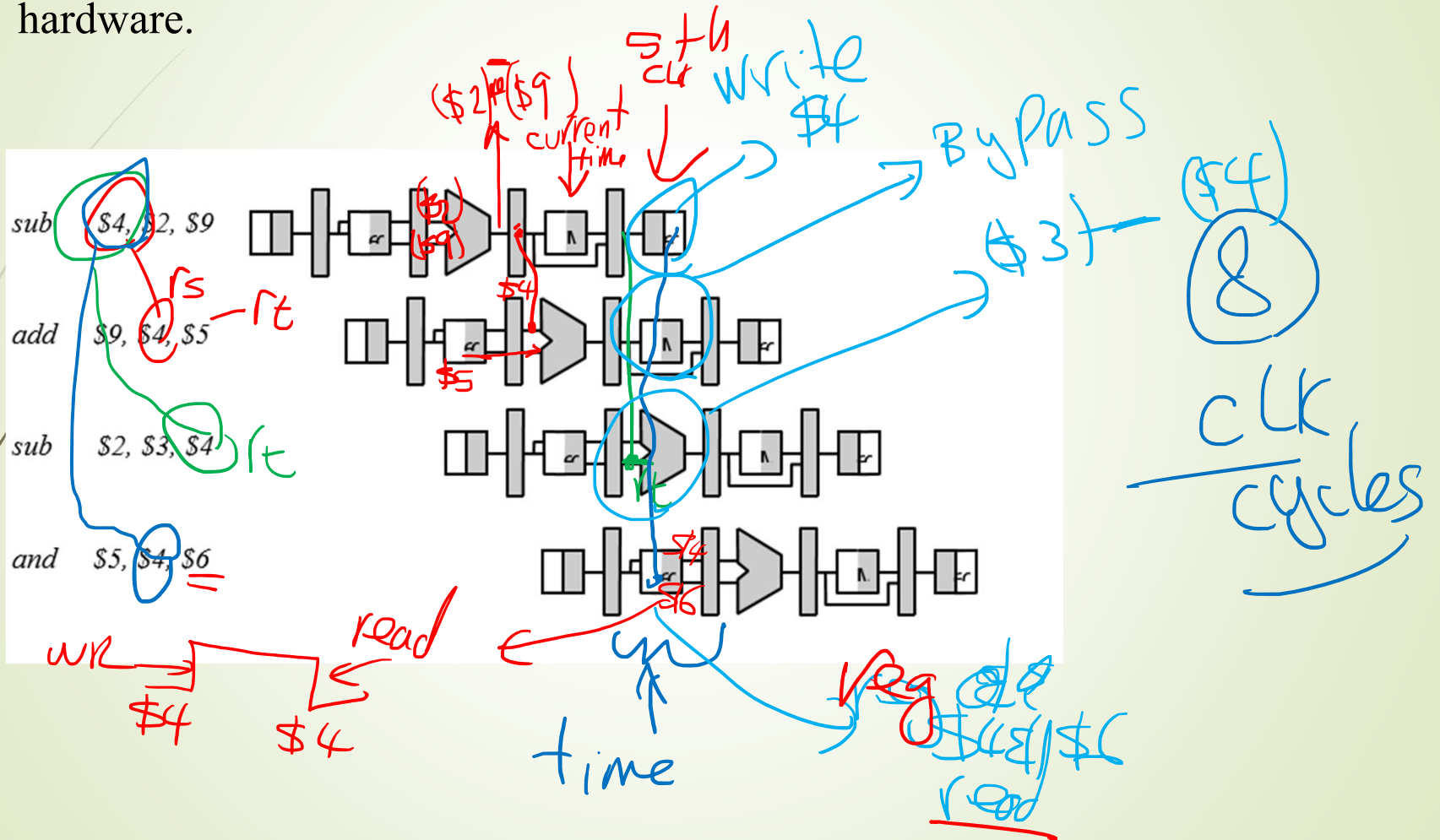
WR →  
← read support

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

~~11 CLK~~

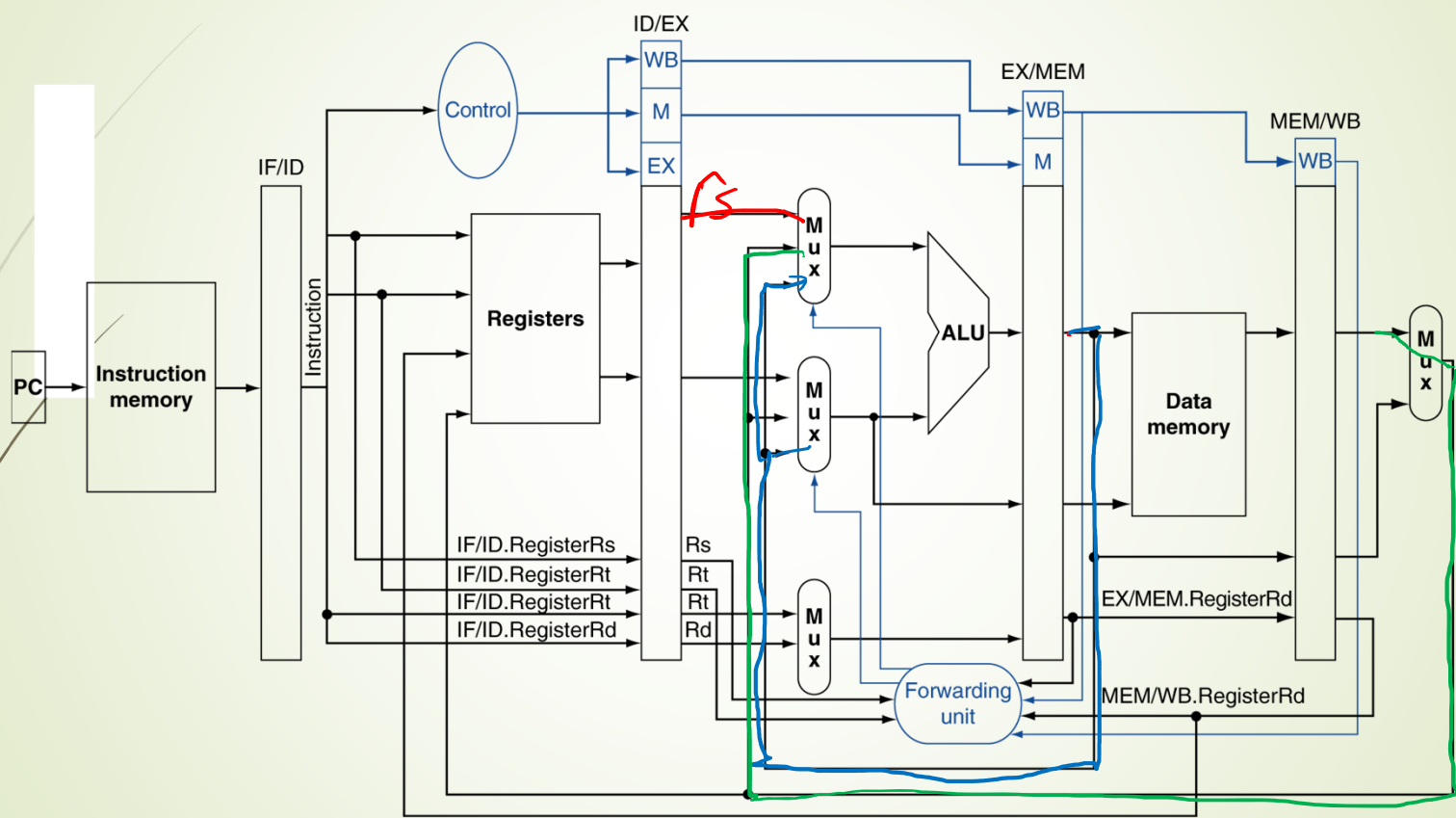
10 CLK

d. 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.



# Datapath with Forwarding

00	Register file
01	Mem. or earlier ALU
10	Prior ALU



e. How many clock cycles does part d take?

8 CLK cycles

f. Indicate what each stage will do during the 5<sup>th</sup> clock cycle.

register read: \$6 & \$4 (and inst.)

ALU: \$3 - \$4 (sub inst.)

Memory: bypasses data (add inst.)

register write: \$4 is updated (sub inst.)

note: next instruction after and is fetched.

3) Given the following set of instructions,

- Identify all the dependencies.
- Indicate which dependency results in data hazard.
- Using NOP's, remove all data hazards.
- How many clock cycles does it take to execute the code segment? **23**
- Rearrange the code in such a way that the overall result is not altered and the number NOP's used is minimized.
- How many clock cycle would code in part e takes?

lw \$t1, 0(\$t0)

lw \$t2, 4(\$t0)

add \$t3, \$t1, \$t2

sw \$t3, 12(\$t0)

lw \$t4, 8(\$t0)

add \$t5, \$t1, \$t4

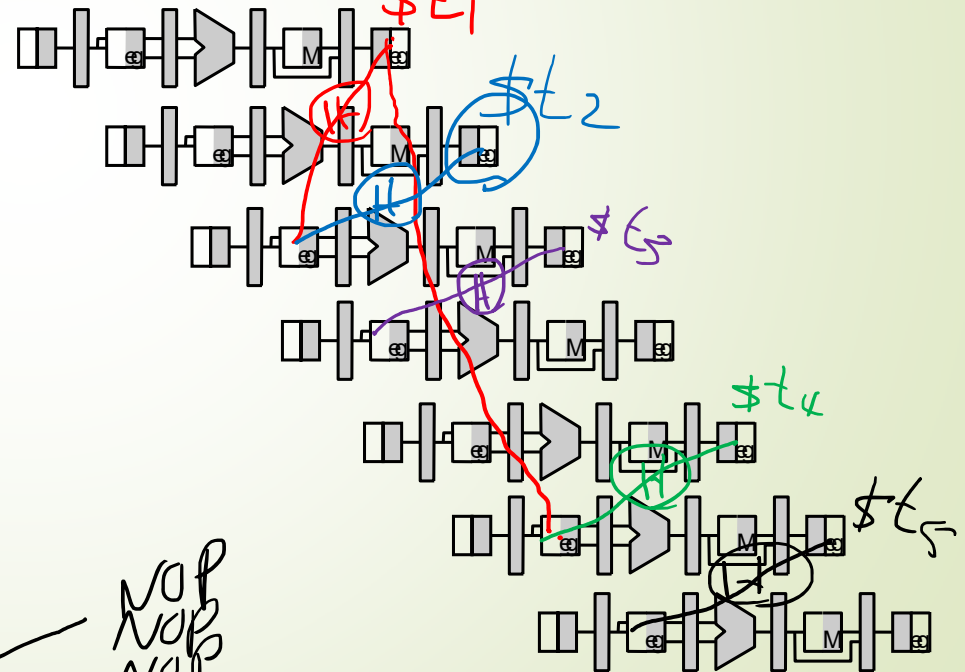
sw \$t5, 16(\$t0)

NOP  
NOP  
NOP

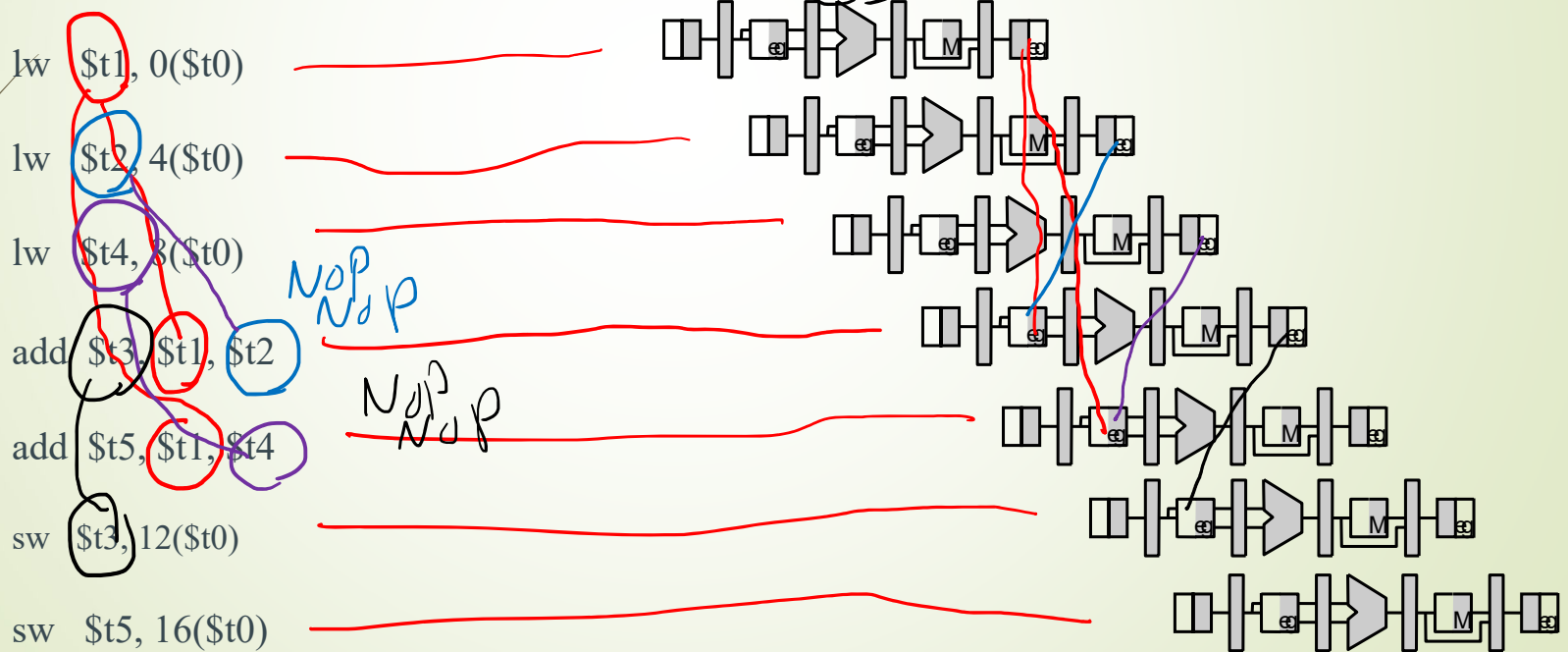
NOP  
NOP  
NOP

NOP  
NOP  
NOP

NOP  
NOP  
NOP



- 1) Given the following set of instructions,
  - a. Identify all the dependencies.
  - b. Indicate which dependency results in data hazard.
  - c. Using NOP's, remove all data hazards.
  - d. How many clock cycles does it take to execute the code segment?
  - e. Rearrange the code in such a way that the overall result is not altered and the number NOP's used is minimized.
  - f. How many clock cycle would code in part e takes? 15





# Data Hazards

- Problem with starting next instruction before first is finished
- Dependencies that “go backward in time” are data hazards

