CS161
Assignment-3 Solution

1.1

Cycle	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
lw r1, 0(r1)	F	D	E	M	W																							
and r1, r1, r2		F	D	D	E	M	W																					
lw r1, 0(r1)			F	F	D	E	M	W																				
lw r1, 0(r1)					F	D	D	E	M	W																		
beq r1, r0, loop						F	F	D	D	E	M	W																
lw r1, 0(r1)								F	F	D	E	M	W															
and r1, r1, r2										F	D	D	E	M	W													
lw r1, 0(r1)											F	F	D	E	M	W												
lw r1, 0(r1)													F	D	D	E	M	W										
beq r1, r0, loop														F	F	D	D	E	M	W								
lw r1, 0(r1)																F	F	D	E	M	W							
and r1, r1, r2																		F	D	D	E	M	W					
lw r1, 0(r1)																			F	F	D	E	M	W				
lw r1, 0(r1)																					F	D	D	E	M	W		
beq r1, r0, loop																						F	F	D	D	E	M	W

1.2 0 cycles have the full pipeline doing useful work

2.1

Cycle	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
lw r2, 0(r1)	F	D	E	M	W																							
beq r2, r0, label2		F	D	D	D	E	M	W F	F	F	D	E	M	W														
lw r3, 0(r2)						F	D	E	M	W																		
beq r3, r0, label1							F	D	D	D	E	M	W															
add r1, r3, r1																												
sw r1, 0(r2)			F	F	F						F	D	E	M	W													

2.2

Cycle	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
lw r2, 0(r1)	F	D	E	M	W																							
beq r2, r0, label2		F	D	D	E	M	W				F	D	E	M	W													
lw r3, 0(r2)						F	D	E	M	W																		
beq r3, r0, label1							F	D	D	E	M	W																
add r1, r3, r1																												
sw r1, 0(r2)														F	D	E	M	W										

3.1

0.25 * (1-0.45) * 2 = 0.275

3.2

0.25 * (1-0.55) * 2 = 0.225

3.3

0.25 * (1-0.85) * 2 = 0.075

4.1

	T	NT	T	T	NT	
Predict always-taken	T	T	T	T	T	3/5 = 60% accuracy
Predict always-not-taken	NT	NT	NT	NT	NT	2/5 = 40% accuracy

4.2

	T	NT	T	T		
2-bit predictor	00 (NT)	01 (NT)	00 (NT)	01 (NT)	11 (T)	1/4 = 25% accuracy

4.3

	T	NT	T	T	NT	T	NT	T	T	NT	T	NT	T	T	NT	
2-bit predictor	00	01	00	01	11	10	11	10	11	11	10	11	10	11	11	

Steady-state accuracy = 3/5 = 60%