1. **How many instructions were added as a result of code replication and control flow checking, both separately and combined? Do not include the results from the Extra Credit optimization in this answer.**

Table 1: Code Replication

Category	.None	.SWFT	Added Instructions
adpcm	200	764	564
arm	350	973	623
basicmath	291	732	441
bh	1384	3798	2414
bitcount	393	1575	1182
crc32	101	325	224
dijkstra	180	536	356
em3d	565	1858	1293
fft	326	938	612
hanoi	64	184	120
hello	14	14	0
kmp	294	1042	748
l2lat	61	162	101
patricia	339	1048	709
qsort	94	268	174
sha	290	1042	752
smatrix	184	637	453
sql	86699	302585	215886
susan	5334	23627	18293

Table 2: Control Flow Checking

Category	.None	.SWFT	Added Instructions
adpcm	200	328	128
arm	350	622	272
basicmath	291	577	286
bh	1384	2682	1298
bitcount	393	651	258
crc32	101	201	100
dijkstra	180	374	194
em3d	565	1137	572
fft	326	678	352
hanoi	64	124	60
hello	14	14	0
kmp	294	560	266
l2lat	61	103	42
patricia	339	755	416
qsort	94	168	74
sha	290	462	172
smatrix	184	404	220
sql	86699	196869	110170
susan	5334	8662	3328

Table 3: Both Passes Combined

Category	.None	.SWFT	Added Instructions
adpcm	200	892	692
arm	350	1245	895
basicmath	291	1018	727
bh	1384	5096	3712
bitcount	393	1833	1440
crc32	101	425	324
dijkstra	180	730	550
em3d	565	2430	1865
fft	326	1290	964
hanoi	64	244	180
hello	14	14	0
kmp	294	1308	1014
l2lat	61	204	143
patricia	339	1464	1125
qsort	94	342	248
sha	290	1214	924
smatrix	184	857	673
sql	86699	412755	326056
susan	5334	26955	21621

2. **How much slower is the program as a result of code replication and control flow checking, both separately and combined? Use the same stipulations as Question 1.**

After lots of hard work, my CFG pass was unable to work properly for all test cases, as sql and susan don't run. It had the correct amount of assert function calls, but I was not able to get timing values from timing.py. However, my code replication pass worked and I was able to get time for that, so Table 4 shows the time increase from that pass. Table 5 shows the values that are working from my Control Flow Checking pass, and Table 6 shows both of them run together. Code replication adds much more time to the program, which makes sense because it also adds a lot more instructions.

Table 4: Timing of Code Replication Pass

Category	.None	.SWFT	Added Time
adpcm	0.5	2.9	2.4
arm	0.0	0.0	0.0
basicmath	0.04	0.08	0.04
bh	0.42	1.02	0.6
bitcount	0.16	0.8	0.64
crc32	0.13	0.33	0.2
dijkstra	0.05	0.2	0.15
em3d	0.23	0.75	0.52
fft	0.03	0.04	0.01
hanoi	1.36	8.09	6.73
kmp	0.15	0.8	0.65
l2lat	0.01	0.04	0.03
patricia	0.04	0.05	0.01
qsort	0.01	0.03	0.02
sha	0.02	0.15	0.13
smatrix	4.03	10.1	6.07
sql	0.0	0.0	0.0
susan	0.6	5.34	4.74

Table 5: Timing of Control Flow Checking

Category	.None	.SWFT	Added Time
adpcm	0.5	0.67	0.17
arm	0.0	0.0	0.0
basicmath	0.04	0.05	0.01
bh	0.42	0.8	0.38
bitcount	0.16	0.24	0.08
crc32	0.13	0.16	0.03
dijkstra	0.05	0.1	0.05
em3d	0.23	0.59	0.36
fft	0.03	0.03	0.0
hanoi	1.36	2.25	0.89
kmp	0.15	0.25	0.1
l2lat	0.01	0.02	0.01
patricia	0.04	0.04	0.0
qsort	0.01	0.01	0.0
sha	0.02	0.03	0.01
smatrix	4.03	5.78	1.75
sql	0.0	0.0	0.0
susan	0.6	0.0	0.0

Table 6: Timing of Both Passes

Category	.None	.SWFT	Added Time
adpcm	0.5	2.96	2.46
arm	0.0	0.0	0.0
basicmath	0.04	0.08	0.04
bh	0.42	1.26	0.84
bitcount	0.16	0.87	0.71
crc32	0.13	0.36	0.23
dijkstra	0.05	0.24	0.19
em3d	0.23	1.04	0.81
fft	0.03	0.04	0.01
hanoi	1.36	8.78	7.42
kmp	0.15	1.1	0.95
l2lat	0.01	0.05	0.04
patricia	0.04	0.05	0.01
qsort	0.01	0.03	0.02
sha	0.02	0.16	0.14
smatrix	4.03	11.08	7.05
sql	0.0	0.0	0.0
susan	0.6	0.0	0.0

The sql and susan test have a timing of 0.0 for the tests that include the CFG pass because something in that pass fails in those tests. After lots of hard work this failure wasn’t able to be fixed so I had to include this incorrect data in my report.