

第一题:

- 1.16 a.  $1/(0.2+0.8/N)$   
 b.  $1/(0.2+8 \times 0.005+0.8/8) = 2.94$   
 c.  $1/(0.2+3 \times 0.005+0.8/8) = 3.17$   
 d.  $1/(.2+\log N \times 0.005+0.8/N)$   
 e.  $d/dN (1/((1-P)+\log N \times 0.005+P/N)=0)$

第二题:

- C.3 a.  $2 \text{ ns} + 0.1 \text{ ns} = 2.1 \text{ ns}$   
 b.  $5 \text{ cycles}/4 \text{ instructions} = 1.25$   
 c. Execution Time =  $I \times \text{CPI} \times \text{Cycle Time}$   
 Speedup =  $(I \times 1 \times 7)/(I \times 1.25 \times 2.1) = 2.67$   
 d. Ignoring extra stall cycles, it would be:  $I \times 1 \times 7/I \times 1 \times 0.1 = 70$

第三题:

a)

Iteration	Instruction	Issue	Executes/ Mem	Wwrite CDB	Comments
1	L.D F2, 0(R1)	1	2	3	First inst. issue
1	MUL.D F4, F2, F0	2	4	19	Wait for F2(CDB) Mult rs [3-4] (For F2) Mult use [5-18]
1	L.D F6, 0(R2)	3	4	5	Ldbuf use [4]
1	ADD.D F6, F4, F6	4	20	30	Wait for F4(CDB) Add rs [5-20] (For F4) Add use [21-29]
1	S.D F6, 0(R2)	5	31		Wait for F6 Stbuf use [6-31] Int rs [6-8]
1	DADDIU R1, R1, #8	6	7	8	
1	DADDIU R2, R2, #8	7	8	9	
1	DSLTI R3, R1, R4	8	9	10	
1	BNEZ R3, foo	9	11		Wait for R3(CDB)
2	L.D F2, 0(R1)	10	12	13	Wait for BNEZ Ldbuf use [11-12]

Iteration	Instruction	Issue	Executes/ Mem	Wwrite CDB	Comments
2	MUL.D F4, F2, F0	11	<del>14</del> -19	34	Wait for F2 Mult busy[5-18] Mult rs [12-19] Mult use [20-33]
2	L.D F6, 0(R2)	12	13	14	Ldbuf use [13]
2	ADD.D F6, F4, F6	13	35	45	Wait for F4 Add rs [14-35] Add use [36-44]
2	S.D F6, 0(R2)	14	46		Wait for F6 Stbuf use [15-46] Int rs[15-17]
2	DADDIU R1, R1, #8	15	16	17	
2	DADDIU R2, R2, #8	16	17	18	
2	DSL TU R3, R1, R4	17	18	20	CDB is busy at cycle=19, due to MUL.D in loop 1
2	BNEZ R3, foo	18	21		Wait for R3(CDB)
3	L.D F2, 0(R1)	19	22	23	Wait for BNEZ
3	MUL.D F4, F2, F0	20	<del>23</del> - 34	49	Wait for F2 Mult Busy [19-33] Mult rs [21-34] Mult use [35-48]
3	L.D F6, 0(R2)	21	23	24	Ld busy [22]
3	ADD.D F6, F4, F6	22	50	60	Wait for F4
3	S.D F6, 0(R2)	23	61		Wait for F6 Stbuf use [24-61] Int rs [24-26]
3	DADDIU R1, R1, #8	24	25	26	
3	DADDIU R2, R2, #8	25	26	27	
3	DSL TU R3, R1, R4	26	27	28	
3	BNEZ R3, foo	27	29		Wait for R3(CDB)

b)

Iteration	Instruction	Issue	Executes/ Mem	Wwrite CDB	Comments
1	L.D F2, 0(R1)	1	2	3	
1	MUL.D F4, F2, F0	1	4	19	Wait for F2 Mult rs [2-4] Mult use [5-19]
1	L.D F6, 0(R2)	2	3	4	
1	ADD.D F6, F4, F6	2	20	30	Wait for F4 Add rs [3-20] Add use [5]
1	S.D F6, 0(R2)	3	31		Wait for F6 Stbuf use [4-31] Int rs [4-5]
1	DADDIU R1, R1, #8	3	4	5	
1	DADDIU R2, R2, #8	4	5	6	
1	DSLTI R3, R1, R4	4	6	7	
1	BNEZ R3, foo	5	8		Wait for R3 INT rs [6-8]
2	L.D F2, 0(R1)	6	9	10	Wait for BNEZ
2	MUL.D F4, F2, F0	6	11	26	Wait for F2 Mult rs[7-11] Mult use [12-25]
2	L.D F6, 0(R2)	7	10	11	Int busy [8-9] Int rs [8-10]
2	ADD.D F6, F4, F6	7	27	37	Wait for F4 Add rs [8-27] Add use [28-36]
2	S.D F6, 0(R2)	8	38		Wait for F6 INT rs [9-12]
2	DADDIU R1, R1, #8	8	11	12	INT busy [9-10] INT rs [9-11]
2	DADDIU R2, R2, #8	9	12	13	INT busy [10-11] INT rs [10-12]
2	DSLTI R3, R1, R4	9	13	14	INT busy [10-12] INT rs [10-13]
2	BNEZ R3, foo	10	15		Wait for R3 INT rs [11-15]
3	L.D F2, 0(R1)	11	16	17	Wait for BNEZ Int rs [12-16]

Iteration	Instruction	Issue	Executes/ Mem	Wwrite CDB	Comments
3	MUL.D F4, F2, F0	11	18	33	Wait for F2 Mult rs[12-18] Mult use [19-33]
3	L.D F6, 0(R2)	12	17	18	Int busy [16] Int rs [13-17]
3	ADD.D F6, F4, F6	12	34	44	Wait for F4 Add rs [13-34] (FULL ADD rs) Add use [35-43]
3	S.D F6, 0(R2)	13	45		Wait for F6 INT rs [14-19] ( FULL INT rs)
3	DADDIU R1, R1, #8	14	18	20	INT busy [16-17] INT rs [15-18] ( FULL INT rs) INT use [19]
3	DADDIU R2, R2, #8	16	19	21	INT busy [17-18] INT rs[17-19] (FULL INT rs) INT use [20]
3	DSL TU R3, R1, R4	17	21	22	Wait for R1 INT rs[18-21] (FULL INT rs)
3	BNEZ R3, foo	18	23		

提示:

1. BNEZ跳转指令需要等到其操作数计算完毕并写入到CDB中才可以读取数据并运行。
2. 第二问最后几个指令需要关注INT 保留站数量 (5个) , 当保留站满了的时候则不能双发射, 因为指令发射会由于没有空闲的保留站而停顿。当一个指令被执行后, 其保留站被释放, 新的指令才被允许发射并进入保留站。
3. LD 和 SD指令的地址计算需要经过整数单元, 但是本题中SD指令占用的INT rs会因为R2的更新而提前被flush掉, 获取正确的R2值后指令直接进入存储单元buffer。
4. 第三题的第二小题为拓展题, 难度较高, 同学们掌握第一小题及基本原理即可。

但是不可以直接抄网上参考答案。作业中只要逻辑前后一致, 而不是如网上答案加入了分支预测等其他条件导致作业出现前后逻辑冲突, 都会比第二问抄答案的作业获得更高分数。

如有其他问题可在群内讨论或私聊T.A., 谢谢。