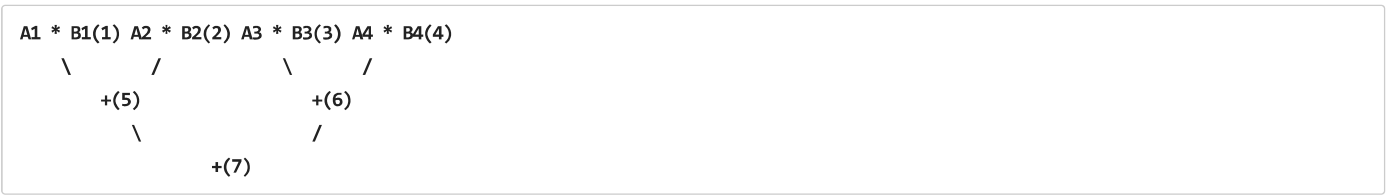


3.8

可以画出计算树为



流水为

pipe\time	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
5				1		2		3		4	5			6				7
4										5			6				7	
3									5			6				7		
2		1	1	2	2	3	3	4	4									
1	1		2		3		4	5			6				7			

总时间为18Δt

TP = 7 / (18Δt) = 0.39 / Δt

S = (4 4Δt + 3 4Δt) / (18Δt) = 14 / 9 = 1.56

E = (4 4Δt + 3 4Δt) / (5 \* 18Δt) = 14 / 45 = 0.31

3.9

(1)

先计算F = {1, 3, 4, 8} 对应二进制为

C0:

C0 = 10001101

C2 = 10101111

C5 = 10001101 = C0

C6 = 10001111

C7 = 10001101 = C0

C2:

C2\_2 = 10101111 = C2

C2\_5 = 10001101 = C0

C2\_6 = 10001111 = C6

C2\_7 = 10001101 = C0

C6:

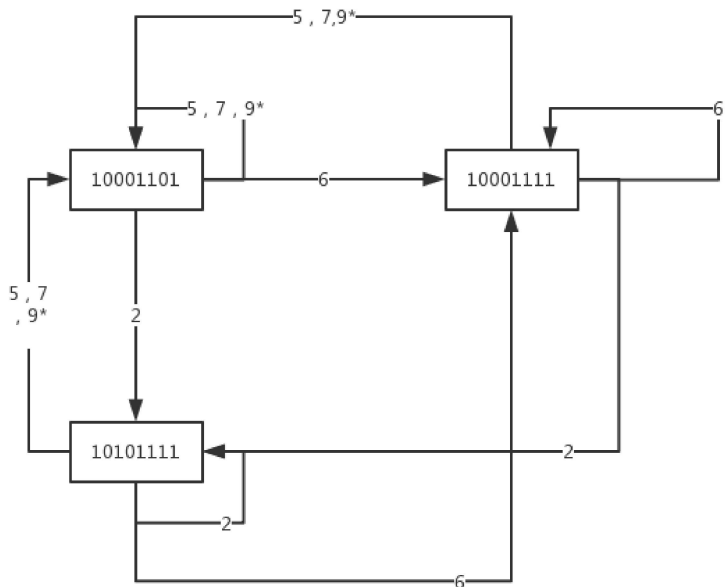
C0 = 10001101

C6\_2 = 10101111 = C2

C6\_5 = 10001101 = C0

C6\_6 = 10001111 = C6

C6\_7 = 10001101 = C0



(2)

计算平均启动距离

Circle	Mean Start Distance
2, 5	3.5
2, 6, 5	4.333
6, 5	5.5
6, 2, 5	4.333
5	5

采用(2,5)的间隔

最大吞吐率为  $1/(3.5\Delta t) = 0.29/\Delta t$

(3)

调度开始处分别为1,3,8,10,15,17，最后一个Task结束时刻为25

吞吐率为  $6/(25\Delta t) = 0.24/\Delta t$

### 3.10

(1)

$F = \{1, 3, 6\}$

$C0 = 100101$

$C2 = 101101$

$C4 = 100111$

$C5 = 100101 = C0$

$C2\_2 = 101111$

$C2\_4 = 100111 = C4$

$C2\_5 = 100101 = C0$

$C4\_2 = 101101 = C2$

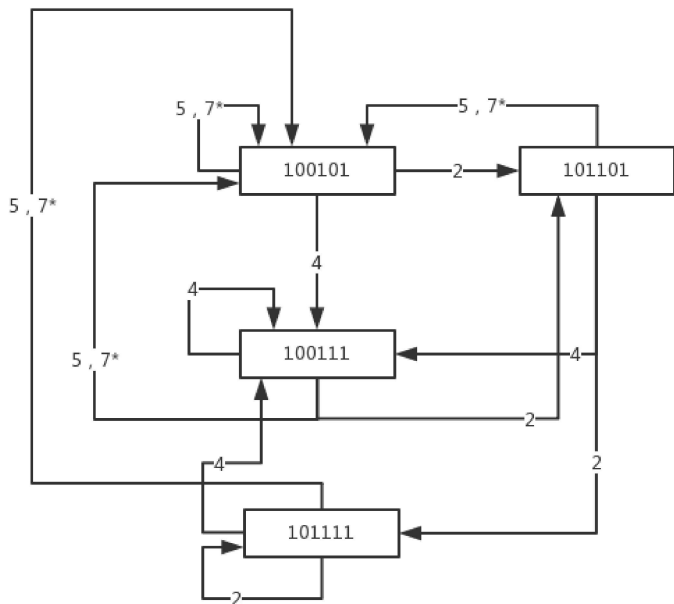
$C4\_4 = 100111 = C4$

$C4\_5 = 100101 = C0$

$C2\_2\_2 = 101111 = C2\_2$

$C2\_2\_4 = 100111 = C4$

$C2\_2\_5 = 100101 = C0$



(2)

如果允许不等时间间隔，那么选择2,2,5，最大吞吐率为 $0.333/\Delta t$   
 如果不允许不等时间间隔，那么选择4，最大吞吐率为 $0.25/\Delta t$

(3)

如果允许不等时间间隔，开始位置为1,3,5,10,12,14,19,21,23,28,结束位置34，吞吐率为 $0.29/\Delta t$ ，加速比为 $70/34=2.06$   
 如果不允许不等时间间隔，开始位置为1,5,9,13,17,21,25,29,33,37，结束位置43，吞吐率为 $0.23/\Delta t$ ，加速比为 $70/43=1.63$

### 3.11

(1)

instruction\time	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
LW	IF	ID	EX	ME	WB															
DADDUI		IF	S	S	ID	EX	ME	WB												
SW						IF	S	S	ID	EX	ME	WB								
DADDUI								IF	ID	EX	ME	WB								
DSUB									IF	S	S	ID	EX	ME	WB					
BNEZ												IF	S	S	ID	EX	ME	WB		
LW(2nd loop)															S	IF	ID	EX	ME	WB

需要一共99个loop，每个loop需要15个时钟周期，总计 $15 \times 99 + 3 = 1488$

(2)

instruction\time	1	2	3	4	5	6	7	8	9	10	11	12	13	14
LW	IF	ID	EX	ME	WB									
DADDUI		IF	ID	S	EX	ME	WB							
SW			IF	S	ID	EX	ME	WB						
DADDUI					IF	ID	EX	ME	WB					
DSUB						IF	ID	EX	ME	WB				

BNEZ							IF	S	ID	EX	ME	WB		
LW(2nd loop)									S	IF	ID	EX	ME	WB

—共需要9 \* 99 + 3 = 894个时钟周期

(3)

更改指令为

```

LW R1,0(R2)
DADDIU R2,R2,#4
DSUB R4,R3,R2
DADDIU R1,R1,#1
BNEZ R4,LOOP
SW R1,-4(R2)

```

instruction\time	1	2	3	4	5	6	7	8	9	10	11
LW	IF	ID	EX	ME	WB						
DADDUI		IF	ID	EX	ME	WB					
DSUB			IF	ID	EX	ME	WB				
DADDUI				IF	ID	EX	ME	WB			
BNEZ					IF	ID	EX	ME	WB		
SW						IF	ID	EX	ME	WB	
LW(2nd loop)							IF	ID	EX	ME	WB

需要6 \* 99 + 4 = 598个时钟周期

Q1

Q1 : Write down the bypass condition for the path between M (Memory) -> D (Decode) stages into register B. (The path is shown with a dotted line in the figure.)

```

Bypass MEM->ID(B) = Case opcode M
    LW => rdata
    ... => addr

```

BSrc need to choose bypass by the rd2 and wd, if rd2 == rd E or rd M or rd W then choose bypass ALU->ID(B) or bypass Memory->ID(B) or bypass Writeback->ID(B)

Q2

Q2 : Write down the stall condition in which stalls are only caused by data hazards.  
Stall = (rsD=wsE). (opcodeE=LWE).(wsE≠0 ).re1D + (rtD=wsE). (opcodeE=LWE).(wsE≠0 ).re2D

Q3

```

LW r2 r1 (r2 <- MEM[r1])
NOP
ADD r3 r1 r2 (r3 <- r1 + r2)
NOP
NOP

```

In the 3th instruction, the register B is r2 and r2 should use the data from instruct ‘LW r2 r1’.