

The Pipeline

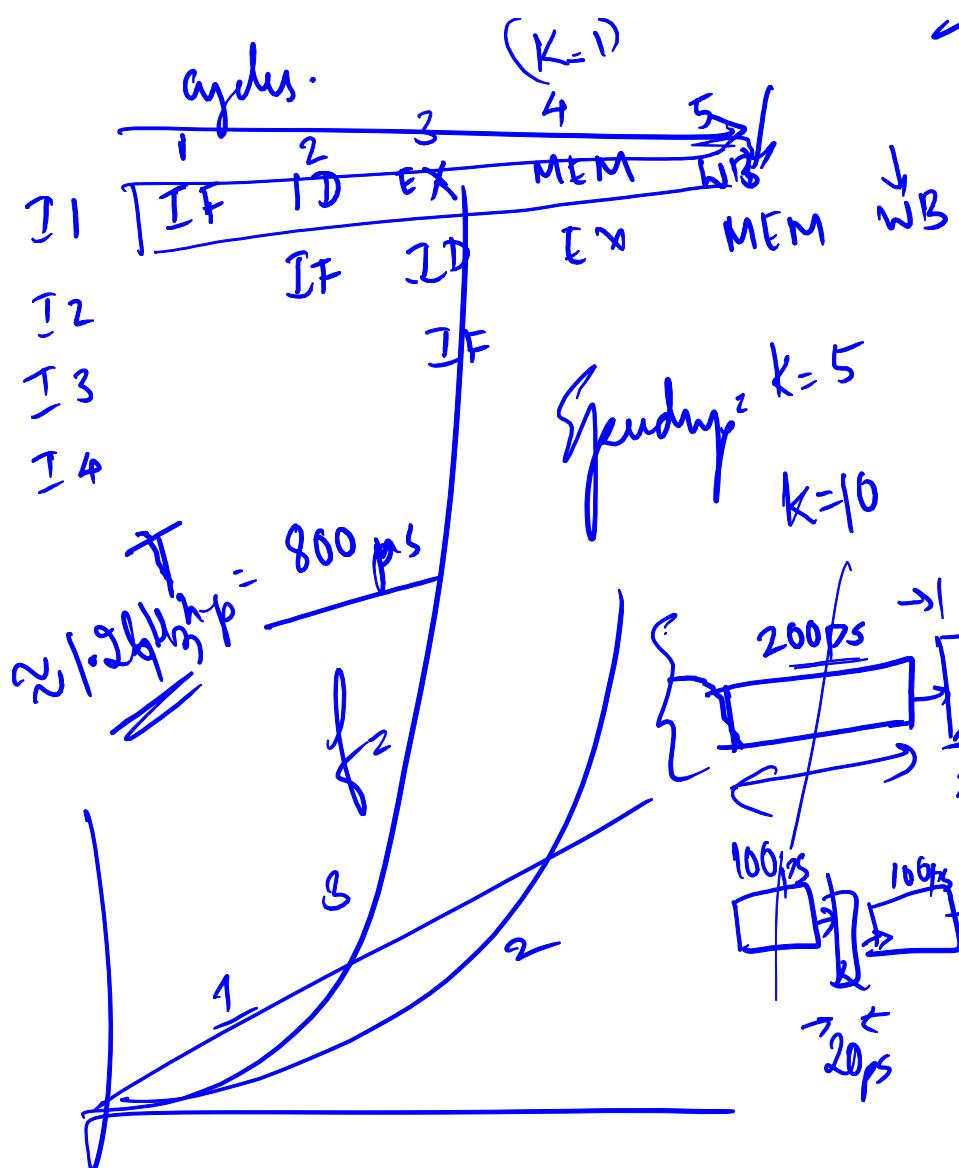
Outline

- Why Pipeline?
 - How to pipeline?
- Speedup of the pipeline
- Pipelined datapath
 - Execution of instructions
 - Pipeline Timing diagram
- Dependences, Hazards
 - Structural, Data - Stalling, Forwarding
- Control Hazards, Branch prediction

$$\text{Speedup} = \frac{T_{n-p}}{T_p} = \frac{n * K}{n + (K-1)} \approx K$$

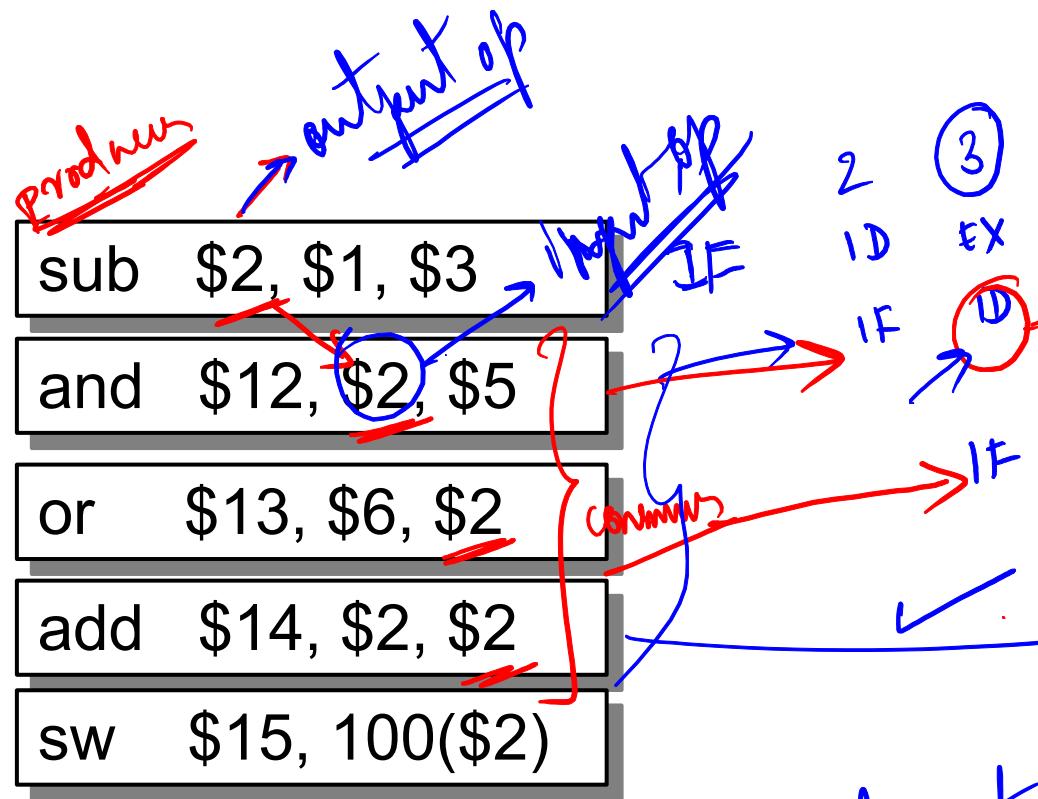
↓ k stages
* gradients

↑ n inst
 $P_2 \propto C V^2 f$
 Capacitance
 \propto
 $P_{\text{dy}} \propto V^2 b$

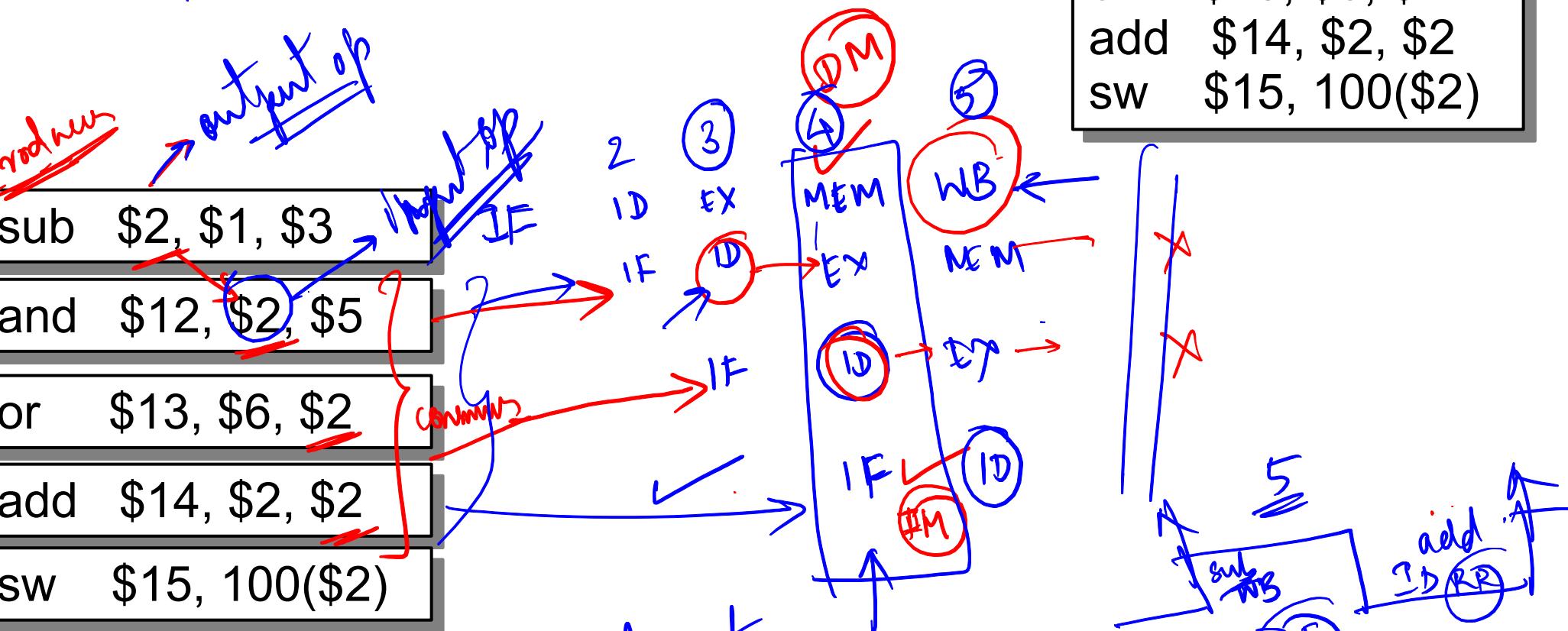


Execution Sequence

$F_1 F_2 D_R D_2 D_3 E_1 E_2 - -$
 $F_1 F_2 D_1 D_2 D_3 E_1$
 $F_1 F_2 D_1 D_2 D_3 - -$



sub	\$2, \$1, \$3
and	\$12, \$2, \$5
or	\$13, \$6, \$2
add	\$14, \$2, \$2
sw	\$15, 100(\$2)



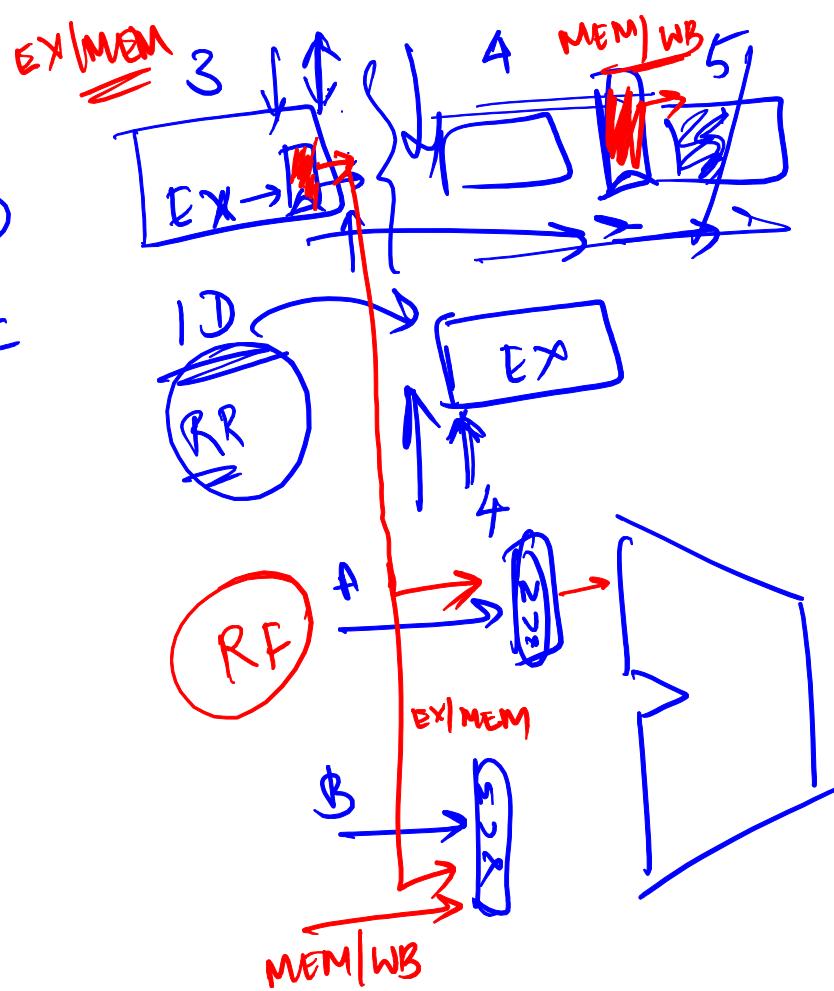
dependent : → read point point
→ write point point

~~prod~~
~~sub~~
~~and~~
~~cont~~

IF
, \$2 ;

ID

, \$2 ;



earliest \$2