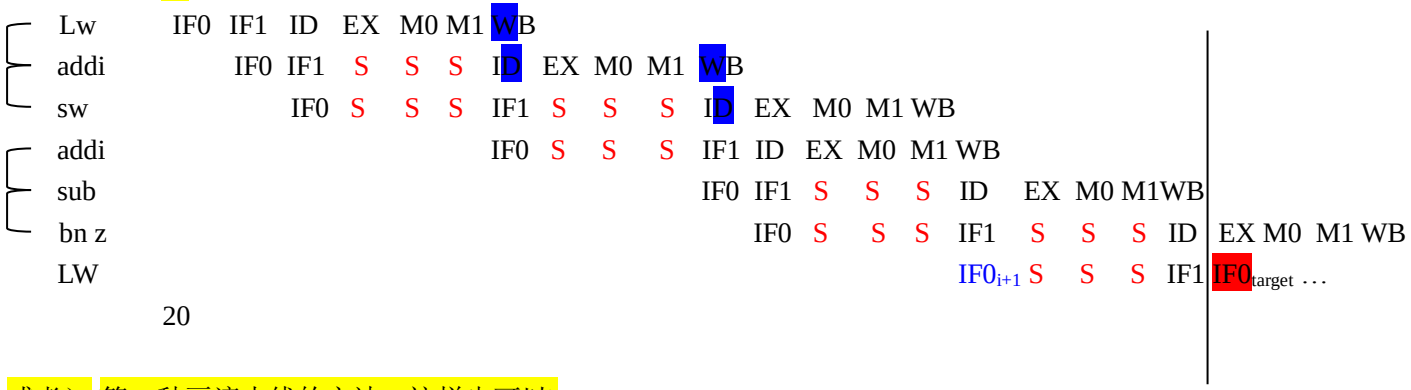
# Answer for homework assignment 3

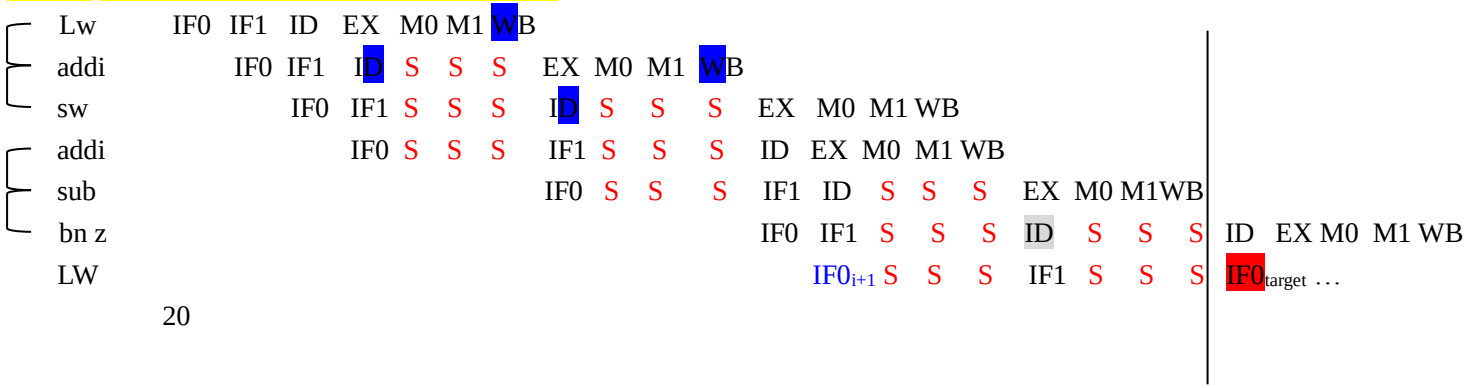
A.1

假设：转移目标地址计算和条件判断在 ID 级进行

（1）已知：无任何 forwarding path，但在一个时钟周期内对寄存器堆可以进行一次写和一次读（前半周期写，后半周期读）。转移用 flushing 方法。

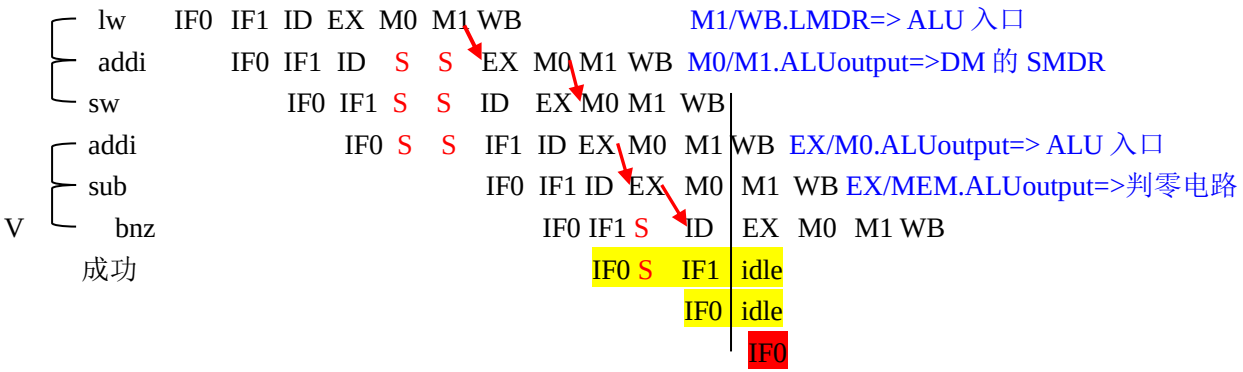



或者）(第二种画流水线的方法，这样也可以)




20*98 + 24(20) = 1984(1980)

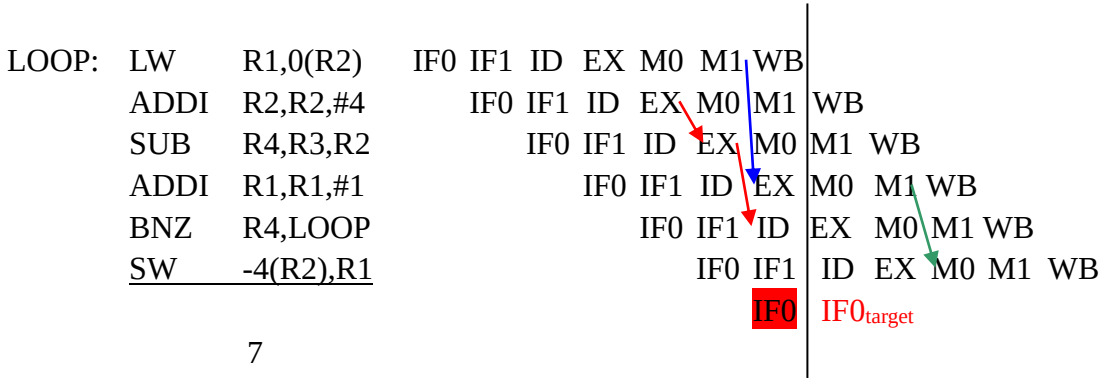
（2） 有 forwarding path, 硬件预测不成功,.




11

11 *98+15(13)=1093(1091)

(3) 有一个延时槽，有 forwarding path，利用延时转移技术，可调整指令顺序或部分修改指令操作数，但不允许减少循环内的指令数，使得尽可能减少 Stall。




7

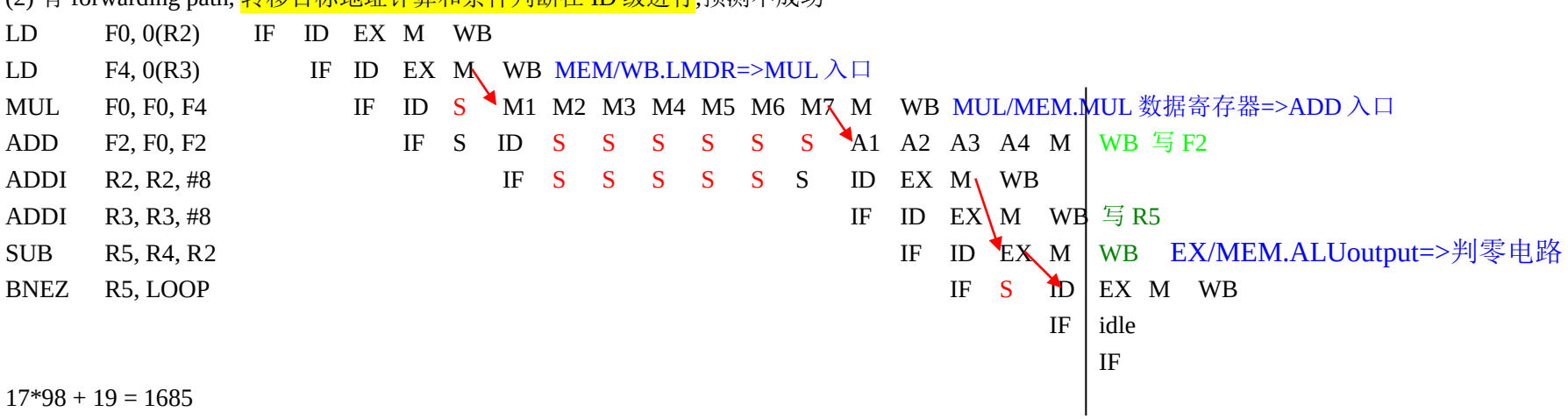
7*98+12= 698

A.2

(1) 无 forwarding path, 转移目标地址计算和条件判断在 ID 级进行,flushing 方法


22*98 + 25 = 2181

(2) 有 forwarding path, 转移目标地址计算和条件判断在 ID 级进行,预测不成功




17*98 + 19 = 1685

(3)

```
      LD      F0, 0(R2)      IF  ID  EX  M   WB
Loop:LD       F4, 0(R3)          IF  ID  EX  M   WB  DM.LMDR=>MUL 入口
      ADDI    R2, R2, #8             IF  ID  EX  M   WB  MEM/WB.ALUoutput=>ALU 入口
      MUL     F0, F0, F4                 IF  ID  M1  M2  M3  M4  M5  M6  M7  M   WB  MUL/MEM.MUL 数据寄存器=>ADD 入口
      SUB     R5, R4, R2                     IF  ID  EX  M   WB
      ADDI    R3, R3, #8                         IF  ID  EX  M   WB
      ADD     F2, F0, F2                             IF  ID  S   S   S   S   A1  A2  A3  A4  M   WB
      BNEZ    R5, LOOP                                   IF  S   S   S   S   ID  EX  M   WB
      LD      F0, 0(R2) (延时槽指令)                                         IF  ID  EX  M   WB
                                                                             IF
```

1+12*98+15 = 1192

```
Loop: LD      F0, 0(R2)      IF  ID  EX  M   WB
      LD      F4, 0(R3)          IF  ID  EX  M   WB  DM.LMDR=>MUL 入口(F4)
      ADDI    R2, R2, #8             IF  ID  EX  M   WB  MEM/WB.ALUoutput => ALU 入口
      MUL     F0, F0, F4                 IF  ID  M1  M2  M3  M4  M5  M6  M7  M   WB  MUL/MEM.MUL 数据寄存器=>ADD 入口
      SUB     R5, R4, R2                     IF  ID  EX  M   WB  EXE/MEM.ALUoutput => 判零电路
      ADDI  R3, R3, #8                           IF  ID  EX  M   WB
      BNEZ    R5, LOOP                               IF  ID  EX  M   WB
      ADD     F2, F0, F2                                 IF  ID  S   S   S   S   A1  A2  A3  A4  M   WB
                                                             IF  S   S   S   S   ID  EX  M   WB
```

12*98+19 = 1195

A.3

Given : unconditional resolved at the end of 2nd stage, conditional resolved at the end of 3rd stage.

Unconditional: L1 L2 L3 L4

L1 L1( target) 1 stall

conditional :

1. Flushing: L1 L2 L3 L4

L1 s L1 ( target or pc+4) 2 stalls

2. predict-untaken:

untaken L1 L2 L3 L4

L1 L2 L3 L4 …… 0 stall

Taken L1 L2 L3 L4

L1 s L1 (pc+4) 2 stall

3. Predict-taken:

taken L1 L2 L3 L4

L1 L1(t) L2 L3 …… 1 stall

Taken L1 L2 L3 L4

L1 L1(t) L1 (pc+4) 2 stall

设 CPIideal = 1

CPIflushing: = CPIideal + 1% * 1 + 15% * 2 = 1.31 speedup = 1.31

CPIpredict-untaken = CPIideal + 1% * 1 + 15% * ( 60% * 2 + 40% * 0 ) = 1.19 speedup = 1.19

CPIpredict-taken = CPIideal + 1% * 1 + 15% * ( 60% * 1 + 40% * 2 ) = 1.22 speedup = 1.22