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LIST OF INITIALIZATION PARAMETERS

-----[General]

Program Name = programma
 Silent = no
 Interactive = yes
 Batch File = no

-----[Architecture]

Logical Registers = 8
 Physical Registers = 24
 Pipeline Structure = FDPiXWC
 Unified LSU = yes
 In-Order Issue = no
 In-Order Complete = no
 Unified Dispatch/Issue = yes
 LSU Queue Length = 6
 Fetch Width = 4
 Decode Width = 4
 Issue Width = 5
 Write-Back Width = 4
 Commit Width = 99
 Window Size = 16
 ROB Size = 99
 Integer ALU Units = 2
 Integer ALU Latency = 0
 Integer Mult. Units = 1
 Integer Mult. Latency = 4
 Integer Mult. Pipe = yes
 Floating Point Units = 4
 Floating Point Mult = 1
 Load Units = 1
 Load Latency = 1
 Load Pipe = yes
 Store Units = 1
 Store Latency = 1
 Store Pipe = yes
 Branch Units = 1
 Branch Latency = 0
 Load Queue Size = 1
 Store Queue Size = 1

-----[Program Defaults]

Log File Name = def.log

 - STAGE = 4 entries.
 FETCH STAGE = 4 entries.
 DECODE STAGE = 4 entries.
 DISPATCH STAGE = 16 entries.
 ISSUE STAGE = 5 entries.
 EXECUTE STAGE = 10 entries.
 COMPLETE STAGE = 4 entries.
 COMMIT STAGE = 99 entries.
 Input program: 'programma'

001) LW R2,0(R1)
 002) LW R4,0(R3)
 003) ADD R5,R5,R2
 004) ADD R5,R5,R4
 005) MUL R5,R5,R5
 006) SW R5,0(R1)
 007) SW R5,0(R3)
 008) ADDI R1,R1,4
 009) ADDI R3,R3,4
 010) ADDI R7,R7,-1
 011) BNE R7,R0,-11

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-----
PHYSICAL REGS:  1  2  3  4  5  6  7  8  9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
                qi:  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1
                vi:  00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
REG.FILE: Ri:    1      2      3      4      5      6      7      8
                Pi:    -      -      -      -      -      -      -      -
                Qi:    0      0      0      0      0      0      0      0
                Vi:  00001000 00000000 00003000 00000000 00000000 00000000 00000003 00000000
STAGES:          F  D  P  I  X  W  C  RENAMED-STR  INSTRUCTION-WINDOW  REORDER-BUFFER  A  M  L  S  B  F  X
TOTAL SLOTS:     4  4 16  5 10  4 99 24          16          99          2  1  1  0  1  4  1
BUSY SLOTS:      4  0  0  0  0  0  0  0  0          0          0          0  0  0  0  0  0  0
STALLS:          0  0  0  0  0  0  0  0  0          0          0          0  0  0  0  0  0  0
000] LW  R2,0(R1)  0                                LQ(0)
001] LW  R4,0(R3)  0
002] ADD R5,R5,R2  0
003] ADD R5,R5,R4  0

```

Press ENTER to continue (PC=4,IC=4,CK=1,IPC=4.00)...

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-----
PHYSICAL REGS:  1  2  3  4  5  6  7  8  9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
                *  *  *  *  *  *  *  *  *  *  *  *  *  *  *  *  *  *  *  *  *  *  *  *
                qi:  0  1  0  1  0  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1
                vi:  00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
REG.FILE: Ri:    1      2      3      4      5      6      7      8
                Pi:    1      2      3      4      5      6      7      -
                Qi:    0      1      0      1      1      0      0      0
                Vi:  00001000 00000000 00003000 00000000 00000000 00000000 00000003 00000000
STAGES:          F  D  P  I  X  W  C  RENAMED-STR  INSTRUCTION-WINDOW  REORDER-BUFFER  A  M  L  S  B  F  X
TOTAL SLOTS:     4  4 16  5 10  4 99 24          16          99          2  1  1  0  1  4  1
BUSY SLOTS:      4  4  0  0  0  0  0  0  7          0          0          0  0  0  0  0  0  0
STALLS:          0  0  0  0  0  0  0  0  0          0          0          0  0  0  0  0  0  0
000] LW  R2,0(R1)  0  1                                P2,0(P1)
001] LW  R4,0(R3)  0  1                                P4,0(P3)
002] ADD R5,R5,R2  0  1                                P6,P5,P2
003] ADD R5,R5,R4  0  1                                P7,P6,P4
004] MUL R5,R5,R5  1
005] SW  R5,0(R1)  1
006] SW  R5,0(R3)  1
007] ADDI R1,R1,4  1

```

Press ENTER to continue (PC=8,IC=8,CK=2,IPC=4.00)...

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-----
PHYSICAL REGS:  1  2  3  4  5  6  7  8  9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
                *  *  *  *  *  *  *  *  *  *  *  *  *  *  *  *  *  *  *  *  *  *  *  *
                qi:  0  1  0  1  0  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1
                vi:  00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
REG.FILE: Ri:    1      2      3      4      5      6      7      8
                Pi:    9      2      3      4      8      -      -      -
                Qi:    1      1      0      1      1      0      0      0
                Vi:  00001000 00000000 00003000 00000000 00000000 00000000 00000003 00000000
STAGES:          F  D  P  I  X  W  C  RENAMED-STR  INSTRUCTION-WINDOW  REORDER-BUFFER  A  M  L  S  B  F  X
TOTAL SLOTS:     4  4 16  5 10  4 99 24          16          99          2  1  1  0  1  4  1
BUSY SLOTS:      3  4  4  0  0  0  0  0  9          4          4          0  0  0  0  0  0  0
STALLS:          0  0  0  0  0  0  0  0  0          0          0          0  0  0  0  0  0  0
000] LW  R2,0(R1)  0  1  2                                P2,0(P1)  000) LW P2 P1 - 0 0 0 0 000) 000 R2 - 0 0 0 LQ(0)
001] LW  R4,0(R3)  0  1  2                                P4,0(P3)  001) LW P4 P3 - 0 0 0 0 001) 001 R4 - 0 0 0
002] ADD R5,R5,R2  0  1  2                                P6,P5,P2  002) ADD P6 P5 P2 - 0 1 0 002) 002 R5 P5 0 0 0
003] ADD R5,R5,R4  0  1  2                                P7,P6,P4  003) ADD P7 P6 P4 - 1 1 0 003) 003 R5 P6 0 0 0 SQ(0)
004] MUL R5,R5,R5  1  2                                P8,P7,P7
005] SW  R5,0(R1)  1  2                                P8,0(P1)
006] SW  R5,0(R3)  1  2                                P8,0(P3)
007] ADDI R1,R1,4  1  2                                P9,P1,4
008] ADDI R3,R3,4  2
009] ADDI R7,R7,-1 2
010] BNE R7,R0,-11 2

```

Press ENTER to continue (PC=0,IC=11,CK=3,IPC=3.67)...

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-----
PHYSICAL REGS:  1  2  3  4  5  6  7  8  9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24

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      * * * * *
qi:  0 1 0 1 0 1 1 1 1 1 0 1 1 1 1 1 1 1 1 1 1 1
vi:  00 00 00 00 00 00 00 00 00 00 03 00 00 00 00 00 00 00 00 00 00
REG.FILE: Ri:  1 2 3 4 5 6 7 8
        Pi:  9 2 10 4 8 - 12 -
        Qi:  1 1 1 1 1 0 1 0
        Vi:  00001000 00000000 00003000 00000000 00000000 00000000 00000003 00000000

STAGES:      F D P I X W C RENAMED-STR INSTRUCTION-WINDOW REORDER-BUFFER A M L S B F X
TOTAL SLOTS:  4 4 16 5 10 4 99 24 16 99 2 1 1 0 1 4 1
BUSY SLOTS:   4 3 7 1 0 0 0 12 7 8 0 0 1 0 0 0 0
STALLS:       0 0 0 3 0 0 0 0 0 0 0 0 0 0 0 0 0
000] LW R2,0(R1) 0 1 2 3 P2,0(P1) 000> LW P2 P1 - 0 0 0 0 000) 000 R2 - 0 0 0 LQ(0)
001] LW R4,0(R3) 0 1 2 P4,0(P3) 001) LW P4 P3 - 0 0 0 0 001) 001 R4 - 0 0 0
002] ADD R5,R5,R2 0 1 2 P6,P5,P2 002) ADD P6 P5 P2 - 0 1 0 002) 002 R5 P5 0 0 0
003] ADD R5,R5,R4 0 1 2 P7,P6,P4 003) ADD P7 P6 P4 - 1 1 0 003) 003 R5 P6 0 0 0 SQ(0)
004] MUL R5,R5,R5 1 2 3 P8,P7,P7 000) MUL P8 P7 P7 - 1 1 0 004) 004 R5 P7 0 0 0
005] SW R5,0(R1) 1 2 3 P8,0(P1) 004) SW - P1 0 P8 0 0 1 005) 005 - - 1 0 0
006] SW R5,0(R3) 1 2 3 P8,0(P3) 005) SW - P3 0 P8 0 0 1 006) 006 - - 1 0 0
007] ADDI R1,R1,4 1 2 3 P9,P1,4 006) ADDI P9 P1 - 4 0 0 0 007) 007 R1 P1 0 0 0
008] ADDI R3,R3,4 2 3 P10,P3,4
009] ADDI R7,R7,-1 2 3 P12,P11,-1
010] BNE R7,R0,-11 2 3 P12,P0,-11
011] LW R2,0(R1) 3
012] LW R4,0(R3) 3
013] ADD R5,R5,R2 3
014] ADD R5,R5,R4 3

----- Press ENTER to continue (PC=4,IC=15,CK=4,IPC=3.75)...
PHYSICAL REGS: 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
                * * * * *
qi:  0 1 0 1 0 1 1 1 1 1 0 1 1 1 1 1 1 1 1 1 1 1
vi:  00 00 00 00 00 00 00 00 04 00 03 00 00 00 00 00 00 00 00 00 00 00
REG.FILE: Ri:  1 2 3 4 5 6 7 8
        Pi:  9 13 10 14 16 - 12 -
        Qi:  1 1 1 1 1 0 1 0
        Vi:  00001000 00000000 00003000 00000000 00000000 00000000 00000003 00000000

STAGES:      F D P I X W C RENAMED-STR INSTRUCTION-WINDOW REORDER-BUFFER A M L S B F X
TOTAL SLOTS:  4 4 16 5 10 4 99 24 16 99 2 1 1 0 1 4 1
BUSY SLOTS:   4 4 8 1 2 0 0 16 8 11 0 0 1 0 0 0 0
STALLS:       0 0 0 8 0 0 0 0 0 0 0 0 0 0 0 0 0
000] LW R2,0(R1) 0 1 2 3 4 P2,0(P1) 000) 000 R2 - 0 0 0 LQ(1)
001] LW R4,0(R3) 0 1 2 4 P4,0(P3) 001> LW P4 P3 - 0 0 0 0 001) 001 R4 - 0 0 0 00) LW P2 0 1000
002] ADD R5,R5,R2 0 1 2 P6,P5,P2 002) ADD P6 P5 P2 - 0 1 0 002) 002 R5 P5 0 0 0
003] ADD R5,R5,R4 0 1 2 P7,P6,P4 003) ADD P7 P6 P4 - 1 1 0 003) 003 R5 P6 0 0 0 SQ(0)
004] MUL R5,R5,R5 1 2 3 P8,P7,P7 000) MUL P8 P7 P7 - 1 1 0 004) 004 R5 P7 0 0 0
005] SW R5,0(R1) 1 2 3 P8,0(P1) 004) SW - P1 0 P8 0 0 1 005) 005 - - 1 0 0
006] SW R5,0(R3) 1 2 3 P8,0(P3) 005) SW - P3 0 P8 0 0 1 006) 006 - - 1 0 0
007] ADDI R1,R1,4 1 2 3 4 4 P9,P1,4 006> ADDI P9 P1 - 4 0 0 0 007) 007 R1 P1 0 0 0
008] ADDI R3,R3,4 2 3 4 P10,P3,4 001) ADDI P10 P3 - 4 0 0 0 008) 008 R3 P3 0 0 0
009] ADDI R7,R7,-1 2 3 4 P12,P11,-1 006) ADDI P12 P11 - -1 0 0 0 009) 009 R7 P11 0 0 0
010] BNE R7,R0,-11 2 3 4 P12,P0,-11 007) BNE - P12 P0 -11 1 0 0 010) 010 - - 0 0 0
011] LW R2,0(R1) 3 4 P13,0(P9)
012] LW R4,0(R3) 3 4 P14,0(P10)
013] ADD R5,R5,R2 3 4 P15,P8,P13
014] ADD R5,R5,R4 3 4 P16,P15,P14
015] MUL R5,R5,R5 4
016] SW R5,0(R1) 4
017] SW R5,0(R3) 4
018] ADDI R1,R1,4 4

----- Press ENTER to continue (PC=8,IC=19,CK=5,IPC=3.80)...
PHYSICAL REGS: 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
                * * * * *
qi:  0 0 0 1 0 1 1 1 1 0 1 1 1 1 1 1 1 1 1 1 1 1
vi:  00 00 00 00 00 00 00 00 04 04 03 00 00 00 00 00 00 00 00 00 00 00
REG.FILE: Ri:  1 2 3 4 5 6 7 8

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Pi:      18      13      10      14      17      -      12      -
Qi:      1      1      1      1      1      0      1      0
Vi: 00001004 00000000 00003000 00000000 00000000 00000000 00000003 00000000
STAGES:      F D P I X W C RENAMED-STR INSTRUCTION-WINDOW REORDER-BUFFER A M L S B F X
TOTAL SLOTS: 4 4 16 5 10 4 99 24 16 99 2 1 1 0 1 4 1
BUSY SLOTS:  3 4 8 1 4 1 0 18 8 15 0 0 1 0 0 0 0
STALLS:      0 0 0 12 0 0 0 0 0 0 1 0 4 0 0 0 0
000] LW R2,0(R1) 0 1 2 3 4 5 P2,0(P1) 000) 000 R2 - 0 0 1 LQ(1)
001] LW R4,0(R3) 0 1 2 4 5 P4,0(P3) 001) 001 R4 - 0 0 0 01) LW P4 0 3000
002] ADD R5,R5,R2 0 1 2 5 5 P6,P5,P2 002> ADD P6 P5 P2 - 0 0 0 002) 002 R5 P5 0 0 0
003] ADD R5,R5,R4 0 1 2 P7,P6,P4 003) ADD P7 P6 P4 - 1 1 0 003) 003 R5 P6 0 0 0 SQ(0)
004] MUL R5,R5,R5 1 2 3 P8,P7,P7 000) MUL P8 P7 P7 - 1 1 0 004) 004 R5 P7 0 0 0
005] SW R5,0(R1) 1 2 3 5 P8,0(P1) 004> SW - P1 0 P8 0 0 1 005) 005 - - 1 0 0
006] SW R5,0(R3) 1 2 3 P8,0(P3) 005) SW - P3 0 P8 0 0 1 006) 006 - - 1 0 0
007] ADDI R1,R1,4 1 2 3 4 4 5 P9,P1,4 007) 007 R1 P1 0 0 1
008] ADDI R3,R3,4 2 3 4 5 5 P10,P3,4 001> ADDI P10 P3 - 4 0 0 0 008) 008 R3 P3 0 0 0
009] ADDI R7,R7,-1 2 3 4 P12,P11,-1 006) ADDI P12 P11 - -1 0 0 0 009) 009 R7 P11 0 0 0
010] BNE R7,R0,-11 2 3 4 5 5 P12,P0,-11 007> BNE - P12 P0 -11 1 0 0 010) 010 - - 0 0 0
011] LW R2,0(R1) 3 4 5 P13,0(P9) 001) LW P13 P9 - 0 0 0 0 011) 000 R2 P2 0 0 0
012] LW R4,0(R3) 3 4 5 P14,0(P10) 002) LW P14 P10 - 0 1 0 0 012) 001 R4 P4 0 0 0
013] ADD R5,R5,R2 3 4 5 P15,P8,P13 004) ADD P15 P8 P13 - 1 1 0 013) 002 R5 P8 0 0 0
014] ADD R5,R5,R4 3 4 5 P16,P15,P14 007) ADD P16 P15 P14 - 1 1 0 014) 003 R5 P15 0 0 0
015] MUL R5,R5,R5 4 5 P17,P16,P16
016] SW R5,0(R1) 4 5 P17,0(P9)
017] SW R5,0(R3) 4 5 P17,0(P10)
018] ADDI R1,R1,4 4 5 P18,P9,4
019] ADDI R3,R3,4 5
020] ADDI R7,R7,-1 5
021] BNE R7,R0,-11 5

```

Press ENTER to continue (PC=0,IC=22,CK=6,IPC=3.67)...

```

PHYSICAL REGS: 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
qi: 0 0 0 0 0 0 1 1 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1
vi: 00 00 00 00 00 00 00 00 04 04 03 02 00 00 00 00 00 00 00 00 00 00 00
REG.FILE: Ri: 1 2 3 4 5 6 7 8
Pi: 18 13 19 14 17 - 20 -
Qi: 1 1 1 1 1 0 1 0
Vi: 00001004 00000000 00003004 00000000 00000000 00000000 00000003 00000000
STAGES:      F D P I X W C RENAMED-STR INSTRUCTION-WINDOW REORDER-BUFFER A M L S B F X
TOTAL SLOTS: 4 4 16 5 10 4 99 24 16 99 2 1 1 0 1 4 1
BUSY SLOTS:  4 3 9 2 2 1 0 20 9 18 0 0 1 0 0 0 0
STALLS:      0 0 0 17 1 0 0 0 0 0 1 0 6 0 0 0 0
000] LW R2,0(R1) 0 1 2 3 4 5 6 P2,0(P1) 001) 001 R4 - 0 0 1 LQ(0)
001] LW R4,0(R3) 0 1 2 4 5 6 P4,0(P3) 002) 002 R5 P5 0 0 1
002] ADD R5,R5,R2 0 1 2 5 5 6 P6,P5,P2 003) 003 R5 P6 0 0 0 SQ(1)
003] ADD R5,R5,R4 0 1 2 6 6 P7,P6,P4 003> ADD P7 P6 P4 - 0 0 0 004) 004 R5 P7 0 0 0 05) SW P8 1 1000
004] MUL R5,R5,R5 1 2 3 P8,P7,P7 000) MUL P8 P7 P7 - 1 1 0
005] SW R5,0(R1) 1 2 3 5 P8,0(P1) 005> SW - P3 0 P8 0 0 1 005) 005 - - 1 0 0
006] SW R5,0(R3) 1 2 3 6 P8,0(P3) 006) 006 - - 1 0 0
007] ADDI R1,R1,4 1 2 3 4 4 5 P9,P1,4 007) 007 R1 P1 0 0 1
008] ADDI R3,R3,4 2 3 4 5 5 6 P10,P3,4 008) 008 R3 P3 0 0 1
009] ADDI R7,R7,-1 2 3 4 6 6 P12,P11,-1 006> ADDI P12 P11 - -1 0 0 0 009) 009 R7 P11 0 0 0
010] BNE R7,R0,-11 2 3 4 5 5 6 P12,P0,-11 010) 010 - - 0 0 1
011] LW R2,0(R1) 3 4 5 P13,0(P9) 001) LW P13 P9 - 0 0 0 0 011) 000 R2 P2 0 0 0
012] LW R4,0(R3) 3 4 5 P14,0(P10) 002) LW P14 P10 - 0 0 0 0 012) 001 R4 P4 0 0 0
013] ADD R5,R5,R2 3 4 5 P15,P8,P13 004) ADD P15 P8 P13 - 1 1 0 013) 002 R5 P8 0 0 0
014] ADD R5,R5,R4 3 4 5 P16,P15,P14 007) ADD P16 P15 P14 - 1 1 0 014) 003 R5 P15 0 0 0
015] MUL R5,R5,R5 4 5 6 P17,P16,P16 003) MUL P17 P16 P16 - 1 1 0 015) 004 R5 P16 0 0 0
016] SW R5,0(R1) 4 5 6 P17,0(P9) 005) SW - P9 0 P17 0 0 1 016) 005 - - 1 0 0
017] SW R5,0(R3) 4 5 6 P17,0(P10) 006) SW - P10 0 P17 0 0 1 017) 006 - - 1 0 0
018] ADDI R1,R1,4 4 5 6 P18,P9,4 008) ADDI P18 P9 - 4 0 0 0 018) 007 R1 P9 0 0 0
019] ADDI R3,R3,4 5 6 P19,P10,4
020] ADDI R7,R7,-1 5 6 P20,P12,-1
021] BNE R7,R0,-11 5 6 P20,P0,-11

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```
022] LW R2,0(R1) 6
023] LW R4,0(R3) 6
024] ADD R5,R5,R2 6
025] ADD R5,R5,R4 6
```

Press ENTER to continue (PC=4,IC=26,CK=7,IPC=3.71)...

```
PHYSICAL REGS: 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
                * * * * *
qi: 0 0 0 0 1 0 0 1 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1
vi: 00 00 00 00 00 00 00 00 04 04 03 02 00 00 00 00 00 08 00 00 00 00 00
REG.FILE: Ri: 1 2 3 4 5 6 7 8
          Pi: 18 21 19 22 24 - 20 -
          Qi: 1 1 1 1 1 0 1 0
          Vi: 00001004 00000000 00003004 00000000 00000000 00000000 00000002 00000000
```

```
STAGES: F D P I X W C RENAMED-STR INSTRUCTION-WINDOW REORDER-BUFFER A M L S B F X
TOTAL SLOTS: 4 4 16 5 10 4 99 24 16 99 2 1 1 0 1 4 1
BUSY SLOTS: 4 4 9 3 2 1 0 23 9 19 0 0 1 0 0 0 0
STALLS: 0 0 0 23 3 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
000] LW R2,0(R1) 0 1 2 3 4 5 6 P2,0(P1)
001] LW R4,0(R3) 0 1 2 4 5 6 7 P4,0(P3)
002] ADD R5,R5,R2 0 1 2 5 5 6 7 P6,P5,P2
003] ADD R5,R5,R4 0 1 2 6 6 7 P7,P6,P4
004] MUL R5,R5,R5 1 2 3 7 7 P8,P7,P7 000> MUL P8 P7 P7 - 0 0 0 003) 003 R5 P6 0 0 1 SQ(2)
005] SW R5,0(R1) 1 2 3 5 P8,0(P1) 004) 004 R5 P7 0 0 0 05) SW P8 1 1000
006] SW R5,0(R3) 1 2 3 6 P8,0(P3) 005) 005 - - 1 0 0 06) SW P8 1 3000
007] ADDI R1,R1,4 1 2 3 4 4 5 P9,P1,4 006) 006 - - 1 0 0
008] ADDI R3,R3,4 2 3 4 5 5 6 P10,P3,4 007) 007 R1 P1 0 0 1
009] ADDI R7,R7,-1 2 3 4 6 6 7 P12,P11,-1 008) 008 R3 P3 0 0 1
010] BNE R7,R0,-11 2 3 4 5 5 6 P12,P0,-11 009) 009 R7 P11 0 0 1
011] LW R2,0(R1) 3 4 5 7 P13,0(P9) 010) 010 - - 0 0 1
012] LW R4,0(R3) 3 4 5 P14,0(P10) 011) 000 R2 P2 0 0 0
013] ADD R5,R5,R2 3 4 5 P15,P8,P13 012) 001 R4 P4 0 0 0
014] ADD R5,R5,R4 3 4 5 P16,P15,P14 013) 002 R5 P8 0 0 0
015] MUL R5,R5,R5 4 5 6 P17,P16,P16 014) 003 R5 P15 0 0 0
016] SW R5,0(R1) 4 5 6 P17,0(P9) 015) 004 R5 P16 0 0 0
017] SW R5,0(R3) 4 5 6 P17,0(P10) 016) 005 - - 1 0 0
018] ADDI R1,R1,4 4 5 6 7 7 P18,P9,4 017) 006 - - 1 0 0
019] ADDI R3,R3,4 5 6 7 P19,P10,4 018) 007 R1 P9 0 0 0
020] ADDI R7,R7,-1 5 6 7 P20,P12,-1 019) 008 R3 P10 0 0 0
021] BNE R7,R0,-11 5 6 7 P20,P0,-11 020) 009 R7 P12 0 0 0
022] LW R2,0(R1) 6 7 P21,0(P18) 021) 010 - - 0 0 0
023] LW R4,0(R3) 6 7 P22,0(P19)
024] ADD R5,R5,R2 6 7 P23,P17,P21
025] ADD R5,R5,R4 6 7 P24,P23,P22
026] MUL R5,R5,R5 7
027] SW R5,0(R1) 7
028] SW R5,0(R3) 7
029] ADDI R1,R1,4 7
```

Press ENTER to continue (PC=8,IC=30,CK=8,IPC=3.75)...

```
PHYSICAL REGS: 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
                * * * * *
qi: 0 0 0 0 1 1 0 1 0 0 0 0 1 1 1 1 1 0 1 1 1 1 1
vi: 00 00 00 00 00 00 00 00 04 04 03 02 00 00 00 00 00 08 08 00 00 00 00
REG.FILE: Ri: 1 2 3 4 5 6 7 8
          Pi: 6 21 19 22 5 - 20 -
          Qi: 1 1 1 1 1 0 1 0
          Vi: 00001008 00000000 00003004 00000000 00000000 00000000 00000002 00000000
```

```
STAGES: F D P I X W C RENAMED-STR INSTRUCTION-WINDOW REORDER-BUFFER A M L S B F X
TOTAL SLOTS: 4 4 16 5 10 4 99 24 16 99 2 1 1 0 1 4 1
BUSY SLOTS: 3 4 11 3 3 1 0 24 11 22 0 0 1 0 0 0 0
STALLS: 0 0 0 30 5 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
000] LW R2,0(R1) 0 1 2 3 4 5 6 P2,0(P1)
001] LW R4,0(R3) 0 1 2 4 5 6 7 P4,0(P3)
002] ADD R5,R5,R2 0 1 2 5 5 6 7 P6,P5,P2
003] ADD R5,R5,R4 0 1 2 6 6 7 8 P7,P6,P4
                                LQ(1)
                                11) LW P13 0 1004
                                SQ(2)
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004] MUL R5,R5,R5      1 2 3 7 7      P8,P7,P7      004) 004 R5 P7 0 0 0 05) SW P8 1 1000
005] SW R5,0(R1)      1 2 3 5      P8,0(P1)      005) 005 - - 1 0 0 06) SW P8 1 3000
006] SW R5,0(R3)      1 2 3 6      P8,0(P3)      006) 006 - - 1 0 0
007] ADDI R1,R1,4      1 2 3 4 4 5      P9,P1,4      007) 007 R1 P1 0 0 1
008] ADDI R3,R3,4      2 3 4 5 5 6      P10,P3,4      008) 008 R3 P3 0 0 1
009] ADDI R7,R7,-1     2 3 4 6 6 7      P12,P11,-1     009) 009 R7 P11 0 0 1
010] BNE R7,R0,-11    2 3 4 5 5 6      P12,P0,-11     010) 010 - - 0 0 1
011] LW R2,0(R1)      3 4 5 7 8      P13,0(P9)      011) 000 R2 P2 0 0 0
012] LW R4,0(R3)      3 4 5 8      P14,0(P10)     012) 001 R4 P4 0 0 0
013] ADD R5,R5,R2      3 4 5      P15,P8,P13     004) ADD P15 P8 P13 - 1 1 0 013) 002 R5 P8 0 0 0
014] ADD R5,R5,R4      3 4 5      P16,P15,P14     007) ADD P16 P15 P14 - 1 1 0 014) 003 R5 P15 0 0 0
015] MUL R5,R5,R5      4 5 6      P17,P16,P16     003) MUL P17 P16 P16 - 1 1 0 015) 004 R5 P16 0 0 0
016] SW R5,0(R1)      4 5 6      P17,0(P9)      005) SW - P9 0 P17 0 0 1 016) 005 - - 1 0 0
017] SW R5,0(R3)      4 5 6      P17,0(P10)     006) SW - P10 0 P17 0 0 1 017) 006 - - 1 0 0
018] ADDI R1,R1,4      4 5 6 7 7 8      P18,P9,4      018) 007 R1 P9 0 0 1
019] ADDI R3,R3,4      5 6 7 8 8      P19,P10,4     000> ADDI P19 P10 - 4 0 0 0 019) 008 R3 P10 0 0 0
020] ADDI R7,R7,-1     5 6 7      P20,P12,-1     001) ADDI P20 P12 - -1 0 0 0 020) 009 R7 P12 0 0 0
021] BNE R7,R0,-11    5 6 7      P20,P0,-11     008) BNE - P20 P0 -11 1 0 0 021) 010 - - 0 0 0
022] LW R2,0(R1)      6 7 8      P21,0(P18)     000) LW P21 P18 - 0 0 0 0 022) 000 R2 P13 0 0 0
023] LW R4,0(R3)      6 7 8      P22,0(P19)     002) LW P22 P19 - 0 1 0 0 023) 001 R4 P14 0 0 0
024] ADD R5,R5,R2      6 7 8      P23,P17,P21     009) ADD P23 P17 P21 - 1 1 0 024) 002 R5 P17 0 0 0
025] ADD R5,R5,R4      6 7 8      P24,P23,P22     010) ADD P24 P23 P22 - 1 1 0 025) 003 R5 P23 0 0 0
026] MUL R5,R5,R5      7 8      P5,P24,P24
027] SW R5,0(R1)      7 8      P5,0(P18)
028] SW R5,0(R3)      7 8      P5,0(P19)
029] ADDI R1,R1,4      7 8      P6,P18,4
030] ADDI R3,R3,4      8
031] ADDI R7,R7,-1     8
032] BNE R7,R0,-11    8

```

Press ENTER to continue (PC=12,IC=33,CK=9,IPC=3.67)...

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PHYSICAL REGS: 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
                * * * * *
qi: 0 0 0 0 1 1 0 1 0 0 0 0 0 1 1 1 1 0 0 1 1 1 1 1
vi: 00 00 00 00 00 00 00 00 04 04 03 02 00 00 00 00 00 08 08 01 00 00 00 00
REG.FILE: Ri: 1 2 3 4 5 6 7 8
        Pi: 6 21 19 22 5 - 20 -
        Qi: 1 1 0 1 1 0 1 0
        Vi: 00001008 00000000 00003008 00000000 00000000 00000000 00000000 00000000
STAGES: F D P I X W C RENAMED-STR INSTRUCTION-WINDOW REORDER-BUFFER A M L S B F X
TOTAL SLOTS: 4 4 16 5 10 4 99 24 16 99 2 1 1 0 1 4 1
BUSY SLOTS: 3 0 13 3 3 1 0 24 13 26 0 0 1 0 0 0 0
STALLS: 0 1 0 39 7 0 0 1 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0
000] LW R2,0(R1) 0 1 2 3 4 5 6 P2,0(P1) 004) 004 R5 P7 0 0 0 05) SW P8 1 1000
001] LW R4,0(R3) 0 1 2 4 5 6 7 P4,0(P3) 005) 005 - - 1 0 0 06) SW P8 1 3000
002] ADD R5,R5,R2 0 1 2 5 5 6 7 P6,P5,P2 006) 006 - - 1 0 0
003] ADD R5,R5,R4 0 1 2 6 6 7 8 P7,P6,P4 007) 007 R1 P1 0 0 1
004] MUL R5,R5,R5 1 2 3 7 7 P8,P7,P7 008) 008 R3 P3 0 0 1
005] SW R5,0(R1) 1 2 3 5 P8,0(P1) 009) 009 R7 P11 0 0 1
006] SW R5,0(R3) 1 2 3 6 P8,0(P3) 010) 010 - - 0 0 1
007] ADDI R1,R1,4 1 2 3 4 4 5 P9,P1,4 011) 000 R2 P2 0 0 1
008] ADDI R3,R3,4 2 3 4 5 5 6 P10,P3,4 012) 001 R4 P4 0 0 0
009] ADDI R7,R7,-1 2 3 4 6 6 7 P12,P11,-1 013) 002 R5 P8 0 0 0
010] BNE R7,R0,-11 2 3 4 5 5 6 P12,P0,-11 014) 003 R5 P15 0 0 0
011] LW R2,0(R1) 3 4 5 7 8 9 P13,0(P9) 015) 004 R5 P16 0 0 0
012] LW R4,0(R3) 3 4 5 8 9 P14,0(P10) 016) 005 - - 1 0 0
013] ADD R5,R5,R2 3 4 5 P15,P8,P13 004) ADD P15 P8 P13 - 1 0 0 017) 006 - - 1 0 0
014] ADD R5,R5,R4 3 4 5 P16,P15,P14 007) ADD P16 P15 P14 - 1 1 0 018) 007 R1 P9 0 0 1
015] MUL R5,R5,R5 4 5 6 P17,P16,P16 003) MUL P17 P16 P16 - 1 1 0 019) 008 R3 P10 0 0 1
016] SW R5,0(R1) 4 5 6 9 P17,0(P9) 005> SW - P9 0 P17 0 0 1 020) 009 R7 P12 0 0 0
017] SW R5,0(R3) 4 5 6 P17,0(P10) 006) SW - P10 0 P17 0 0 1 021) 010 - - 0 0 0
018] ADDI R1,R1,4 4 5 6 7 7 8 P18,P9,4
019] ADDI R3,R3,4 5 6 7 8 8 9 P19,P10,4
020] ADDI R7,R7,-1 5 6 7 9 9 P20,P12,-1 001> ADDI P20 P12 - -1 0 0 0
021] BNE R7,R0,-11 5 6 7 P20,P0,-11 008) BNE - P20 P0 -11 1 0 0

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022] LW R2,0(R1) 6 7 8 P21,0(P18) 000) LW P21 P18 - 0 0 0 0 022) 000 R2 P13 0 0 0
023] LW R4,0(R3) 6 7 8 P22,0(P19) 002) LW P22 P19 - 0 0 0 0 023) 001 R4 P14 0 0 0
024] ADD R5,R5,R2 6 7 8 P23,P17,P21 009) ADD P23 P17 P21 - 1 1 0 024) 002 R5 P17 0 0 0
025] ADD R5,R5,R4 6 7 8 P24,P23,P22 010) ADD P24 P23 P22 - 1 1 0 025) 003 R5 P23 0 0 0
026] MUL R5,R5,R5 7 8 9 P5,P24,P24 001) MUL P5 P24 P24 - 1 1 0 026) 004 R5 P24 0 0 0
027] SW R5,0(R1) 7 8 9 P5,0(P18) 005) SW - P18 0 P5 0 0 1 027) 005 - - 1 0 0
028] SW R5,0(R3) 7 8 9 P5,0(P19) 011) SW - P19 0 P5 0 0 1 028) 006 - - 1 0 0
029] ADDI R1,R1,4 7 8 9 P6,P18,4 012) ADDI P6 P18 - 4 0 0 0 029) 007 R1 P18 0 0 0
030] ADDI R3,R3,4 8
031] ADDI R7,R7,-1 8
032] BNE R7,R0,-11 8

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Press ENTER to continue (PC=12,IC=33,CK=10,IPC=3.30)...

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PHYSICAL REGS: 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
                * * * * *
qi: 0 0 0 0 1 1 0 1 0 0 0 0 0 0 1 1 1 0 0 0 1 1 1 1
vi: 00 00 00 00 00 00 00 00 04 04 03 02 00 00 00 00 00 08 08 01 00 00 00 00
REG.FILE: Ri: 1 2 3 4 5 6 7 8
         Pi: 6 21 19 22 5 - 20 -
         Qi: 1 1 0 1 1 0 0 0
         Vi: 00001008 00000000 00003008 00000000 00000000 00000000 00000000 00000001 00000000
STAGES: F D P I X W C RENAMED-STR INSTRUCTION-WINDOW REORDER-BUFFER A M L S B F X
TOTAL SLOTS: 4 4 16 5 10 4 99 24 16 99 2 1 1 0 1 4 1
BUSY SLOTS: 3 0 11 4 2 1 0 24 11 26 0 0 1 0 0 0 0
STALLS: 0 2 0 50 10 0 0 2 0 0 1 0 12 0 0 0
000] LW R2,0(R1) 0 1 2 3 4 5 6 P2,0(P1) 004) 004 R5 P7 0 0 0 SQ(3)
001] LW R4,0(R3) 0 1 2 4 5 6 7 P4,0(P3) 005) 005 - - 1 0 0 05) SW P8 1 1000
002] ADD R5,R5,R2 0 1 2 5 5 6 7 P6,P5,P2 006) 006 - - 1 0 0 06) SW P8 1 3000
003] ADD R5,R5,R4 0 1 2 6 6 7 8 P7,P6,P4 007) 007 R1 P1 0 0 1 16) SW P17 1 1004
004] MUL R5,R5,R5 1 2 3 7 7 P8,P7,P7 008) 008 R3 P3 0 0 1
005] SW R5,0(R1) 1 2 3 5 P8,0(P1) 009) 009 R7 P11 0 0 1
006] SW R5,0(R3) 1 2 3 6 P8,0(P3) 010) 010 - - 0 0 1
007] ADDI R1,R1,4 1 2 3 4 4 5 P9,P1,4 011) 000 R2 P2 0 0 1
008] ADDI R3,R3,4 2 3 4 5 5 6 P10,P3,4 012) 001 R4 P4 0 0 1
009] ADDI R7,R7,-1 2 3 4 6 6 7 P12,P11,-1 013) 002 R5 P8 0 0 0
010] BNE R7,R0,-11 2 3 4 5 5 6 P12,P0,-11 014) 003 R5 P15 0 0 0
011] LW R2,0(R1) 3 4 5 7 8 9 P13,0(P9) 015) 004 R5 P16 0 0 0
012] LW R4,0(R3) 3 4 5 8 9 10 P14,0(P10) 016) 005 - - 1 0 0
013] ADD R5,R5,R2 3 4 5 P15,P8,P13 004) ADD P15 P8 P13 - 1 0 0 017) 006 - - 1 0 0
014] ADD R5,R5,R4 3 4 5 P16,P15,P14 007) ADD P16 P15 P14 - 1 0 0 018) 007 R1 P9 0 0 1
015] MUL R5,R5,R5 4 5 6 P17,P16,P16 003) MUL P17 P16 P16 - 1 1 0 019) 008 R3 P10 0 0 1
016] SW R5,0(R1) 4 5 6 9 P17,0(P9) 006> SW - P10 0 P17 0 0 1 020) 009 R7 P12 0 0 1
017] SW R5,0(R3) 4 5 6 10 P17,0(P10) 008> BNE - P20 P0 -11 0 0 0 021) 010 - - 0 0 0
018] ADDI R1,R1,4 4 5 6 7 7 8 P18,P9,4 000) LW P21 P18 - 0 0 0 0 022) 000 R2 P13 0 0 0
019] ADDI R3,R3,4 5 6 7 8 8 9 P19,P10,4 002) LW P22 P19 - 0 0 0 0 023) 001 R4 P14 0 0 0
020] ADDI R7,R7,-1 5 6 7 9 9 10 P20,P12,-1 009) ADD P23 P17 P21 - 1 1 0 024) 002 R5 P17 0 0 0
021] BNE R7,R0,-11 5 6 7 10 10 P20,P0,-11 010) ADD P24 P23 P22 - 1 1 0 025) 003 R5 P23 0 0 0
022] LW R2,0(R1) 6 7 8 P21,0(P18) 000) LW P21 P18 - 0 0 0 0 026) 004 R5 P24 0 0 0
023] LW R4,0(R3) 6 7 8 P22,0(P19) 002) LW P22 P19 - 0 0 0 0 027) 005 - - 1 0 0
024] ADD R5,R5,R2 6 7 8 P23,P17,P21 009) ADD P23 P17 P21 - 1 1 0 028) 006 - - 1 0 0
025] ADD R5,R5,R4 6 7 8 P24,P23,P22 010) ADD P24 P23 P22 - 1 1 0 029) 007 R1 P18 0 0 0
026] MUL R5,R5,R5 7 8 9 P5,P24,P24 001) MUL P5 P24 P24 - 1 1 0
027] SW R5,0(R1) 7 8 9 P5,0(P18) 005) SW - P18 0 P5 0 0 1
028] SW R5,0(R3) 7 8 9 P5,0(P19) 011) SW - P19 0 P5 0 0 1
029] ADDI R1,R1,4 7 8 9 P6,P18,4 012) ADDI P6 P18 - 4 0 0 0
030] ADDI R3,R3,4 8
031] ADDI R7,R7,-1 8
032] BNE R7,R0,-11 8

```

Press ENTER to continue (PC=12,IC=33,CK=11,IPC=3.00)...

```

PHYSICAL REGS: 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
                * * * * *
qi: 0 0 0 0 1 1 0 1 0 0 0 0 0 0 1 1 1 0 0 0 1 1 1 1
vi: 00 00 00 00 00 00 00 00 04 04 03 02 00 00 00 00 00 08 08 01 00 00 00 00
REG.FILE: Ri: 1 2 3 4 5 6 7 8
         Pi: 6 21 19 22 5 - 20 -

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      Qi: 1 1 0 1 0 0
      Vi: 00001008 00000000 00003008 00000000 00000000 00000000 00000001 00000000
STAGES: F D P I X W C RENAMED-STR INSTRUCTION-WINDOW REORDER-BUFFER A M L S B F X
TOTAL SLOTS: 4 4 16 5 10 4 99 24 16 99 2 1 1 0 1 4 1
BUSY SLOTS: 3 0 10 5 1 1 0 24 10 26 0 0 1 0 0 0 0
STALLS: 0 3 0 60 14 0 0 3 0 0 1 0 12 0 0 0 0
000] LW R2,0(R1) 0 1 2 3 4 5 6 P2,0(P1) LQ(0)
001] LW R4,0(R3) 0 1 2 4 5 6 7 P4,0(P3)
002] ADD R5,R5,R2 0 1 2 5 5 6 7 P6,P5,P2
003] ADD R5,R5,R4 0 1 2 6 6 7 8 P7,P6,P4
004] MUL R5,R5,R5 1 2 3 7 7 P8,P7,P7
005] SW R5,0(R1) 1 2 3 5 P8,0(P1)
006] SW R5,0(R3) 1 2 3 6 P8,0(P3)
007] ADDI R1,R1,4 1 2 3 4 4 5 P9,P1,4
008] ADDI R3,R3,4 2 3 4 5 5 6 P10,P3,4
009] ADDI R7,R7,-1 2 3 4 6 6 7 P12,P11,-1
010] BNE R7,R0,-11 2 3 4 5 5 6 P12,P0,-11
011] LW R2,0(R1) 3 4 5 7 8 9 P13,0(P9)
012] LW R4,0(R3) 3 4 5 8 9 10 P14,0(P10)
013] ADD R5,R5,R2 3 4 5 P15,P8,P13 004) ADD P15 P8 P13 - 1 0 0
014] ADD R5,R5,R4 3 4 5 P16,P15,P14 007) ADD P16 P15 P14 - 1 0 0
015] MUL R5,R5,R5 4 5 6 P17,P16,P16 003) MUL P17 P16 P16 - 1 1 0
016] SW R5,0(R1) 4 5 6 9 P17,0(P9)
017] SW R5,0(R3) 4 5 6 10 P17,0(P10)
018] ADDI R1,R1,4 4 5 6 7 7 8 P18,P9,4
019] ADDI R3,R3,4 5 6 7 8 8 9 P19,P10,4
020] ADDI R7,R7,-1 5 6 7 9 9 10 P20,P12,-1
021] BNE R7,R0,-11 5 6 7 10 10 11 P20,P0,-11
022] LW R2,0(R1) 6 7 8 11 P21,0(P18) 000> LW P21 P18 - 0 0 0 0
023] LW R4,0(R3) 6 7 8 P22,0(P19) 002) LW P22 P19 - 0 0 0 0
024] ADD R5,R5,R2 6 7 8 P23,P17,P21 009) ADD P23 P17 P21 - 1 1 0
025] ADD R5,R5,R4 6 7 8 P24,P23,P22 010) ADD P24 P23 P22 - 1 1 0
026] MUL R5,R5,R5 7 8 9 P5,P24,P24 001) MUL P5 P24 P24 - 1 1 0
027] SW R5,0(R1) 7 8 9 P5,0(P18) 005) SW - P18 0 P5 0 0 1
028] SW R5,0(R3) 7 8 9 P5,0(P19) 011) SW - P19 0 P5 0 0 1
029] ADDI R1,R1,4 7 8 9 P6,P18,4 012) ADDI P6 P18 - 4 0 0 0
030] ADDI R3,R3,4 8
031] ADDI R7,R7,-1 8
032] BNE R7,R0,-11 8

```

Press ENTER to continue (PC=12,IC=33,CK=12,IPC=2.75)...

```

PHYSICAL REGS: 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
                * * * * *
      qi: 0 0 0 0 1 1 0 0 0 0 0 0 0 0 1 1 1 0 0 0 1 1 1 1
      vi: 00 00 00 00 00 00 00 00 04 04 03 02 00 00 00 00 00 08 08 01 00 00 00 00
REG.FILE: Ri: 1 2 3 4 5 6 7 8
          Pi: 6 21 19 22 5 - 20 -
          Qi: 1 1 0 1 1 0 0
          Vi: 00001008 00000000 00003008 00000000 00000000 00000000 00000001 00000000
STAGES: F D P I X W C RENAMED-STR INSTRUCTION-WINDOW REORDER-BUFFER A M L S B F X
TOTAL SLOTS: 4 4 16 5 10 4 99 24 16 99 2 1 1 0 1 4 1
BUSY SLOTS: 3 0 10 2 3 1 0 24 10 26 0 0 0 0 0 0 0
STALLS: 0 4 0 70 16 0 0 4 0 0 1 0 12 0 0 0 0
000] LW R2,0(R1) 0 1 2 3 4 5 6 P2,0(P1) LQ(1)
001] LW R4,0(R3) 0 1 2 4 5 6 7 P4,0(P3) 22) LW P21 0 1008
002] ADD R5,R5,R2 0 1 2 5 5 6 7 P6,P5,P2
003] ADD R5,R5,R4 0 1 2 6 6 7 8 P7,P6,P4
004] MUL R5,R5,R5 1 2 3 7 7 12 P8,P7,P7
005] SW R5,0(R1) 1 2 3 5 12 P8,0(P1)
006] SW R5,0(R3) 1 2 3 6 12 P8,0(P3)
007] ADDI R1,R1,4 1 2 3 4 4 5 P9,P1,4
008] ADDI R3,R3,4 2 3 4 5 5 6 P10,P3,4
009] ADDI R7,R7,-1 2 3 4 6 6 7 P12,P11,-1
010] BNE R7,R0,-11 2 3 4 5 5 6 P12,P0,-11
011] LW R2,0(R1) 3 4 5 7 8 9 P13,0(P9)

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012] LW R4,0(R3) 3 4 5 8 9 10 P14,0(P10)
013] ADD R5,R5,R2 3 4 5 P15,P8,P13
014] ADD R5,R5,R4 3 4 5 P16,P15,P14
015] MUL R5,R5,R5 4 5 6 P17,P16,P16
016] SW R5,0(R1) 4 5 6 9 P17,0(P9)
017] SW R5,0(R3) 4 5 6 10 P17,0(P10)
018] ADDI R1,R1,4 4 5 6 7 7 8 P18,P9,4
019] ADDI R3,R3,4 5 6 7 8 8 9 P19,P10,4
020] ADDI R7,R7,-1 5 6 7 9 9 10 P20,P12,-1
021] BNE R7,R0,-11 5 6 7 10 10 11 P20,P0,-11
022] LW R2,0(R1) 6 7 8 11 12 P21,0(P18)
023] LW R4,0(R3) 6 7 8 P22,0(P19)
024] ADD R5,R5,R2 6 7 8 P23,P17,P21
025] ADD R5,R5,R4 6 7 8 P24,P23,P22
026] MUL R5,R5,R5 7 8 9 P5,P24,P24
027] SW R5,0(R1) 7 8 9 P5,0(P18)
028] SW R5,0(R3) 7 8 9 P5,0(P19)
029] ADDI R1,R1,4 7 8 9 P6,P18,4
030] ADDI R3,R3,4 8
031] ADDI R7,R7,-1 8
032] BNE R7,R0,-11 8

```

Press ENTER to continue (PC=12,IC=33,CK=13,IPC=2.54)...

```

PHYSICAL REGS: 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
                * * * * *
qi: 0 0 0 0 1 1 1 0 0 0 0 0 0 0 1 1 1 0 0 0 0 1 1 1
vi: 00 00 00 00 00 0C 00 00 04 04 03 02 00 00 00 00 00 08 08 01 00 00 00 00
REG.FILE: Ri: 1 2 3 4 5 6 7 8
          Pi: 6 21 7 22 5 - 20 -
          Qi: 1 0 1 1 1 0 0
          Vi: 00001008 00000000 00003008 00000000 00000000 00000000 00000000 00000001 00000000

```

```

STAGES: F D P I X W C RENAMED-STR INSTRUCTION-WINDOW
TOTAL SLOTS: 4 4 16 5 10 4 99 24
BUSY SLOTS: 2 1 7 3 2 1 0 24
STALLS: 0 5 0 77 18 0 0 5

```

```

000] LW R2,0(R1) 0 1 2 3 4 5 6 P2,0(P1)
001] LW R4,0(R3) 0 1 2 4 5 6 7 P4,0(P3)
002] ADD R5,R5,R2 0 1 2 5 5 6 7 P6,P5,P2
003] ADD R5,R5,R4 0 1 2 6 6 7 8 P7,P6,P4
004] MUL R5,R5,R5 1 2 3 7 7 12 13 P8,P7,P7
005] SW R5,0(R1) 1 2 3 5 12 13 P8,0(P1)
006] SW R5,0(R3) 1 2 3 6 12 13 P8,0(P3)
007] ADDI R1,R1,4 1 2 3 4 4 5 P9,P1,4
008] ADDI R3,R3,4 2 3 4 5 5 6 P10,P3,4
009] ADDI R7,R7,-1 2 3 4 6 6 7 P12,P11,-1
010] BNE R7,R0,-11 2 3 4 5 5 6 P12,P0,-11
011] LW R2,0(R1) 3 4 5 7 8 9 P13,0(P9)
012] LW R4,0(R3) 3 4 5 8 9 10 P14,0(P10)
013] ADD R5,R5,R2 3 4 5 13 13 P15,P8,P13
014] ADD R5,R5,R4 3 4 5 P16,P15,P14
015] MUL R5,R5,R5 4 5 6 P17,P16,P16
016] SW R5,0(R1) 4 5 6 9 P17,0(P9)
017] SW R5,0(R3) 4 5 6 10 P17,0(P10)
018] ADDI R1,R1,4 4 5 6 7 7 8 P18,P9,4
019] ADDI R3,R3,4 5 6 7 8 8 9 P19,P10,4
020] ADDI R7,R7,-1 5 6 7 9 9 10 P20,P12,-1
021] BNE R7,R0,-11 5 6 7 10 10 11 P20,P0,-11
022] LW R2,0(R1) 6 7 8 11 12 13 P21,0(P18)
023] LW R4,0(R3) 6 7 8 13 P22,0(P19)
024] ADD R5,R5,R2 6 7 8 P23,P17,P21
025] ADD R5,R5,R4 6 7 8 P24,P23,P22
026] MUL R5,R5,R5 7 8 9 P5,P24,P24
027] SW R5,0(R1) 7 8 9 P5,0(P18)
028] SW R5,0(R3) 7 8 9 P5,0(P19)
029] ADDI R1,R1,4 7 8 9 13 13 P6,P18,4

```

```

REORDER-BUFFER A M L S B F X
99 2 1 1 0 1 4 1
25 0 0 1 0 0 0 0
0 1 0 14 0 0 0 0

```

SQ(2)

```

16) SW P17 1 1004
17) SW P17 1 3004

```

```

005) 005 - - 1 0 1
006) 006 - - 1 0 1
007) 007 R1 P1 0 0 1
008) 008 R3 P3 0 0 1
009) 009 R7 P11 0 0 1
010) 010 - - 0 0 1
011) 000 R2 P2 0 0 1
012) 001 R4 P4 0 0 1
013) 002 R5 P8 0 0 0
014) 003 R5 P15 0 0 0
015) 004 R5 P16 0 0 0
016) 005 - - 1 0 0
017) 006 - - 1 0 0
018) 007 R1 P9 0 0 1
019) 008 R3 P10 0 0 1
020) 009 R7 P12 0 0 1
021) 010 - - 0 0 1
022) 000 R2 P13 0 0 1
023) 001 R4 P14 0 0 0
024) 002 R5 P17 0 0 0
025) 003 R5 P23 0 0 0
026) 004 R5 P24 0 0 0
027) 005 - - 1 0 0
028) 006 - - 1 0 0
029) 007 R1 P18 0 0 0

```

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```
030] ADDI R3,R3,4      8 13          P7,P19,4
031] ADDI R7,R7,-1     8
032] BNE R7,R0,-11     8
```

Press ENTER to continue (PC=12,IC=33,CK=14,IPC=2.36)...

```
PHYSICAL REGS:  1  2  3  4  5  6  7  8  9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
                *  *  *  *  *  *  *  *  *  *  *  *  *  *  *  *  *  *  *  *  *  *  *
qi:  1  0  1  0  1  0  1  0  0  0  0  0  0  0  0  1  1  0  0  0  0  1  1  1
vi:  00 00 00 00 00 0C 00 00 04 04 03 02 00 00 00 00 00 08 08 01 00 00 00 00
REG.FILE: Ri:  1  2  3  4  5  6  7  8
Pi:  6  21  7  22  5  -  1  -
Qi:  0  0  1  1  1  0  1  0
Vi:  0000100C 00000000 00003008 00000000 00000000 00000000 00000000 00000001 00000000
```

```
STAGES: F D P I X W C RENAMED-STR INSTRUCTION-WINDOW REORDER-BUFFER A M L S B F X
TOTAL SLOTS: 4 4 16 5 10 4 99 24 16 99 2 1 1 0 1 4 1
BUSY SLOTS: 0 2 6 3 2 1 0 23 6 22 0 0 1 0 0 0 0
STALLS: 0 5 0 82 20 0 0 5 0 0 1 0 14 0 0 0 0
000] LW R2,0(R1) 0 1 2 3 4 5 6 P2,0(P1) LQ(1)
001] LW R4,0(R3) 0 1 2 4 5 6 7 P4,0(P3) 23) LW P22 0 3008
002] ADD R5,R5,R2 0 1 2 5 5 6 7 P6,P5,P2
003] ADD R5,R5,R4 0 1 2 6 6 7 8 P7,P6,P4
004] MUL R5,R5,R5 1 2 3 7 7 12 13 P8,P7,P7
005] SW R5,0(R1) 1 2 3 5 12 13 14 P8,0(P1)
006] SW R5,0(R3) 1 2 3 6 12 13 14 P8,0(P3)
007] ADDI R1,R1,4 1 2 3 4 4 5 14 P9,P1,4
008] ADDI R3,R3,4 2 3 4 5 5 6 14 P10,P3,4
009] ADDI R7,R7,-1 2 3 4 6 6 7 P12,P11,-1
010] BNE R7,R0,-11 2 3 4 5 5 6 P12,P0,-11
011] LW R2,0(R1) 3 4 5 7 8 9 P13,0(P9)
012] LW R4,0(R3) 3 4 5 8 9 10 P14,0(P10)
013] ADD R5,R5,R2 3 4 5 13 13 14 P15,P8,P13
014] ADD R5,R5,R4 3 4 5 14 14 P16,P15,P14 007> ADD P16 P15 P14 - 0 0 0
015] MUL R5,R5,R5 4 5 6 P17,P16,P16 003) MUL P17 P16 P16 - 1 1 0
016] SW R5,0(R1) 4 5 6 9 P17,0(P9)
017] SW R5,0(R3) 4 5 6 10 P17,0(P10)
018] ADDI R1,R1,4 4 5 6 7 7 8 P18,P9,4
019] ADDI R3,R3,4 5 6 7 8 8 9 P19,P10,4
020] ADDI R7,R7,-1 5 6 7 9 9 10 P20,P12,-1
021] BNE R7,R0,-11 5 6 7 10 10 11 P20,P0,-11
022] LW R2,0(R1) 6 7 8 11 12 13 P21,0(P18)
023] LW R4,0(R3) 6 7 8 13 14 P22,0(P19)
024] ADD R5,R5,R2 6 7 8 P23,P17,P21 009) ADD P23 P17 P21 - 1 0 0
025] ADD R5,R5,R4 6 7 8 P24,P23,P22 010) ADD P24 P23 P22 - 1 1 0
026] MUL R5,R5,R5 7 8 9 P5,P24,P24 001) MUL P5 P24 P24 - 1 1 0
027] SW R5,0(R1) 7 8 9 14 P5,0(P18) 005> SW - P18 0 P5 0 0 1
028] SW R5,0(R3) 7 8 9 P5,0(P19) 011) SW - P19 0 P5 0 0 1
029] ADDI R1,R1,4 7 8 9 13 13 14 P6,P18,4
030] ADDI R3,R3,4 8 13 14 P7,P19,4 000) ADDI P7 P19 - 4 0 0 0
031] ADDI R7,R7,-1 8 14 P1,P20,-1
032] BNE R7,R0,-11 8 14 P1,P0,-11
```

Press ENTER to continue (PC=12,IC=33,CK=15,IPC=2.20)...

```
PHYSICAL REGS:  1  2  3  4  5  6  7  8  9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
                *  *  *  *  *  *  *  *  *  *  *  *  *  *  *  *  *  *  *  *  *  *  *
qi:  1  1  1  1  1  0  1  0  0  0  1  0  0  0  0  0  1  0  0  0  0  0  1  1
vi:  00 00 00 00 00 0C 00 00 04 04 03 02 00 00 00 00 00 08 08 01 00 00 00 00
REG.FILE: Ri:  1  2  3  4  5  6  7  8
Pi:  6  21  7  22  5  -  1  -
Qi:  0  0  1  1  1  0  1  0
Vi:  0000100C 00000000 00003008 00000000 00000000 00000000 00000000 00000001 00000000
```

```
STAGES: F D P I X W C RENAMED-STR INSTRUCTION-WINDOW REORDER-BUFFER A M L S B F X
TOTAL SLOTS: 4 4 16 5 10 4 99 24 16 99 0 0 1 0 1 4 1
BUSY SLOTS: 0 0 6 4 1 1 0 20 6 20 0 0 1 0 0 0 0
STALLS: 0 5 0 86 23 0 0 5 0 0 1 0 14 0 0 0 0
000] LW R2,0(R1) 0 1 2 3 4 5 6 P2,0(P1) LQ(0)
001] LW R4,0(R3) 0 1 2 4 5 6 7 P4,0(P3)
```

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```

002] ADD R5,R5,R2      0 1 2 5 5 6 7 P6,P5,P2
003] ADD R5,R5,R4      0 1 2 6 6 7 8 P7,P6,P4
004] MUL R5,R5,R5      1 2 3 7 7 12 13 P8,P7,P7
005] SW R5,0(R1)       1 2 3 5 12 13 14 P8,0(P1)
006] SW R5,0(R3)       1 2 3 6 12 13 14 P8,0(P3)
007] ADDI R1,R1,4      1 2 3 4 4 5 14 P9,P1,4
008] ADDI R3,R3,4      2 3 4 5 5 6 14 P10,P3,4
009] ADDI R7,R7,-1     2 3 4 6 6 7 15 P12,P11,-1
010] BNE R7,R0,-11    2 3 4 5 5 6 15 P12,P0,-11
011] LW R2,0(R1)       3 4 5 7 8 9 15 P13,0(P9)
012] LW R4,0(R3)       3 4 5 8 9 10 15 P14,0(P10)
013] ADD R5,R5,R2      3 4 5 13 13 14 P15,P8,P13
014] ADD R5,R5,R4      3 4 5 14 14 15 P16,P15,P14
015] MUL R5,R5,R5      4 5 6 15 15 P17,P16,P16
016] SW R5,0(R1)       4 5 6 9 P17,0(P9)
017] SW R5,0(R3)       4 5 6 10 P17,0(P10)
018] ADDI R1,R1,4      4 5 6 7 7 8 P18,P9,4
019] ADDI R3,R3,4      5 6 7 8 8 9 P19,P10,4
020] ADDI R7,R7,-1     5 6 7 9 9 10 P20,P12,-1
021] BNE R7,R0,-11    5 6 7 10 10 11 P20,P0,-11
022] LW R2,0(R1)       6 7 8 11 12 13 P21,0(P18)
023] LW R4,0(R3)       6 7 8 13 14 15 P22,0(P19)
024] ADD R5,R5,R2      6 7 8 P23,P17,P21
025] ADD R5,R5,R4      6 7 8 P24,P23,P22
026] MUL R5,R5,R5      7 8 9 P5,P24,P24
027] SW R5,0(R1)       7 8 9 14 P5,0(P18)
028] SW R5,0(R3)       7 8 9 15 P5,0(P19)
029] ADDI R1,R1,4      7 8 9 13 13 14 P6,P18,4
030] ADDI R3,R3,4      8 13 14 P7,P19,4
031] ADDI R7,R7,-1     8 14 15 P1,P20,-1
032] BNE R7,R0,-11    8 14 15 P1,P0,-11

```

SQ(3)
16) SW P17 1 1004
17) SW P17 1 3004
27) SW P5 1 1008

```

003> MUL P17 P16 P16 - 0 0 0
009) ADD P23 P17 P21 - 1 0 0
010) ADD P24 P23 P22 - 1 0 0
001) MUL P5 P24 P24 - 1 1 0
011> SW - P19 0 P5 0 0 1
000) ADDI P7 P19 - 4 0 0 0
002) ADDI P1 P20 - -1 0 0 0
003) BNE - P1 P0 -11 1 0 0

```

013) 002 R5 P8 0 0 1
014) 003 R5 P15 0 0 1
015) 004 R5 P16 0 0 0
016) 005 - - 1 0 0
017) 006 - - 1 0 0
018) 007 R1 P9 0 0 1
019) 008 R3 P10 0 0 1
020) 009 R7 P12 0 0 1
021) 010 - - 0 0 1
022) 000 R2 P13 0 0 1
023) 001 R4 P14 0 0 1
024) 002 R5 P17 0 0 0
025) 003 R5 P23 0 0 0
026) 004 R5 P24 0 0 0
027) 005 - - 1 0 0
028) 006 - - 1 0 0
029) 007 R1 P18 0 0 1
030) 008 R3 P19 0 0 0
031) 009 R7 P20 0 0 0
032) 010 - - 0 0 0

Press ENTER to continue (PC=12,IC=33,CK=16,IPC=2.06)...

PHYSICAL REGS: 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24

REG.FILE: qi: 1 1 1 1 1 0 1 1 0 0 1 0 0 0 1 0 1 0 0 0 0 0 1 1
vi: 00 00 00 00 00 0C 0C 00 04 04 03 02 00 00 00 00 00 08 08 01 00 00 00 00
Ri: 1 2 3 4 5 6 7 8
Pi: 6 21 7 22 5 - 1 -
Qi: 0 0 1 0 1 0 1 0
Vi: 0000100C 00000000 00003008 00000000 00000000 00000000 00000000 00000001 00000000

STAGES: F D P I X W C RENAMED-STR INSTRUCTION-WINDOW

TOTAL SLOTS: 4 4 16 5 10 4 99 24

BUSY SLOTS: 0 0 5 4 2 1 0 18

STALLS: 0 5 0 91 27 0 5

```

000] LW R2,0(R1)      0 1 2 3 4 5 6 P2,0(P1)
001] LW R4,0(R3)      0 1 2 4 5 6 7 P4,0(P3)
002] ADD R5,R5,R2      0 1 2 5 5 6 7 P6,P5,P2
003] ADD R5,R5,R4      0 1 2 6 6 7 8 P7,P6,P4
004] MUL R5,R5,R5      1 2 3 7 7 12 13 P8,P7,P7
005] SW R5,0(R1)       1 2 3 5 12 13 14 P8,0(P1)
006] SW R5,0(R3)       1 2 3 6 12 13 14 P8,0(P3)
007] ADDI R1,R1,4      1 2 3 4 4 5 14 P9,P1,4
008] ADDI R3,R3,4      2 3 4 5 5 6 14 P10,P3,4
009] ADDI R7,R7,-1     2 3 4 6 6 7 15 P12,P11,-1
010] BNE R7,R0,-11    2 3 4 5 5 6 15 P12,P0,-11
011] LW R2,0(R1)       3 4 5 7 8 9 15 P13,0(P9)
012] LW R4,0(R3)       3 4 5 8 9 10 15 P14,0(P10)
013] ADD R5,R5,R2      3 4 5 13 13 14 16 P15,P8,P13
014] ADD R5,R5,R4      3 4 5 14 14 15 16 P16,P15,P14
015] MUL R5,R5,R5      4 5 6 15 15 P17,P16,P16
016] SW R5,0(R1)       4 5 6 9 P17,0(P9)
017] SW R5,0(R3)       4 5 6 10 P17,0(P10)
018] ADDI R1,R1,4      4 5 6 7 7 8 P18,P9,4
019] ADDI R3,R3,4      5 6 7 8 8 9 P19,P10,4

```

REORDER-BUFFER

99

18

0

A M L S B F X

2 1 1 0 1 4 1

0 0 0 0 0 0 0

1 0 14 0 0 0 0

LQ(0)

SQ(4)

16) SW P17 1 1004

17) SW P17 1 3004

27) SW P5 1 1008

28) SW P5 1 3008

015) 004 R5 P16 0 0 0

016) 005 - - 1 0 0

017) 006 - - 1 0 0

018) 007 R1 P9 0 0 1

019) 008 R3 P10 0 0 1

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```

020] ADDI R7,R7,-1      5 6 7 9 9 10    P20,P12,-1      020) 009 R7 P12 0 0 1
021] BNE R7,R0,-11     5 6 7 10 10 11   P20,P0,-11     021) 010 - - 0 0 1
022] LW R2,0(R1)       6 7 8 11 12 13   P21,0(P18)     022) 000 R2 P13 0 0 1
023] LW R4,0(R3)       6 7 8 13 14 15   P22,0(P19)     023) 001 R4 P14 0 0 1
024] ADD R5,R5,R2      6 7 8           P23,P17,P21    009) ADD P23 P17 P21 - 1 0 0
025] ADD R5,R5,R4      6 7 8           P24,P23,P22    010) ADD P24 P23 P22 - 1 0 0
026] MUL R5,R5,R5      7 8 9           P5,P24,P24    001) MUL P5 P24 P24 - 1 1 0
027] SW R5,0(R1)       7 8 9 14        P5,0(P18)     024) 002 R5 P17 0 0 0
028] SW R5,0(R3)       7 8 9 15        P5,0(P19)     025) 003 R5 P23 0 0 0
029] ADDI R1,R1,4       7 8 9 13 13 14   P6,P18,4       026) 004 R5 P24 0 0 0
030] ADDI R3,R3,4       8 13 14 16 16    P7,P19,4       027) 005 - - 1 0 0
031] ADDI R7,R7,-1     8 14 15          P1,P20,-1     028) 006 - - 1 0 0
032] BNE R7,R0,-11    8 14 15          P1,P0,-11     029) 007 R1 P18 0 0 1
                                000> ADDI P7 P19 - 4 0 0 0
                                002) ADDI P1 P20 - -1 0 0 0
                                003) BNE - P1 P0 -11 1 0 0
                                030) 008 R3 P19 0 0 0
                                031) 009 R7 P20 0 0 0
                                032) 010 - - 0 0 0

```

Press ENTER to continue (PC=12, IC=33, CK=17, IPC=1.94)...

```

PHYSICAL REGS:  1  2  3  4  5  6  7  8  9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
                *  *  *  *  *  *  *  *  *  *  *  *  *  *  *  *  *  *  *  *  *  *  *
qi:  1  1  1  1  1  0  0  1  0  0  1  0  0  0  1  0  1  0  0  0  0  0  1  1
vi:  00 00 00 00 00 0C 0C 00 04 04 03 02 00 00 00 00 00 08 08 01 00 00 00 00
REG.FILE: Ri:  1  2  3  4  5  6  7  8
Pi:  6  21  7  22  5  -  1  -
Qi:  0  0  0  0  1  0  1  0
Vi:  0000100C 00000000 0000300C 00000000 00000000 00000000 00000000 00000001 00000000

```

```

STAGES:          F D P I X W C RENAMED-STR INSTRUCTION-WINDOW
TOTAL SLOTS:     4 4 16 5 10 4 99 24
BUSY SLOTS:      0 0 4 4 2 1 0 18
STALLS:          0 5 0 95 31 0 0 5

```

```

000] LW R2,0(R1)    0 1 2 3 4 5 6 P2,0(P1)
001] LW R4,0(R3)    0 1 2 4 5 6 7 P4,0(P3)
002] ADD R5,R5,R2    0 1 2 5 5 6 7 P6,P5,P2
003] ADD R5,R5,R4    0 1 2 6 6 7 8 P7,P6,P4
004] MUL R5,R5,R5    1 2 3 7 7 12 13 P8,P7,P7
005] SW R5,0(R1)     1 2 3 5 12 13 14 P8,0(P1)
006] SW R5,0(R3)     1 2 3 6 12 13 14 P8,0(P3)
007] ADDI R1,R1,4     1 2 3 4 4 5 14 P9,P1,4
008] ADDI R3,R3,4     2 3 4 5 5 6 14 P10,P3,4
009] ADDI R7,R7,-1    2 3 4 6 6 7 15 P12,P11,-1
010] BNE R7,R0,-11   2 3 4 5 5 6 15 P12,P0,-11
011] LW R2,0(R1)     3 4 5 7 8 9 15 P13,0(P9)
012] LW R4,0(R3)     3 4 5 8 9 10 15 P14,0(P10)
013] ADD R5,R5,R2     3 4 5 13 13 14 16 P15,P8,P13
014] ADD R5,R5,R4     3 4 5 14 14 15 16 P16,P15,P14
015] MUL R5,R5,R5     4 5 6 15 15      P17,P16,P16
016] SW R5,0(R1)     4 5 6 9          P17,0(P9)
017] SW R5,0(R3)     4 5 6 10         P17,0(P10)
018] ADDI R1,R1,4     4 5 6 7 7 8      P18,P9,4
019] ADDI R3,R3,4     5 6 7 8 8 9      P19,P10,4
020] ADDI R7,R7,-1    5 6 7 9 9 10     P20,P12,-1
021] BNE R7,R0,-11   5 6 7 10 10 11    P20,P0,-11
022] LW R2,0(R1)     6 7 8 11 12 13    P21,0(P18)
023] LW R4,0(R3)     6 7 8 13 14 15    P22,0(P19)
024] ADD R5,R5,R2     6 7 8           P23,P17,P21    009) ADD P23 P17 P21 - 1 0 0
025] ADD R5,R5,R4     6 7 8           P24,P23,P22    010) ADD P24 P23 P22 - 1 0 0
026] MUL R5,R5,R5     7 8 9           P5,P24,P24    001) MUL P5 P24 P24 - 1 1 0
027] SW R5,0(R1)     7 8 9 14        P5,0(P18)
028] SW R5,0(R3)     7 8 9 15        P5,0(P19)
029] ADDI R1,R1,4     7 8 9 13 13 14   P6,P18,4
030] ADDI R3,R3,4     8 13 14 16 16 17   P7,P19,4
031] ADDI R7,R7,-1    8 14 15 17 17     P1,P20,-1    002> ADDI P1 P20 - -1 0 0 0
032] BNE R7,R0,-11   8 14 15          P1,P0,-11    003) BNE - P1 P0 -11 1 0 0

```

REORDER-BUFFER

```

99  2 1 1 0 1 4 1
18  0 0 0 0 0 0 0
0   1 0 14 0 0 0 0

```

LQ(0)

SQ(4)

```

16) SW P17 1 1004
17) SW P17 1 3004
27) SW P5 1 1008
28) SW P5 1 3008

```

```

015) 004 R5 P16 0 0 0
016) 005 - - 1 0 0
017) 006 - - 1 0 0
018) 007 R1 P9 0 0 1
019) 008 R3 P10 0 0 1
020) 009 R7 P12 0 0 1
021) 010 - - 0 0 1
022) 000 R2 P13 0 0 1
023) 001 R4 P14 0 0 1
024) 002 R5 P17 0 0 0
025) 003 R5 P23 0 0 0
026) 004 R5 P24 0 0 0
027) 005 - - 1 0 0
028) 006 - - 1 0 0
029) 007 R1 P18 0 0 1
030) 008 R3 P19 0 0 1
031) 009 R7 P20 0 0 0
032) 010 - - 0 0 0

```

Press ENTER to continue (PC=12, IC=33, CK=18, IPC=1.83)...

```

PHYSICAL REGS:  1  2  3  4  5  6  7  8  9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
                *  *  *  *  *  *  *  *  *  *  *  *  *  *  *  *  *  *  *  *  *  *  *
qi:  0  1  1  1  1  0  0  1  0  0  1  0  0  0  1  0  1  0  0  0  0  0  1  1
vi:  00 00 00 00 00 0C 0C 00 04 04 03 02 00 00 00 00 00 08 08 01 00 00 00 00

```

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```

REG.FILE: Ri:      1      2      3      4      5      6      7      8
           Pi:      6      21     7      22     5      -      1      -
           Qi:      0      0      0      0      1      0      0      0
           Vi: 0000100C 00000000 0000300C 00000000 00000000 00000000 00000000 00000000

STAGES:      F D P I X W C RENAMED-STR INSTRUCTION-WINDOW REORDER-BUFFER A M L S B F X
TOTAL SLOTS: 4 4 16 5 10 4 99 24 16 99 2 1 1 0 1 4 1
BUSY SLOTS:  0 0 3 4 2 1 0 18 3 18 0 0 0 0 0 0 0
STALLS:      0 5 0 98 35 0 0 5 0 0 1 0 14 0 0 0
000] LW R2,0(R1) 0 1 2 3 4 5 6 P2,0(P1)
001] LW R4,0(R3) 0 1 2 4 5 6 7 P4,0(P3)
002] ADD R5,R5,R2 0 1 2 5 5 6 7 P6,P5,P2
003] ADD R5,R5,R4 0 1 2 6 6 7 8 P7,P6,P4
004] MUL R5,R5,R5 1 2 3 7 7 12 13 P8,P7,P7
005] SW R5,0(R1)  1 2 3 5 12 13 14 P8,0(P1)
006] SW R5,0(R3)  1 2 3 6 12 13 14 P8,0(P3)
007] ADDI R1,R1,4 1 2 3 4 4 5 14 P9,P1,4
008] ADDI R3,R3,4 2 3 4 5 5 6 14 P10,P3,4
009] ADDI R7,R7,-1 2 3 4 6 6 7 15 P12,P11,-1
010] BNE R7,R0,-11 2 3 4 5 5 6 15 P12,P0,-11
011] LW R2,0(R1)  3 4 5 7 8 9 15 P13,0(P9)
012] LW R4,0(R3)  3 4 5 8 9 10 15 P14,0(P10)
013] ADD R5,R5,R2 3 4 5 13 13 14 16 P15,P8,P13
014] ADD R5,R5,R4 3 4 5 14 14 15 16 P16,P15,P14
015] MUL R5,R5,R5 4 5 6 15 15 16 P17,P16,P16
016] SW R5,0(R1)  4 5 6 9 16 P17,0(P9)
017] SW R5,0(R3)  4 5 6 10 16 P17,0(P10)
018] ADDI R1,R1,4 4 5 6 7 7 8 P18,P9,4
019] ADDI R3,R3,4 5 6 7 8 8 9 P19,P10,4
020] ADDI R7,R7,-1 5 6 7 9 9 10 P20,P12,-1
021] BNE R7,R0,-11 5 6 7 10 10 11 P20,P0,-11
022] LW R2,0(R1)  6 7 8 11 12 13 P21,0(P18)
023] LW R4,0(R3)  6 7 8 13 14 15 P22,0(P19)
024] ADD R5,R5,R2 6 7 8 P23,P17,P21 009] ADD P23 P17 P21 - 1 0 0
025] ADD R5,R5,R4 6 7 8 P24,P23,P22 010] ADD P24 P23 P22 - 1 0 0
026] MUL R5,R5,R5 7 8 9 P5,P24,P24 001] MUL P5 P24 P24 - 1 1 0
027] SW R5,0(R1)  7 8 9 14 P5,0(P18)
028] SW R5,0(R3)  7 8 9 15 P5,0(P19)
029] ADDI R1,R1,4 7 8 9 13 13 14 P6,P18,4
030] ADDI R3,R3,4 8 13 14 16 16 17 P7,P19,4
031] ADDI R7,R7,-1 8 14 15 17 17 18 P1,P20,-1
032] BNE R7,R0,-11 8 14 15 18 18 P1,P0,-11

003> BNE - P1 P0 -11 0 0 0
Press ENTER to continue (PC=12,IC=33,CK=19,IPC=1.74)...

PHYSICAL REGS: 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
                * * * * *
qi: 0 1 1 1 1 0 0 1 0 0 1 0 0 0 1 0 1 0 0 0 0 0 1 1
vi: 00 00 00 00 00 0C 0C 00 04 04 03 02 00 00 00 00 00 08 08 01 00 00 00 00
REG.FILE: Ri: 1 2 3 4 5 6 7 8
           Pi: 6 21 7 22 5 - 1 -
           Qi: 0 0 0 0 1 0 0 0
           Vi: 0000100C 00000000 0000300C 00000000 00000000 00000000 00000000 00000000

STAGES:      F D P I X W C RENAMED-STR INSTRUCTION-WINDOW REORDER-BUFFER A M L S B F X
TOTAL SLOTS: 4 4 16 5 10 4 99 24 16 99 2 1 1 0 1 4 1
BUSY SLOTS:  0 0 3 4 1 1 0 18 3 18 0 0 0 0 0 0 0
STALLS:      0 5 0 101 39 0 0 5 0 0 1 0 14 0 0 0
000] LW R2,0(R1) 0 1 2 3 4 5 6 P2,0(P1)
001] LW R4,0(R3) 0 1 2 4 5 6 7 P4,0(P3)
002] ADD R5,R5,R2 0 1 2 5 5 6 7 P6,P5,P2
003] ADD R5,R5,R4 0 1 2 6 6 7 8 P7,P6,P4
004] MUL R5,R5,R5 1 2 3 7 7 12 13 P8,P7,P7
005] SW R5,0(R1)  1 2 3 5 12 13 14 P8,0(P1)
006] SW R5,0(R3)  1 2 3 6 12 13 14 P8,0(P3)
007] ADDI R1,R1,4 1 2 3 4 4 5 14 P9,P1,4
008] ADDI R3,R3,4 2 3 4 5 5 6 14 P10,P3,4
009] ADDI R7,R7,-1 2 3 4 6 6 7 15 P12,P11,-1

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010] BNE R7,R0,-11      2 3 4 5 5 6 15 P12,P0,-11
011] LW R2,0(R1)        3 4 5 7 8 9 15 P13,0(P9)
012] LW R4,0(R3)        3 4 5 8 9 10 15 P14,0(P10)
013] ADD R5,R5,R2       3 4 5 13 13 14 16 P15,P8,P13
014] ADD R5,R5,R4       3 4 5 14 14 15 16 P16,P15,P14
015] MUL R5,R5,R5       4 5 6 15 15      P17,P16,P16
016] SW R5,0(R1)        4 5 6 9          P17,0(P9)
017] SW R5,0(R3)        4 5 6 10         P17,0(P10)
018] ADDI R1,R1,4        4 5 6 7 7 8      P18,P9,4
019] ADDI R3,R3,4        5 6 7 8 8 9      P19,P10,4
020] ADDI R7,R7,-1       5 6 7 9 9 10     P20,P12,-1
021] BNE R7,R0,-11      5 6 7 10 10 11    P20,P0,-11
022] LW R2,0(R1)        6 7 8 11 12 13    P21,0(P18)
023] LW R4,0(R3)        6 7 8 13 14 15    P22,0(P19)
024] ADD R5,R5,R2       6 7 8            P23,P17,P21 009] ADD P23 P17 P21 - 1 0 0
025] ADD R5,R5,R4       6 7 8            P24,P23,P22 010] ADD P24 P23 P22 - 1 0 0
026] MUL R5,R5,R5       7 8 9            P5,P24,P24 001] MUL P5 P24 P24 - 1 1 0
027] SW R5,0(R1)        7 8 9 14         P5,0(P18)
028] SW R5,0(R3)        7 8 9 15         P5,0(P19)
029] ADDI R1,R1,4        7 8 9 13 13 14    P6,P18,4
030] ADDI R3,R3,4        8 13 14 16 16 17   P7,P19,4
031] ADDI R7,R7,-1       8 14 15 17 17 18   P1,P20,-1
032] BNE R7,R0,-11      8 14 15 18 18 19   P1,P0,-11

```

Press ENTER to continue (PC=12,IC=33,CK=20,IPC=1.65)...

```

PHYSICAL REGS:  1  2  3  4  5  6  7  8  9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
                *  *  *  *  *  *  *  *  *  *  *  *  *  *  *  *  *  *  *  *  *  *  *
qi:  0  1  1  1  1  0  0  1  0  0  1  0  0  0  1  0  0  0  0  0  0  0  1  1
vi:  00 00 00 00 00 0C 0C 00 04 04 03 02 00 00 00 00 00 08 08 01 00 00 00 00
REG.FILE: Ri:  1  2  3  4  5  6  7  8
Pi:  6  21 7 22 5 - 1 -
Qi:  0  0  0  0  1  0  0  0
Vi:  0000100C 00000000 0000300C 00000000 00000000 00000000 00000000 00000000

```

```

STAGES:          F D P I X W C RENAMED-STR INSTRUCTION-WINDOW
TOTAL SLOTS:     4 4 16 5 10 4 99 24
BUSY SLOTS:      0 0 2 2 3 1 0 18
STALLS:          0 5 0103 41 0 0 5

```

```

000] LW R2,0(R1)    0 1 2 3 4 5 6 P2,0(P1)
001] LW R4,0(R3)    0 1 2 4 5 6 7 P4,0(P3)
002] ADD R5,R5,R2   0 1 2 5 5 6 7 P6,P5,P2
003] ADD R5,R5,R4   0 1 2 6 6 7 8 P7,P6,P4
004] MUL R5,R5,R5   1 2 3 7 7 12 13 P8,P7,P7
005] SW R5,0(R1)    1 2 3 5 12 13 14 P8,0(P1)
006] SW R5,0(R3)    1 2 3 6 12 13 14 P8,0(P3)
007] ADDI R1,R1,4    1 2 3 4 4 5 14 P9,P1,4
008] ADDI R3,R3,4    2 3 4 5 5 6 14 P10,P3,4
009] ADDI R7,R7,-1   2 3 4 6 6 7 15 P12,P11,-1
010] BNE R7,R0,-11  2 3 4 5 5 6 15 P12,P0,-11
011] LW R2,0(R1)    3 4 5 7 8 9 15 P13,0(P9)
012] LW R4,0(R3)    3 4 5 8 9 10 15 P14,0(P10)
013] ADD R5,R5,R2   3 4 5 13 13 14 16 P15,P8,P13
014] ADD R5,R5,R4   3 4 5 14 14 15 16 P16,P15,P14
015] MUL R5,R5,R5   4 5 6 15 15 20     P17,P16,P16
016] SW R5,0(R1)    4 5 6 9 20        P17,0(P9)
017] SW R5,0(R3)    4 5 6 10 20       P17,0(P10)
018] ADDI R1,R1,4    4 5 6 7 7 8      P18,P9,4
019] ADDI R3,R3,4    5 6 7 8 8 9      P19,P10,4
020] ADDI R7,R7,-1   5 6 7 9 9 10     P20,P12,-1
021] BNE R7,R0,-11  5 6 7 10 10 11    P20,P0,-11
022] LW R2,0(R1)    6 7 8 11 12 13    P21,0(P18)
023] LW R4,0(R3)    6 7 8 13 14 15    P22,0(P19)
024] ADD R5,R5,R2   6 7 8 20 20       P23,P17,P21 009> ADD P23 P17 P21 - 0 0 0
025] ADD R5,R5,R4   6 7 8            P24,P23,P22 010] ADD P24 P23 P22 - 1 0 0
026] MUL R5,R5,R5   7 8 9            P5,P24,P24 001] MUL P5 P24 P24 - 1 1 0
027] SW R5,0(R1)    7 8 9 14         P5,0(P18)

```

```

015) 004 R5 P16 0 0 0
016) 005 - - 1 0 0
017) 006 - - 1 0 0
018) 007 R1 P9 0 0 1
019) 008 R3 P10 0 0 1
020) 009 R7 P12 0 0 1
021) 010 - - 0 0 1
022) 000 R2 P13 0 0 1
023) 001 R4 P14 0 0 1
024) 002 R5 P17 0 0 0
025) 003 R5 P23 0 0 0
026) 004 R5 P24 0 0 0
027) 005 - - 1 0 0
028) 006 - - 1 0 0
029) 007 R1 P18 0 0 1
030) 008 R3 P19 0 0 1
031) 009 R7 P20 0 0 1
032) 010 - - 0 0 1

```

```

REORDER-BUFFER  A M L S B F X
99              2 1 1 0 1 4 1
18              0 0 0 0 0 0 0
0               1 0 14 0 0 0 0
                LQ(0)

SQ(4)
16) SW P17 0 1004
17) SW P17 0 3004
27) SW P5 1 1008
28) SW P5 1 3008

```

```

015) 004 R5 P16 0 0 1
016) 005 - - 1 0 0
017) 006 - - 1 0 0
018) 007 R1 P9 0 0 1
019) 008 R3 P10 0 0 1
020) 009 R7 P12 0 0 1
021) 010 - - 0 0 1
022) 000 R2 P13 0 0 1
023) 001 R4 P14 0 0 1
024) 002 R5 P17 0 0 0
025) 003 R5 P23 0 0 0
026) 004 R5 P24 0 0 0
027) 005 - - 1 0 0

```

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```

028] SW    R5,0(R3)      7  8  9 15      P5,0(P19)
029] ADDI  R1,R1,4       7  8  9 13 14     P6,P18,4
030] ADDI  R3,R3,4       8 13 14 16 17     P7,P19,4
031] ADDI  R7,R7,-1      8 14 15 17 18     P1,P20,-1
032] BNE   R7,R0,-11     8 14 15 18 19     P1,P0,-11

```

```

028) 006 - - 1 0 0
029) 007 R1 P18 0 0 1
030) 008 R3 P19 0 0 1
031) 009 R7 P20 0 0 1
032) 010 - - 0 0 1

```

Press ENTER to continue (PC=12,IC=33,CK=21,IPC=1.57)...

```

PHYSICAL REGS:  1  2  3  4  5  6  7  8  9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
                *  *  *  *  *  *  *  *  *  *  *  *  *  *  *  *  *  *  *  *  *  *
qi:  0  1  1  1  1  0  0  1  0  0  1  0  0  0  1  1  0  0  0  0  0  0  0  1
vi:  00 00 00 00 00 0C 0C 00 04 04 03 02 00 00 00 00 00 08 08 01 00 00 00 00
REG.FILE: Ri:  1  2  3  4  5  6  7  8  9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
Pi:  6  21 7 22 5 6 7 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
Qi:  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
Vi:  0000100C 00000000 0000300C 00000000 00000000 00000000 00000000 00000000 00000000

```

```

STAGES:  F D P I X W C RENAMED-STR INSTRUCTION-WINDOW
TOTAL SLOTS:  4 4 16 5 10 4 99 24 16
BUSY SLOTS:  0 0 1 2 1 1 0 17 1
STALLS:  0 5 0104 43 0 0 5
000] LW    R2,0(R1)      0  1  2  3  4  5  6 P2,0(P1)
001] LW    R4,0(R3)      0  1  2  4  5  6  7 P4,0(P3)
002] ADD   R5,R5,R2      0  1  2  5  5  6  7 P6,P5,P2
003] ADD   R5,R5,R4      0  1  2  6  6  7  8 P7,P6,P4
004] MUL   R5,R5,R5      1  2  3  7  7 12 13 P8,P7,P7
005] SW    R5,0(R1)      1  2  3  5 12 13 14 P8,0(P1)
006] SW    R5,0(R3)      1  2  3  6 12 13 14 P8,0(P3)
007] ADDI  R1,R1,4       1  2  3  4  4  5 14 P9,P1,4
008] ADDI  R3,R3,4       2  3  4  5  5  6 14 P10,P3,4
009] ADDI  R7,R7,-1      2  3  4  6  6  7 15 P12,P11,-1
010] BNE   R7,R0,-11     2  3  4  5  5  6 15 P12,P0,-11
011] LW    R2,0(R1)      3  4  5  7  8  9 15 P13,0(P9)
012] LW    R4,0(R3)      3  4  5  8  9 10 15 P14,0(P10)
013] ADD   R5,R5,R2      3  4  5 13 13 14 16 P15,P8,P13
014] ADD   R5,R5,R4      3  4  5 14 14 15 16 P16,P15,P14
015] MUL   R5,R5,R5      4  5  6 15 15 20 21 P17,P16,P16
016] SW    R5,0(R1)      4  5  6  9 20 21 P17,0(P9)
017] SW    R5,0(R3)      4  5  6 10 20 21 P17,0(P10)
018] ADDI  R1,R1,4       4  5  6  7  7  8 P18,P9,4
019] ADDI  R3,R3,4       5  6  7  8  8  9 P19,P10,4
020] ADDI  R7,R7,-1      5  6  7  9  9 10 P20,P12,-1
021] BNE   R7,R0,-11     5  6  7 10 10 11 P20,P0,-11
022] LW    R2,0(R1)      6  7  8 11 12 13 P21,0(P18)
023] LW    R4,0(R3)      6  7  8 13 14 15 P22,0(P19)
024] ADD   R5,R5,R2      6  7  8 20 20 21 P23,P17,P21
025] ADD   R5,R5,R4      6  7  8 21 21 P24,P23,P22
026] MUL   R5,R5,R5      7  8  9 P5,P24,P24
027] SW    R5,0(R1)      7  8  9 14 P5,0(P18)
028] SW    R5,0(R3)      7  8  9 15 P5,0(P19)
029] ADDI  R1,R1,4       7  8  9 13 13 14 P6,P18,4
030] ADDI  R3,R3,4       8 13 14 16 16 17 P7,P19,4
031] ADDI  R7,R7,-1      8 14 15 17 17 18 P1,P20,-1
032] BNE   R7,R0,-11     8 14 15 18 18 19 P1,P0,-11

```

REORDER-BUFFER

99

17

0

A M L S B F X

2 1 1 0 1 4 1

0 0 0 0 0 0 0

1 0 14 0 0 0 0

LQ(0)

SQ(2)

27) SW P5 1 1008

28) SW P5 1 3008

016) 005 - - 1 0 1

017) 006 - - 1 0 1

018) 007 R1 P9 0 0 1

019) 008 R3 P10 0 0 1

020) 009 R7 P12 0 0 1

021) 010 - - 0 0 1

022) 000 R2 P13 0 0 1

023) 001 R4 P14 0 0 1

024) 002 R5 P17 0 0 1

025) 003 R5 P23 0 0 0

026) 004 R5 P24 0 0 0

027) 005 - - 1 0 0

028) 006 - - 1 0 0

029) 007 R1 P18 0 0 1

030) 008 R3 P19 0 0 1

031) 009 R7 P20 0 0 1

032) 010 - - 0 0 1

Press ENTER to continue (PC=12,IC=33,CK=22,IPC=1.50)...

```

PHYSICAL REGS:  1  2  3  4  5  6  7  8  9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
                *  *  *  *  *  *  *  *  *  *  *  *  *  *  *  *  *  *  *  *  *  *
qi:  0  1  1  1  1  0  0  1  1  1  1  0  0  0  1  1  0  0  0  0  0  0  0  0
vi:  00 00 00 00 00 0C 0C 00 04 04 03 02 00 00 00 00 00 08 08 01 00 00 00 00
REG.FILE: Ri:  1  2  3  4  5  6  7  8  9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
Pi:  6  21 7 22 5 6 7 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
Qi:  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
Vi:  0000100C 00000000 0000300C 00000000 00000000 00000000 00000000 00000000 00000000

```

```

STAGES:  F D P I X W C RENAMED-STR INSTRUCTION-WINDOW
TOTAL SLOTS:  4 4 16 5 10 4 99 24 16
BUSY SLOTS:  0 0 0 2 1 1 0 15 0
STALLS:  0 5 0104 45 0 0 5

```

REORDER-BUFFER

99

13

0

A M L S B F X

2 1 1 0 1 4 1

0 0 0 0 0 0 0

1 0 14 0 0 0 0

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000]	LW	R2,0(R1)	0	1	2	3	4	5	6	P2,0(P1)								LQ(0)							
001]	LW	R4,0(R3)	0	1	2	4	5	6	7	P4,0(P3)															
002]	ADD	R5,R5,R2	0	1	2	5	5	6	7	P6,P5,P2															
003]	ADD	R5,R5,R4	0	1	2	6	6	7	8	P7,P6,P4															
004]	MUL	R5,R5,R5	1	2	3	7	7	12	13	P8,P7,P7								SQ(2)							
005]	SW	R5,0(R1)	1	2	3	5	12	13	14	P8,0(P1)								27)	SW	P5	1	1008			
006]	SW	R5,0(R3)	1	2	3	6	12	13	14	P8,0(P3)								28)	SW	P5	1	3008			
007]	ADDI	R1,R1,4	1	2	3	4	4	5	14	P9,P1,4															
008]	ADDI	R3,R3,4	2	3	4	5	5	6	14	P10,P3,4															
009]	ADDI	R7,R7,-1	2	3	4	6	6	7	15	P12,P11,-1															
010]	BNE	R7,R0,-11	2	3	4	5	5	6	15	P12,P0,-11															
011]	LW	R2,0(R1)	3	4	5	7	8	9	15	P13,0(P9)															
012]	LW	R4,0(R3)	3	4	5	8	9	10	15	P14,0(P10)															
013]	ADD	R5,R5,R2	3	4	5	13	13	14	16	P15,P8,P13															
014]	ADD	R5,R5,R4	3	4	5	14	14	15	16	P16,P15,P14															
015]	MUL	R5,R5,R5	4	5	6	15	15	20	21	P17,P16,P16															
016]	SW	R5,0(R1)	4	5	6	9	20	21	22	P17,0(P9)															
017]	SW	R5,0(R3)	4	5	6	10	20	21	22	P17,0(P10)															
018]	ADDI	R1,R1,4	4	5	6	7	7	8	22	P18,P9,4															
019]	ADDI	R3,R3,4	5	6	7	8	8	9	22	P19,P10,4															
020]	ADDI	R7,R7,-1	5	6	7	9	9	10		P20,P12,-1							020)	009	R7	P12	0	0	1		
021]	BNE	R7,R0,-11	5	6	7	10	10	11		P20,P0,-11							021)	010	-	-	0	0	1		
022]	LW	R2,0(R1)	6	7	8	11	12	13		P21,0(P18)							022)	000	R2	P13	0	0	1		
023]	LW	R4,0(R3)	6	7	8	13	14	15		P22,0(P19)							023)	001	R4	P14	0	0	1		
024]	ADD	R5,R5,R2	6	7	8	20	20	21		P23,P17,P21							024)	002	R5	P17	0	0	1		
025]	ADD	R5,R5,R4	6	7	8	21	21	22		P24,P23,P22							025)	003	R5	P23	0	0	1		
026]	MUL	R5,R5,R5	7	8	9	22	22			P5,P24,P24	001>	MUL	P5	P24	P24	-	0	0	0						
027]	SW	R5,0(R1)	7	8	9	14				P5,0(P18)							027)	005	-	-	1	0	0		
028]	SW	R5,0(R3)	7	8	9	15				P5,0(P19)							028)	006	-	-	1	0	0		
029]	ADDI	R1,R1,4	7	8	9	13	13	14		P6,P18,4							029)	007	R1	P18	0	0	1		
030]	ADDI	R3,R3,4	8	13	14	16	16	17		P7,P19,4							030)	008	R3	P19	0	0	1		
031]	ADDI	R7,R7,-1	8	14	15	17	17	18		P1,P20,-1							031)	009	R7	P20	0	0	1		
032]	BNE	R7,R0,-11	8	14	15	18	18	19		P1,P0,-11							032)	010	-	-	0	0	1		
----- Press ENTER to continue (PC=12,IC=33,CK=23,IPC=1.43)...																									
PHYSICAL	REGS:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
		*				*	*	*										*	*	*	*	*	*	*	*
	qi:	0	1	1	1	1	0	0	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0
	vi:	00	00	00	00	00	0C	0C	00	04	04	03	02	00	00	00	00	00	08	08	01	00	00	00	00
REG.FILE:	Ri:				1					3			4			5			6						8
	Pi:		6			21			7			22			5			-			1			-	
	Qi:		0			0			0			0			1			0			0			0	
	Vi:	0000100C	00000000	00000000	0000300C	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
STAGES:		F	D	P	I	X	W	C	RENAMED-STR	INSTRUCTION-WINDOW	REORDER-BUFFER	A	M	L	S	B	F	X							
TOTAL SLOTS:		4	4	16	5	10	4	99	24	16	99	2	1	1	0	1	4	1							
BUSY SLOTS:		0	0	0	2	1	0	0	12	0	9	0	0	0	0	0	0	0							
STALLS:		0	5	0104	47	0	0	5		0	0	1	0	14	0	0	0	0							
000]	LW	R2,0(R1)	0	1	2	3	4	5	6	P2,0(P1)															
001]	LW	R4,0(R3)	0	1	2	4	5	6	7	P4,0(P3)															
002]	ADD	R5,R5,R2	0	1	2	5	5	6	7	P6,P5,P2															
003]	ADD	R5,R5,R4	0	1	2	6	6	7	8	P7,P6,P4															
004]	MUL	R5,R5,R5	1	2	3	7	7	12	13	P8,P7,P7								SQ(2)							
005]	SW	R5,0(R1)	1	2	3	5	12	13	14	P8,0(P1)								27)	SW	P5	1	1008			
006]	SW	R5,0(R3)	1	2	3	6	12	13	14	P8,0(P3)								28)	SW	P5	1	3008			
007]	ADDI	R1,R1,4	1	2	3	4	4	5	14	P9,P1,4															
008]	ADDI	R3,R3,4	2	3	4	5	5	6	14	P10,P3,4															
009]	ADDI	R7,R7,-1	2	3	4	6	6	7	15	P12,P11,-1															
010]	BNE	R7,R0,-11	2	3	4	5	5	6	15	P12,P0,-11															
011]	LW	R2,0(R1)	3	4	5	7	8	9	15	P13,0(P9)															
012]	LW	R4,0(R3)	3	4	5	8	9	10	15	P14,0(P10)															
013]	ADD	R5,R5,R2	3	4	5	13	13	14	16	P15,P8,P13															
014]	ADD	R5,R5,R4	3	4	5	14	14	15	16	P16,P15,P14															
015]	MUL	R5,R5,R5	4	5	6	15	15	20	21	P17,P16,P16															
016]	SW	R5,0(R1)	4	5	6	9	20	21	22	P17,0(P9)															
017]	SW	R5,0(R3)	4	5	6	10	20	21	22	P17,0(P10)															

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```

018] ADDI R1,R1,4      4 5 6 7 7 8 22 P18,P9,4
019] ADDI R3,R3,4      5 6 7 8 8 9 22 P19,P10,4
020] ADDI R7,R7,-1     5 6 7 9 9 10 23 P20,P12,-1
021] BNE R7,R0,-11    5 6 7 10 10 11 23 P20,P0,-11
022] LW R2,0(R1)       6 7 8 11 12 13 23 P21,0(P18)
023] LW R4,0(R3)       6 7 8 13 14 15 23 P22,0(P19)
024] ADD R5,R5,R2      6 7 8 20 20 21 P23,P17,P21
025] ADD R5,R5,R4      6 7 8 21 21 22 P24,P23,P22
026] MUL R5,R5,R5      7 8 9 22 22 P5,P24,P24
027] SW R5,0(R1)       7 8 9 14 P5,0(P18)
028] SW R5,0(R3)       7 8 9 15 P5,0(P19)
029] ADDI R1,R1,4      7 8 9 13 13 14 P6,P18,4
030] ADDI R3,R3,4      8 13 14 16 16 17 P7,P19,4
031] ADDI R7,R7,-1     8 14 15 17 17 18 P1,P20,-1
032] BNE R7,R0,-11    8 14 15 18 18 19 P1,P0,-11

```

```

024) 002 R5 P17 0 0 1
025) 003 R5 P23 0 0 1
026) 004 R5 P24 0 0 0
027) 005 - - 1 0 0
028) 006 - - 1 0 0
029) 007 R1 P18 0 0 1
030) 008 R3 P19 0 0 1
031) 009 R7 P20 0 0 1
032) 010 - - 0 0 1

```

----- Press ENTER to continue (PC=12,IC=33,CK=24,IPC=1.38)...

```

PHYSICAL REGS:  1  2  3  4  5  6  7  8  9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
                  *  *  *  *  *  *  *  *  *  *  *  *  *  *  *  *  *  *  *  *  *  *
qi:  0  1  1  1  1  0  0  1  1  1  1  1  1  1  1  1  1  0  0  0  0  0  1  0
vi:  00 00 00 00 00 0C 0C 00 04 04 03 02 00 00 00 00 00 08 08 01 00 00 00 00
REG.FILE: Ri:  1  2  3  4  5  6  7  8
        Pi:  6  21  7  22  5  -  1  -
        Qi:  0  0  0  0  1  0  0  0
        Vi:  0000100C 00000000 0000300C 00000000 00000000 00000000 00000000 00000000

```

STAGES: F D P I X W C RENAMED-STR INSTRUCTION-WINDOW

TOTAL SLOTS: 4 4 16 5 10 4 99 24 16

BUSY SLOTS: 0 0 0 2 1 0 0 10 0

STALLS: 0 5 0104 49 0 0 5 0

```

000] LW R2,0(R1)      0 1 2 3 4 5 6 P2,0(P1)
001] LW R4,0(R3)      0 1 2 4 5 6 7 P4,0(P3)
002] ADD R5,R5,R2      0 1 2 5 5 6 7 P6,P5,P2
003] ADD R5,R5,R4      0 1 2 6 6 7 8 P7,P6,P4
004] MUL R5,R5,R5      1 2 3 7 7 12 13 P8,P7,P7
005] SW R5,0(R1)      1 2 3 5 12 13 14 P8,0(P1)
006] SW R5,0(R3)      1 2 3 6 12 13 14 P8,0(P3)
007] ADDI R1,R1,4      1 2 3 4 4 5 14 P9,P1,4
008] ADDI R3,R3,4      2 3 4 5 5 6 14 P10,P3,4
009] ADDI R7,R7,-1     2 3 4 6 6 7 15 P12,P11,-1
010] BNE R7,R0,-11    2 3 4 5 5 6 15 P12,P0,-11
011] LW R2,0(R1)      3 4 5 7 8 9 15 P13,0(P9)
012] LW R4,0(R3)      3 4 5 8 9 10 15 P14,0(P10)
013] ADD R5,R5,R2      3 4 5 13 13 14 16 P15,P8,P13
014] ADD R5,R5,R4      3 4 5 14 14 15 16 P16,P15,P14
015] MUL R5,R5,R5      4 5 6 15 15 20 21 P17,P16,P16
016] SW R5,0(R1)      4 5 6 9 20 21 22 P17,0(P9)
017] SW R5,0(R3)      4 5 6 10 20 21 22 P17,0(P10)
018] ADDI R1,R1,4      4 5 6 7 7 8 22 P18,P9,4
019] ADDI R3,R3,4      5 6 7 8 8 9 22 P19,P10,4
020] ADDI R7,R7,-1     5 6 7 9 9 10 23 P20,P12,-1
021] BNE R7,R0,-11    5 6 7 10 10 11 23 P20,P0,-11
022] LW R2,0(R1)      6 7 8 11 12 13 23 P21,0(P18)
023] LW R4,0(R3)      6 7 8 13 14 15 23 P22,0(P19)
024] ADD R5,R5,R2      6 7 8 20 20 21 24 P23,P17,P21
025] ADD R5,R5,R4      6 7 8 21 21 22 24 P24,P23,P22
026] MUL R5,R5,R5      7 8 9 22 22 P5,P24,P24
027] SW R5,0(R1)      7 8 9 14 P5,0(P18)
028] SW R5,0(R3)      7 8 9 15 P5,0(P19)
029] ADDI R1,R1,4      7 8 9 13 13 14 P6,P18,4
030] ADDI R3,R3,4      8 13 14 16 16 17 P7,P19,4
031] ADDI R7,R7,-1     8 14 15 17 17 18 P1,P20,-1
032] BNE R7,R0,-11    8 14 15 18 18 19 P1,P0,-11

```

REORDER-BUFFER

99

7

0

A M L S B F X

2 1 1 0 1 4 1

0 0 0 0 0 0 0

1 0 14 0 0 0 0

LQ(0)

SQ(2)

27) SW P5 1 1008

28) SW P5 1 3008

```

026) 004 R5 P24 0 0 0
027) 005 - - 1 0 0
028) 006 - - 1 0 0
029) 007 R1 P18 0 0 1
030) 008 R3 P19 0 0 1
031) 009 R7 P20 0 0 1
032) 010 - - 0 0 1

```

----- Press ENTER to continue (PC=12,IC=33,CK=25,IPC=1.32)...

```

PHYSICAL REGS:  1  2  3  4  5  6  7  8  9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
                  *  *  *  *  *  *  *  *  *  *  *  *  *  *  *  *  *  *  *  *  *  *

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```

qi: 0 1 1 1 1 0 0 1 1 1 1 1 1 1 1 0 0 0 0 0 1 0
vi: 00 00 00 00 00 0C 0C 00 04 04 03 02 00 00 00 00 00 08 08 01 00 00 00 00
REG.FILE: Ri: 1 2 3 4 5 6 7 8
Pi: 6 21 7 22 5 - 1 -
Qi: 0 0 0 0 1 0 0 0
Vi: 0000100C 00000000 0000300C 00000000 00000000 00000000 00000000 00000000 00000000

STAGES: F D P I X W C RENAMED-STR INSTRUCTION-WINDOW REORDER-BUFFER A M L S B F X
TOTAL SLOTS: 4 4 16 5 10 4 99 24 16 99 2 1 1 0 1 4 1
BUSY SLOTS: 0 0 0 2 1 0 0 10 0 7 0 0 0 0 0 0 0
STALLS: 0 5 0104 51 0 0 5 0 0 0 1 0 14 0 0 0 0
000] LW R2,0(R1) 0 1 2 3 4 5 6 P2,0(P1)
001] LW R4,0(R3) 0 1 2 4 5 6 7 P4,0(P3)
002] ADD R5,R5,R2 0 1 2 5 5 6 7 P6,P5,P2
003] ADD R5,R5,R4 0 1 2 6 6 7 8 P7,P6,P4
004] MUL R5,R5,R5 1 2 3 7 7 12 13 P8,P7,P7
005] SW R5,0(R1) 1 2 3 5 12 13 14 P8,0(P1)
006] SW R5,0(R3) 1 2 3 6 12 13 14 P8,0(P3)
007] ADDI R1,R1,4 1 2 3 4 4 5 14 P9,P1,4
008] ADDI R3,R3,4 2 3 4 5 5 6 14 P10,P3,4
009] ADDI R7,R7,-1 2 3 4 6 6 7 15 P12,P11,-1
010] BNE R7,R0,-11 2 3 4 5 5 6 15 P12,P0,-11
011] LW R2,0(R1) 3 4 5 7 8 9 15 P13,0(P9)
012] LW R4,0(R3) 3 4 5 8 9 10 15 P14,0(P10)
013] ADD R5,R5,R2 3 4 5 13 13 14 16 P15,P8,P13
014] ADD R5,R5,R4 3 4 5 14 14 15 16 P16,P15,P14
015] MUL R5,R5,R5 4 5 6 15 15 20 21 P17,P16,P16
016] SW R5,0(R1) 4 5 6 9 20 21 22 P17,0(P9)
017] SW R5,0(R3) 4 5 6 10 20 21 22 P17,0(P10)
018] ADDI R1,R1,4 4 5 6 7 7 8 22 P18,P9,4
019] ADDI R3,R3,4 5 6 7 8 8 9 22 P19,P10,4
020] ADDI R7,R7,-1 5 6 7 9 9 10 23 P20,P12,-1
021] BNE R7,R0,-11 5 6 7 10 10 11 23 P20,P0,-11
022] LW R2,0(R1) 6 7 8 11 12 13 23 P21,0(P18)
023] LW R4,0(R3) 6 7 8 13 14 15 23 P22,0(P19)
024] ADD R5,R5,R2 6 7 8 20 20 21 24 P23,P17,P21
025] ADD R5,R5,R4 6 7 8 21 21 22 24 P24,P23,P22
026] MUL R5,R5,R5 7 8 9 22 22 P5,P24,P24
027] SW R5,0(R1) 7 8 9 14 P5,0(P18)
028] SW R5,0(R3) 7 8 9 15 P5,0(P19)
029] ADDI R1,R1,4 7 8 9 13 13 14 P6,P18,4
030] ADDI R3,R3,4 8 13 14 16 16 17 P7,P19,4
031] ADDI R7,R7,-1 8 14 15 17 17 18 P1,P20,-1
032] BNE R7,R0,-11 8 14 15 18 18 19 P1,P0,-11

Press ENTER to continue (PC=12,IC=33,CK=26,IPC=1.27)...

```

```

PHYSICAL REGS: 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
* * * * *
qi: 0 1 1 1 1 0 0 1 1 1 1 1 1 1 1 1 1 0 0 0 0 1 0
vi: 00 00 00 00 00 0C 0C 00 04 04 03 02 00 00 00 00 00 08 08 01 00 00 00 00
REG.FILE: Ri: 1 2 3 4 5 6 7 8
Pi: 6 21 7 22 5 - 1 -
Qi: 0 0 0 0 1 0 0 0
Vi: 0000100C 00000000 0000300C 00000000 00000000 00000000 00000000 00000000 00000000

STAGES: F D P I X W C RENAMED-STR INSTRUCTION-WINDOW REORDER-BUFFER A M L S B F X
TOTAL SLOTS: 4 4 16 5 10 4 99 24 16 99 2 1 1 0 1 4 1
BUSY SLOTS: 0 0 0 2 1 0 0 10 0 7 0 0 0 0 0 0 0
STALLS: 0 5 0104 53 0 0 5 0 0 0 1 0 14 0 0 0 0
000] LW R2,0(R1) 0 1 2 3 4 5 6 P2,0(P1)
001] LW R4,0(R3) 0 1 2 4 5 6 7 P4,0(P3)
002] ADD R5,R5,R2 0 1 2 5 5 6 7 P6,P5,P2
003] ADD R5,R5,R4 0 1 2 6 6 7 8 P7,P6,P4
004] MUL R5,R5,R5 1 2 3 7 7 12 13 P8,P7,P7
005] SW R5,0(R1) 1 2 3 5 12 13 14 P8,0(P1)
006] SW R5,0(R3) 1 2 3 6 12 13 14 P8,0(P3)
007] ADDI R1,R1,4 1 2 3 4 4 5 14 P9,P1,4

SQ(2)
27) SW P5 1 1008
28) SW P5 1 3008

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```

008] ADDI R3,R3,4      2 3 4 5 5 6 14 P10,P3,4
009] ADDI R7,R7,-1    2 3 4 6 6 7 15 P12,P11,-1
010] BNE R7,R0,-11    2 3 4 5 5 6 15 P12,P0,-11
011] LW R2,0(R1)      3 4 5 7 8 9 15 P13,0(P9)
012] LW R4,0(R3)      3 4 5 8 9 10 15 P14,0(P10)
013] ADD R5,R5,R2      3 4 5 13 13 14 16 P15,P8,P13
014] ADD R5,R5,R4      3 4 5 14 14 15 16 P16,P15,P14
015] MUL R5,R5,R5      4 5 6 15 15 20 21 P17,P16,P16
016] SW R5,0(R1)      4 5 6 9 20 21 22 P17,0(P9)
017] SW R5,0(R3)      4 5 6 10 20 21 22 P17,0(P10)
018] ADDI R1,R1,4      4 5 6 7 7 8 22 P18,P9,4
019] ADDI R3,R3,4      5 6 7 8 8 9 22 P19,P10,4
020] ADDI R7,R7,-1    5 6 7 9 9 10 23 P20,P12,-1
021] BNE R7,R0,-11    5 6 7 10 10 11 23 P20,P0,-11
022] LW R2,0(R1)      6 7 8 11 12 13 23 P21,0(P18)
023] LW R4,0(R3)      6 7 8 13 14 15 23 P22,0(P19)
024] ADD R5,R5,R2      6 7 8 20 20 21 24 P23,P17,P21
025] ADD R5,R5,R4      6 7 8 21 21 22 24 P24,P23,P22
026] MUL R5,R5,R5      7 8 9 22 22 P5,P24,P24
027] SW R5,0(R1)      7 8 9 14 P5,0(P18)
028] SW R5,0(R3)      7 8 9 15 P5,0(P19)
029] ADDI R1,R1,4      7 8 9 13 13 14 P6,P18,4
030] ADDI R3,R3,4      8 13 14 16 16 17 P7,P19,4
031] ADDI R7,R7,-1    8 14 15 17 17 18 P1,P20,-1
032] BNE R7,R0,-11    8 14 15 18 18 19 P1,P0,-11

```

```

026) 004 R5 P24 0 0 0
027) 005 - - 1 0 0
028) 006 - - 1 0 0
029) 007 R1 P18 0 0 1
030) 008 R3 P19 0 0 1
031) 009 R7 P20 0 0 1
032) 010 - - 0 0 1

```

Press ENTER to continue (PC=12, IC=33, CK=27, IPC=1.22)...

```

PHYSICAL REGS: 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
                * * * * *
qi: 0 1 1 1 0 0 0 1 1 1 1 1 1 1 1 1 1 1 0 0 0 0 1 0
vi: 00 00 00 00 00 0C 0C 00 04 04 03 02 00 00 00 00 00 08 08 01 00 00 00 00
REG.FILE: Ri: 1 2 3 4 5 6 7 8
          Pi: 6 21 7 22 5 - 1 -
          Qi: 0 0 0 0 0 0 0 0
          Vi: 0000100C 00000000 0000300C 00000000 00000000 00000000 00000000 00000000

```

```

STAGES: F D P I X W C RENAMED-STR INSTRUCTION-WINDOW
TOTAL SLOTS: 4 4 16 5 10 4 99 24
BUSY SLOTS: 0 0 0 0 2 1 0 10
STALLS: 0 5 0104 53 0 0 5

```

```

REORDER-BUFFER A M L S B F X
99 2 1 1 0 1 4 1
7 0 0 0 0 0 0
0 1 0 14 0 0 0
    LQ(0)
    SQ(2)
27) SW P5 0 1008
28) SW P5 0 3008

```

```

000] LW R2,0(R1)      0 1 2 3 4 5 6 P2,0(P1)
001] LW R4,0(R3)      0 1 2 4 5 6 7 P4,0(P3)
002] ADD R5,R5,R2      0 1 2 5 5 6 7 P6,P5,P2
003] ADD R5,R5,R4      0 1 2 6 6 7 8 P7,P6,P4
004] MUL R5,R5,R5      1 2 3 7 7 12 13 P8,P7,P7
005] SW R5,0(R1)      1 2 3 5 12 13 14 P8,0(P1)
006] SW R5,0(R3)      1 2 3 6 12 13 14 P8,0(P3)
007] ADDI R1,R1,4      1 2 3 4 4 5 14 P9,P1,4
008] ADDI R3,R3,4      2 3 4 5 5 6 14 P10,P3,4
009] ADDI R7,R7,-1    2 3 4 6 6 7 15 P12,P11,-1
010] BNE R7,R0,-11    2 3 4 5 5 6 15 P12,P0,-11
011] LW R2,0(R1)      3 4 5 7 8 9 15 P13,0(P9)
012] LW R4,0(R3)      3 4 5 8 9 10 15 P14,0(P10)
013] ADD R5,R5,R2      3 4 5 13 13 14 16 P15,P8,P13
014] ADD R5,R5,R4      3 4 5 14 14 15 16 P16,P15,P14
015] MUL R5,R5,R5      4 5 6 15 15 20 21 P17,P16,P16
016] SW R5,0(R1)      4 5 6 9 20 21 22 P17,0(P9)
017] SW R5,0(R3)      4 5 6 10 20 21 22 P17,0(P10)
018] ADDI R1,R1,4      4 5 6 7 7 8 22 P18,P9,4
019] ADDI R3,R3,4      5 6 7 8 8 9 22 P19,P10,4
020] ADDI R7,R7,-1    5 6 7 9 9 10 23 P20,P12,-1
021] BNE R7,R0,-11    5 6 7 10 10 11 23 P20,P0,-11
022] LW R2,0(R1)      6 7 8 11 12 13 23 P21,0(P18)
023] LW R4,0(R3)      6 7 8 13 14 15 23 P22,0(P19)
024] ADD R5,R5,R2      6 7 8 20 20 21 24 P23,P17,P21
025] ADD R5,R5,R4      6 7 8 21 21 22 24 P24,P23,P22

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```

026] MUL R5,R5,R5      7  8  9 22 22 27      P5,P24,P24      026) 004 R5 P24 0 0 1
027] SW R5,0(R1)       7  8  9 14 27      P5,0(P18)      027) 005 - - 1 0 0
028] SW R5,0(R3)       7  8  9 15 27      P5,0(P19)      028) 006 - - 1 0 0
029] ADDI R1,R1,4       7  8  9 13 13 14     P6,P18,4      029) 007 R1 P18 0 0 1
030] ADDI R3,R3,4       8 13 14 16 16 17     P7,P19,4      030) 008 R3 P19 0 0 1
031] ADDI R7,R7,-1      8 14 15 17 17 18     P1,P20,-1     031) 009 R7 P20 0 0 1
032] BNE R7,R0,-11     8 14 15 18 18 19     P1,P0,-11     032) 010 - - 0 0 1

```

----- Press ENTER to continue (PC=12,IC=33,CK=28,IPC=1.18)...

```

PHYSICAL REGS:  1  2  3  4  5  6  7  8  9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
                *  *  *  *  *  *  *  *  *  *  *  *  *  *  *  *  *  *  *  *  *  *
qi:  0  1  1  1  0  0  0  1  1  1  1  1  1  1  1  1  1  1  0  0  0  0  1  1
vi:  00 00 00 00 00 0C 0C 00 04 04 03 02 00 00 00 00 00 08 08 01 00 00 00 00
REG.FILE: Ri:  1  2  3  4  5  6  7  8
Pi:  6  21  7  22  5  -  1  -
Qi:  0  0  0  0  0  0  0  0
Vi:  0000100C 00000000 0000300C 00000000 00000000 00000000 00000000 00000000 00000000

```

```

STAGES:          F D P I X W C RENAMED-STR INSTRUCTION-WINDOW
TOTAL SLOTS:      4  4 16 5 10  4 99 24
BUSY SLOTS:       0  0  0  0  0  1  0  9
STALLS:          0  5 0104 53 0 0 5
000] LW R2,0(R1)    0  1  2  3  4  5  6 P2,0(P1)
001] LW R4,0(R3)    0  1  2  4  5  6  7 P4,0(P3)
002] ADD R5,R5,R2    0  1  2  5  5  6  7 P6,P5,P2
003] ADD R5,R5,R4    0  1  2  6  6  7  8 P7,P6,P4
004] MUL R5,R5,R5    1  2  3  7  7 12 13 P8,P7,P7
005] SW R5,0(R1)    1  2  3  5 12 13 14 P8,0(P1)
006] SW R5,0(R3)    1  2  3  6 12 13 14 P8,0(P3)
007] ADDI R1,R1,4    1  2  3  4  4  5 14 P9,P1,4
008] ADDI R3,R3,4    2  3  4  5  5  6 14 P10,P3,4
009] ADDI R7,R7,-1   2  3  4  6  6  7 15 P12,P11,-1
010] BNE R7,R0,-11  2  3  4  5  5  6 15 P12,P0,-11
011] LW R2,0(R1)    3  4  5  7  8  9 15 P13,0(P9)
012] LW R4,0(R3)    3  4  5  8  9 10 15 P14,0(P10)
013] ADD R5,R5,R2    3  4  5 13 13 14 16 P15,P8,P13
014] ADD R5,R5,R4    3  4  5 14 14 15 16 P16,P15,P14
015] MUL R5,R5,R5    4  5  6 15 15 20 21 P17,P16,P16
016] SW R5,0(R1)    4  5  6  9 20 21 22 P17,0(P9)
017] SW R5,0(R3)    4  5  6 10 20 21 22 P17,0(P10)
018] ADDI R1,R1,4    4  5  6  7  7  8 22 P18,P9,4
019] ADDI R3,R3,4    5  6  7  8  8  9 22 P19,P10,4
020] ADDI R7,R7,-1   5  6  7  9  9 10 23 P20,P12,-1
021] BNE R7,R0,-11  5  6  7 10 10 11 23 P20,P0,-11
022] LW R2,0(R1)    6  7  8 11 12 13 23 P21,0(P18)
023] LW R4,0(R3)    6  7  8 13 14 15 23 P22,0(P19)
024] ADD R5,R5,R2    6  7  8 20 20 21 24 P23,P17,P21
025] ADD R5,R5,R4    6  7  8 21 21 22 24 P24,P23,P22
026] MUL R5,R5,R5    7  8  9 22 22 27 28 P5,P24,P24
027] SW R5,0(R1)    7  8  9 14 27 28      P5,0(P18)
028] SW R5,0(R3)    7  8  9 15 27 28      P5,0(P19)
029] ADDI R1,R1,4    7  8  9 13 13 14     P6,P18,4
030] ADDI R3,R3,4    8 13 14 16 16 17     P7,P19,4
031] ADDI R7,R7,-1   8 14 15 17 17 18     P1,P20,-1
032] BNE R7,R0,-11  8 14 15 18 18 19     P1,P0,-11

```

```

REORDER-BUFFER  A M L S B F X
99              2 1 1 0 1 4 1
6               0 0 0 0 0 0 0
0               1 0 14 0 0 0 0
                LQ(0)

```

SQ(0)

----- Press ENTER to continue (PC=12,IC=33,CK=29,IPC=1.14)...

```

PHYSICAL REGS:  1  2  3  4  5  6  7  8  9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
                *  *  *  *  *  *  *  *  *  *  *  *  *  *  *  *  *  *  *  *  *  *
qi:  0  1  1  1  0  0  0  1  1  1  1  1  1  1  1  1  1  1  0  0  0  1  1
vi:  00 00 00 00 00 0C 0C 00 04 04 03 02 00 00 00 00 00 08 08 01 00 00 00 00
REG.FILE: Ri:  1  2  3  4  5  6  7  8
Pi:  6  21  7  22  5  -  1  -
Qi:  0  0  0  0  0  0  0  0
Vi:  0000100C 00000000 0000300C 00000000 00000000 00000000 00000000 00000000

```

```

STAGES:          F D P I X W C RENAMED-STR INSTRUCTION-WINDOW
TOTAL SLOTS:      4  4 16 5 10  4 99 24

```

```

REORDER-BUFFER  A M L S B F X
99              2 1 1 0 1 4 1

```

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```

BUSY SLOTS:      0 0 0 0 0 1 0 7      0      2      0 0 0 0 0 0 0
STALLS:          0 5 0104 53 0 0 5      0      0      1 0 14 0 0 0 0
000] LW R2,0(R1)  0 1 2 3 4 5 6 P2,0(P1)      LQ(0)
001] LW R4,0(R3)  0 1 2 4 5 6 7 P4,0(P3)
002] ADD R5,R5,R2  0 1 2 5 5 6 7 P6,P5,P2
003] ADD R5,R5,R4  0 1 2 6 6 7 8 P7,P6,P4      SQ(0)
004] MUL R5,R5,R5  1 2 3 7 7 12 13 P8,P7,P7
005] SW R5,0(R1)   1 2 3 5 12 13 14 P8,0(P1)
006] SW R5,0(R3)   1 2 3 6 12 13 14 P8,0(P3)
007] ADDI R1,R1,4  1 2 3 4 4 5 14 P9,P1,4
008] ADDI R3,R3,4  2 3 4 5 5 6 14 P10,P3,4
009] ADDI R7,R7,-1 2 3 4 6 6 7 15 P12,P11,-1
010] BNE R7,R0,-11 2 3 4 5 5 6 15 P12,P0,-11
011] LW R2,0(R1)   3 4 5 7 8 9 15 P13,0(P9)
012] LW R4,0(R3)   3 4 5 8 9 10 15 P14,0(P10)
013] ADD R5,R5,R2  3 4 5 13 13 14 16 P15,P8,P13
014] ADD R5,R5,R4  3 4 5 14 14 15 16 P16,P15,P14
015] MUL R5,R5,R5  4 5 6 15 15 20 21 P17,P16,P16
016] SW R5,0(R1)   4 5 6 9 20 21 22 P17,0(P9)
017] SW R5,0(R3)   4 5 6 10 20 21 22 P17,0(P10)
018] ADDI R1,R1,4  4 5 6 7 7 8 22 P18,P9,4
019] ADDI R3,R3,4  5 6 7 8 8 9 22 P19,P10,4
020] ADDI R7,R7,-1 5 6 7 9 9 10 23 P20,P12,-1
021] BNE R7,R0,-11 5 6 7 10 10 11 23 P20,P0,-11
022] LW R2,0(R1)   6 7 8 11 12 13 23 P21,0(P18)
023] LW R4,0(R3)   6 7 8 13 14 15 23 P22,0(P19)
024] ADD R5,R5,R2  6 7 8 20 20 21 24 P23,P17,P21
025] ADD R5,R5,R4  6 7 8 21 21 22 24 P24,P23,P22
026] MUL R5,R5,R5  7 8 9 22 22 27 28 P5,P24,P24
027] SW R5,0(R1)   7 8 9 14 27 28 29 P5,0(P18)
028] SW R5,0(R3)   7 8 9 15 27 28 29 P5,0(P19)
029] ADDI R1,R1,4  7 8 9 13 13 14 29 P6,P18,4
030] ADDI R3,R3,4  8 13 14 16 16 17 29 P7,P19,4
031] ADDI R7,R7,-1 8 14 15 17 17 18 P1,P20,-1      031) 009 R7 P20 0 0 1
032] BNE R7,R0,-11 8 14 15 18 18 19 P1,P0,-11      032) 010 - - 0 0 1

```

Press ENTER to continue (PC=12,IC=33,CK=30,IPC=1.10)...

```

PHYSICAL REGS:  1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
                * * * * *
qi:  0 1 1 1 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 0 0 1 1
vi:  00 00 00 00 00 0C 0C 00 04 04 03 02 00 00 00 00 00 08 08 01 00 00 00 00
REG.FILE: Ri:  1 2 3 4 5 6 7 8
Pi:  6 21 7 22 5 - 1 -
Qi:  0 0 0 0 0 0 0 0
Vi:  0000100C 00000000 0000300C 00000000 00000000 00000000 00000000 00000000

```

```

STAGES:          F D P I X W C RENAMED-STR INSTRUCTION-WINDOW REORDER-BUFFER A M L S B F X
TOTAL SLOTS:     4 4 16 5 10 4 99 24      16      99      2 1 1 0 1 4 1
BUSY SLOTS:      0 0 0 0 0 0 0 0 6      0      0      0 0 0 0 0 0 0
STALLS:          0 5 0104 53 0 0 5      0      0      1 0 14 0 0 0 0
000] LW R2,0(R1)  0 1 2 3 4 5 6 P2,0(P1)      LQ(0)
001] LW R4,0(R3)  0 1 2 4 5 6 7 P4,0(P3)
002] ADD R5,R5,R2  0 1 2 5 5 6 7 P6,P5,P2
003] ADD R5,R5,R4  0 1 2 6 6 7 8 P7,P6,P4      SQ(0)
004] MUL R5,R5,R5  1 2 3 7 7 12 13 P8,P7,P7
005] SW R5,0(R1)   1 2 3 5 12 13 14 P8,0(P1)
006] SW R5,0(R3)   1 2 3 6 12 13 14 P8,0(P3)
007] ADDI R1,R1,4  1 2 3 4 4 5 14 P9,P1,4
008] ADDI R3,R3,4  2 3 4 5 5 6 14 P10,P3,4
009] ADDI R7,R7,-1 2 3 4 6 6 7 15 P12,P11,-1
010] BNE R7,R0,-11 2 3 4 5 5 6 15 P12,P0,-11
011] LW R2,0(R1)   3 4 5 7 8 9 15 P13,0(P9)
012] LW R4,0(R3)   3 4 5 8 9 10 15 P14,0(P10)
013] ADD R5,R5,R2  3 4 5 13 13 14 16 P15,P8,P13
014] ADD R5,R5,R4  3 4 5 14 14 15 16 P16,P15,P14
015] MUL R5,R5,R5  4 5 6 15 15 20 21 P17,P16,P16

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```

016] SW    R5,0(R1)      4  5  6  9 20 21 22 P17,0(P9)
017] SW    R5,0(R3)      4  5  6 10 20 21 22 P17,0(P10)
018] ADDI  R1,R1,4       4  5  6  7  7  8 22 P18,P9,4
019] ADDI  R3,R3,4       5  6  7  8  8  9 22 P19,P10,4
020] ADDI  R7,R7,-1      5  6  7  9  9 10 23 P20,P12,-1
021] BNE   R7,R0,-11     5  6  7 10 10 11 23 P20,P0,-11
022] LW    R2,0(R1)      6  7  8 11 12 13 23 P21,0(P18)
023] LW    R4,0(R3)      6  7  8 13 14 15 23 P22,0(P19)
024] ADD   R5,R5,R2      6  7  8 20 20 21 24 P23,P17,P21
025] ADD   R5,R5,R4      6  7  8 21 21 22 24 P24,P23,P22
026] MUL   R5,R5,R5      7  8  9 22 22 27 28 P5,P24,P24
027] SW    R5,0(R1)      7  8  9 14 27 28 29 P5,0(P18)
028] SW    R5,0(R3)      7  8  9 15 27 28 29 P5,0(P19)
029] ADDI  R1,R1,4       7  8  9 13 13 14 29 P6,P18,4
030] ADDI  R3,R3,4       8 13 14 16 16 17 29 P7,P19,4
031] ADDI  R7,R7,-1      8 14 15 17 17 18 30 P1,P20,-1
032] BNE   R7,R0,-11     8 14 15 18 18 19 30 P1,P0,-11

```

----- Press ENTER to continue (PC=12,IC=33,CK=31,IPC=1.06)...

Program 'programma' FINISHED

PC=12, IC=33, CK=31, IPC=1.06

Goodbye.