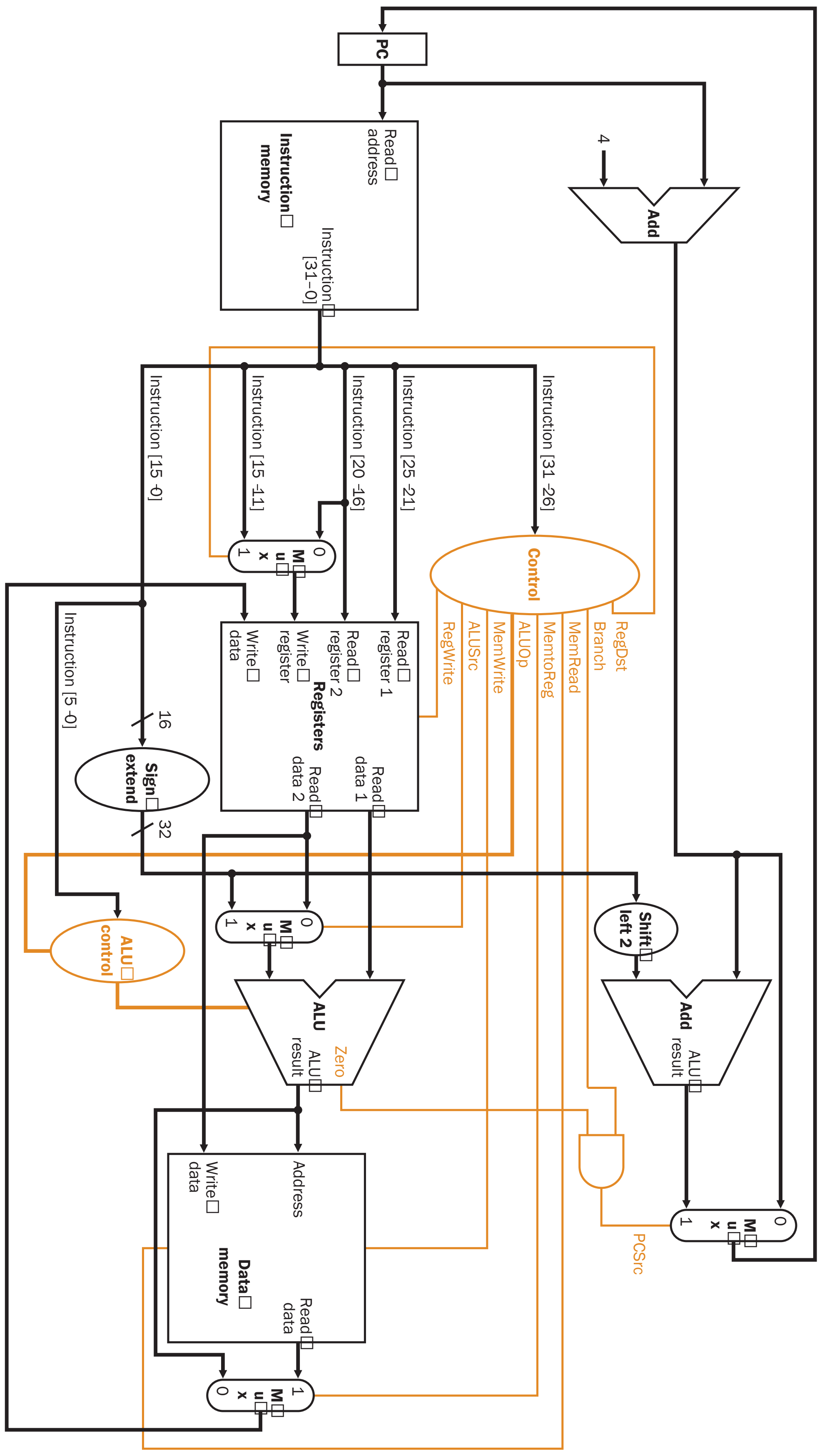
3. ***Give Up the Funk (30 points)***: Consider the single-cycle processor implementation. Your task will be to augment this datapath with a new instruction: the *funkyb* instruction. This instruction will be an R-type instruction, and will have the following effect:

```
if (R[rs]<R[rt])
        PC=PC+4+R[rs]           // Note that these two statements
        R[rd]=R[rt]             // will be concurrent.
else
        PC=PC+4+R[rt]           // Note that these two statements
        R[rd]=R[rs]             // will be concurrent.
```

Implement *funkyb* on the **single cycle datapath**. Use the R-type instruction format – so this instruction will have the same opcode as all other R-types. Use a unique function field to modify the ALU controller to implement this instruction, not the main controller.

Implement your solution on the following two pages. All other instructions must still work correctly after your modifications. You should not add any new ALUs, register file ports, or ports to memory.


PC
Add
4
Read address
Instruction [31–0]
Instruction memory
Instruction [31–26]
Instruction [25–21]
Instruction [20–16]
Instruction [15–11]
Instruction [15–0]
Instruction [5–0]
Control
RegDst
Branch
MemRead
MemtoReg
ALUOp
MemWrite
ALUSrc
RegWrite
0
M
u
x
1
Read register 1
Read register 2
Write register
Write data
Registers
Read data 1
Read data 2
16
Sign extend
32
Shift left 2
ALU control
ALU
Zero
ALU result
Add
ALU result
Address
Write data
Data memory
Read data
PCSrc

Main Controller

Input or Output	Signal Name	R-format	lw	sw	Beq
Inputs	Op5	0	1	1	0
	Op4	0	0	0	0
	Op3	0	0	1	0
	Op2	0	0	0	1
	Op1	0	1	1	0
	Op0	0	1	1	0
Outputs	RegDst	1	0	X	X
	ALUSrc	0	1	1	0
	MemtoReg	0	1	X	X
	RegWrite	1	1	0	0
	MemRead	0	1	0	0
	MemWrite	0	0	1	0
	Branch	0	0	0	1
	ALUOp1	1	0	0	0
	ALUOp0	0	0	0	1

ALU Controller

Opcode	**ALUOp**	**instruction**	**function**	**ALU Action**	**ALUCtrl**
Lw	00	load word	XXXXXX	add	010
Sw	00	store word	XXXXXX	add	010
Beq	01	branch equal	XXXXXX	subtract	110
R-type	10	add	100000	add	010
R-type	10	subtract	100010	subtract	110
R-type	10	AND	100100	AND	000
R-type	10	OR	100101	OR	001
R-type	10	SLT	101010	SLT	111