1. Pipelining Basics ub 0...0 000111111001 0001

i. 0x8df80000 # lw \$24, 0(\$15) #Inst.Addr = 0x100

| IF/ID | |
|---|-------|
| No Cont rol Sign al | |
| PC+4 | 9×104 |
| OpCode | 0×23 |
| Rs | \$15 |
| Rt | \$24 |
| Rd | Х |
| Funct | X |
| Imm(16) | 0 |

| ID/I | ΣX | | EX/M | EM |
|---------|-------|---------|---------|--------------------|
| MToR | ı | | MToR | ١ |
| RegWr | 1 | | RegWr | 1 |
| MemRd | - | | MemRd | |
| MemWr | ø | П | метка | |
| Branch | ø | | MemWr | 1 |
| RegDst | ø | П | Memwr | P |
| ALUsrc | i | | Branch | _ |
| ALUop | 00 | $ \ $ | Branch | þ |
| PC+4 | 0 101 | | BrcTgt | 0xl |
| PC+4 | 0×104 | | isZero? | ø |
| RData1 | 11610 | | AluRes | III _{bia} |
| RData2 | Χ | RData2 | de au | |
| Rt | \$24 | | nData2 | \$2 |
| Rd | Х | DstRNum | \$2 | |
| Imm(32) | 0 | | DSINNUM | |

| MToR | - 1 |
|---------|-----------|
| RegWr | l |
| MemRd | |
| MemWr | ø |
| Branch | þ |
| BrcTgt | 0x104 |
| isZero? | ø |
| AluRes | 11610 + 0 |
| RData2 | \$24 |
| DstRNum | \$24 |

| MEM/WB | |
|---------|-----------------------|
| MToR | -000+ |
| RegWr | |
| MemRes | Mem (11610 +0) |
| AluRes | 116,0+0 |
| DstRNum | \$24 |

ii. 0x1023000C # beq \$1, \$3, 12 #Inst.Addr = 0x100

| No Cont Fol Sign al | IF/ID | |
|---|---|------------------|
| OpCode Ox4 Rs \$1 Rt \$3 Rd X Funct X | Cont rol Sign | |
| Rs \$1 Rt \$3 Rd X Funct X | PC+4 | 0×lo4 |
| Rt \$3 Rd X Funct X | OpCode | 0×4 |
| Rd X Funct X | | \$1 |
| Funct X | | \$3 |
| Imm(16) | | X |
| Imm(16) (2 to | 000000000000000000000000000000000000000 | χ |
| | lmm(16) | 12 ₁₀ |

| ID/EX | |
|---------|-------|
| MToR | X |
| RegWr | ø |
| MemRd | 16 |
| MemWr | ø |
| Branch | ı |
| RegDst | Χ |
| ALUsrc | ø |
| ALUop | οl |
| PC+4 | 0×104 |
| RData1 | 10210 |
| RData2 | 10410 |
| Rt | \$3 |
| Rd | × |
| Imm(32) | 1210 |

| EX/MEM | |
|---------|-------|
| MToR | X |
| RegWr | ø |
| MemRd | ø |
| MemWr | þ |
| Branch | l |
| BrcTgt | Oxilo |
| isZero? | ø |
| AluRes | -210 |
| RData2 | 10410 |
| DstRNum | \$3 |

| MEM/WB | | |
|---------|------------------|--|
| MToR | × | |
| RegWr | ø | |
| MemRes | X | |
| AluRes | -2 ₁₀ | |
| DstRNum | \$3 | |

iii. 0x0285c822 # sub \$25, \$20, \$5 #Inst.Addr = 0x100

| IF/ID | |
|---|-------|
| No Cont rOl Sign al | |
| PC+4 | 0×104 |
| OpCode | 0×0 |
| Rs | \$20 |
| Rt | \$5 |
| Rd | \$ 25 |
| Funct | 0×22 |
| Imm(16) | X |

| ID/EX | |
|---------|-------|
| MToR | ø |
| RegWr | Ì |
| MemRd | ø |
| MemWr | ø |
| Branch | þ |
| RegDst | l |
| ALUsrc | ø |
| ALUop | 10 |
| PC+4 | 0×104 |
| RData1 | 1210 |
| RData2 | 10610 |
| Rt | \$5 |
| Rd | \$25 |
| Imm(32) | X |

| EX/MEM | |
|---------|-------|
| MToR | þ |
| RegWr | 1 |
| MemRd | ø |
| MemWr | ø |
| Branch | ø |
| BrcTgt | X |
| isZero? | ø |
| AluRes | 15,0 |
| RData2 | 10610 |
| DstRNum | \$25 |

| MEM/WB | |
|---------|------------------|
| MToR | ø |
| RegWr | ١ |
| MemRes | X |
| AluRes | (5 ₁₀ |
| DstRNum | \$25 |

| 2. | Pipeline | . н | 0 ZQY | ds | | | | | | | | | | | | | | | | |
|------|----------|--------|-------|----|-----|-----|-----|-----|------------|----|-----|-----|----|-------|-----|----|----|----|----|--|
| | , i pour | | | | | | | | | | | | | | | | | | | |
| (a). | | F | 2_ | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | μ | 12 | 13 | 14 | lS | (6 | 17 | 18 | |
| | Lw | F | D | E | M | W | | | | | | | | | | | | | | |
| | addi | | F | D | {p | D |) E | M | M | | | | | | | | | | | |
| | SW | | | F | F | 7)(|) D | (2) | 1 <u>0</u> | E | M | W | | | | | | | | |
| | addi | | | | | | F | (F | XE. | 10 | E | M | W | E D (| | | | | | |
| | sub | | | | | | | · | | F | (D) | (g) | D | E | M | W | | | | |
| | bne | | | | | | | | | ı | (F) | (E) | F | D (| 2)(| D | E | Μ | W | |
| | lw | | | | | | | | | | | • | | | | | | | F | |
| | Total | cycles | : 18 | 3 | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | |
| (Ь). | | ţ | 2_ | 3 | 4 | S | 6 | 7 | 8 | 9 | lo | ĮΙ | 12 | 13 | 14 | 15 | 16 | 17 | 18 | |
| | Lw | F | D | E | M | w | | | | | | | | | | | | | | |
| | addi | | F | D | (P) | E | М | W | | | | | | | | | | | | |
| | SW | | | F | F | D | E | Μ | W | | | | | | | | | | | |
| | addi | | | | | F | D | E | М | W | | | | | | | | | | |
| | sub | | | | | | F | D | E, | М | W | | | | | | | | | |
| | bne | | | | | | | F | D | E | М | W | | | | | | | | |
| | Lw | | | | | | | | | | | F | | | | | | | | |
| | Total | cycles | - 1 | 1 | | | | | | | | | | | | | | | | |
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| (e). | | ţ | 2 | 3 | 4 | S | 6 | 7 | 8 | 9 | 10 | H | 12 | 13 | 14 | 15 | (6 | 17 | 18 | |
|------|------------|-------|------|-----|---|---|---|----|----|-----|----|-----|----|----|-----|----|-----|----|-----|--|
| | Lw | | | | | | | | | | | | | | | | | | | |
| | addi | | | | | | | | | | | | | | | | | | | |
| | SM | | | | | | | | | | | | | | | | | | | |
| | addi | | | | | | | | | | | | | | | | | | | |
| | sub | | | | | | | | | | | | | | | | | | | |
| | bne | | | | | | | | | | | | | | | | | | | |
| | lw | | | | | | | | | | | | | | | | | | | |
| | Total | cycle | s: | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | |
| (q). | | l | 2 | 3 | 4 | S | 6 | 7 | 8 | 9 | lo | 11 | 12 | 13 | 14 | 15 | ίβ | ।र | 18 | |
| | Lw | | | | | | | | | | | | | | | | | | | |
| | addi | | | | | | | | | | | | | | | | | | | |
| | SW | | | | | | | | | | | | | | | | | | | |
| | addi | | | | | | | | | | | | | | | | | | | |
| | sub | | | | | | | | | | | | | | | | | | | |
| | bne | | | | | | | | | | | | | | | | | | | |
| | lw. | | | | | | | | | | | | | | | | | | | |
| | Total | cycle | 15 : | | | | | | | | | | | | | | | | | |
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| (e)· | | (| 2 | . 3 | 4 | 5 | 6 | 7 | 6 | ٦ | 10 | į t | L | 15 | 14 | 12 | (6 | (T | (4 | |
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- 3. Data Forwarding Mechanism
- (a). Latch information
- (b). Datapath
- (c) Signal

