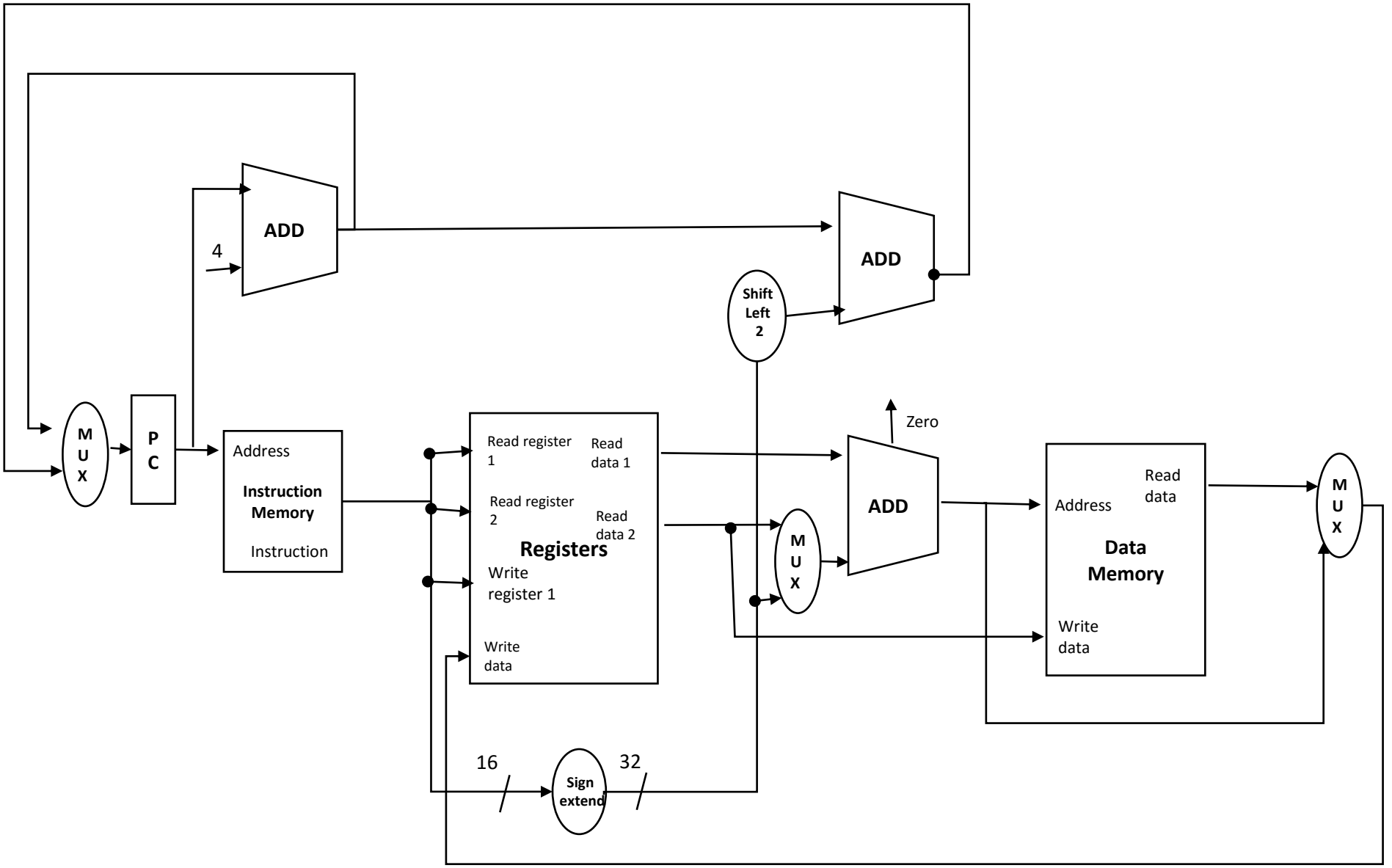
Datapath and Control

The simple datapath for MIPS Architecture



Different Instruction Formats

a. R-type Instruction (add $5, $1, $2)

Field	0	rs	rt	rd	shamt	funct
Bit Position	31:26	25:21	20:16	15:11	10:6	5:0

b . Load or Store Instruction (ld $5, 10($2) / st $2, 100($3))

Field	35 or 43	rs	rt	address
Bit Position	31:26	25:21	20:16	15:0

c. Branch Instruction (beq $1, $2, 104)

Field	4	rs	rt	address
Bit Position	31:26	25:21	20:16	15:0

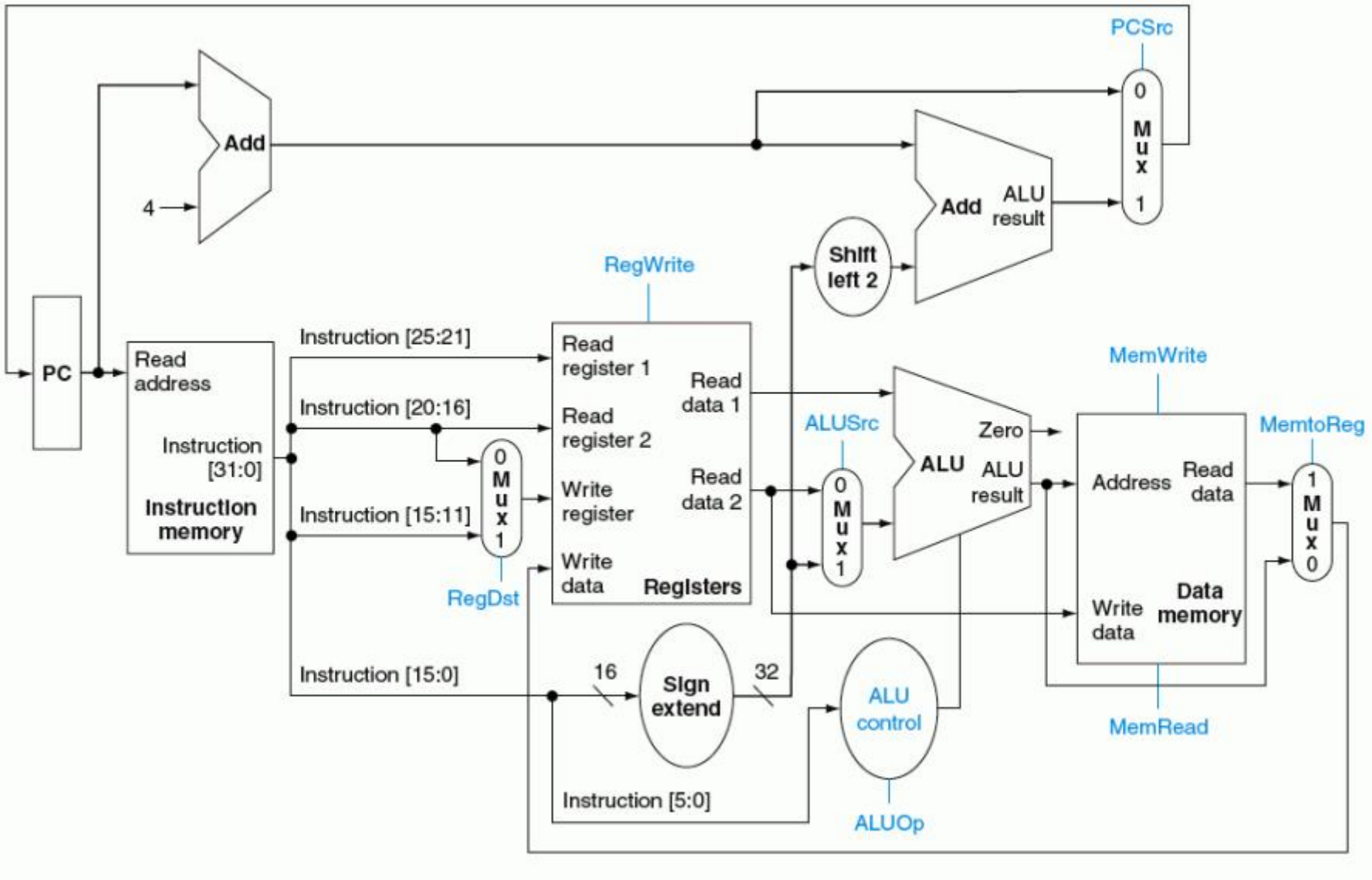
ALU Control

ALU Control lines	Function
0000	AND
0001	OR
0010	add
0110	subtract
0111	set on less than
1100	NOR

How to Set ALUOp Control Bits

Instruction Opcode	ALUOp	Instruction Operation	Funct field	Desired ALU action	ALU Control Input
LW	00	Load Word	XXXXXX	add	0010
SW	00	Store Word	XXXXXX	add	0010
Branch equal	01	Branch Equal	XXXXXX	subtract	0110
R-type	10	Add	100000	add	0010
R-type	10	Subtract	100010	subtract	0110
R-type	10	AND	100100	and	0000
R-type	10	OR	100101	or	0001
R-type	10	Set on less than	101010	set on less than	0111

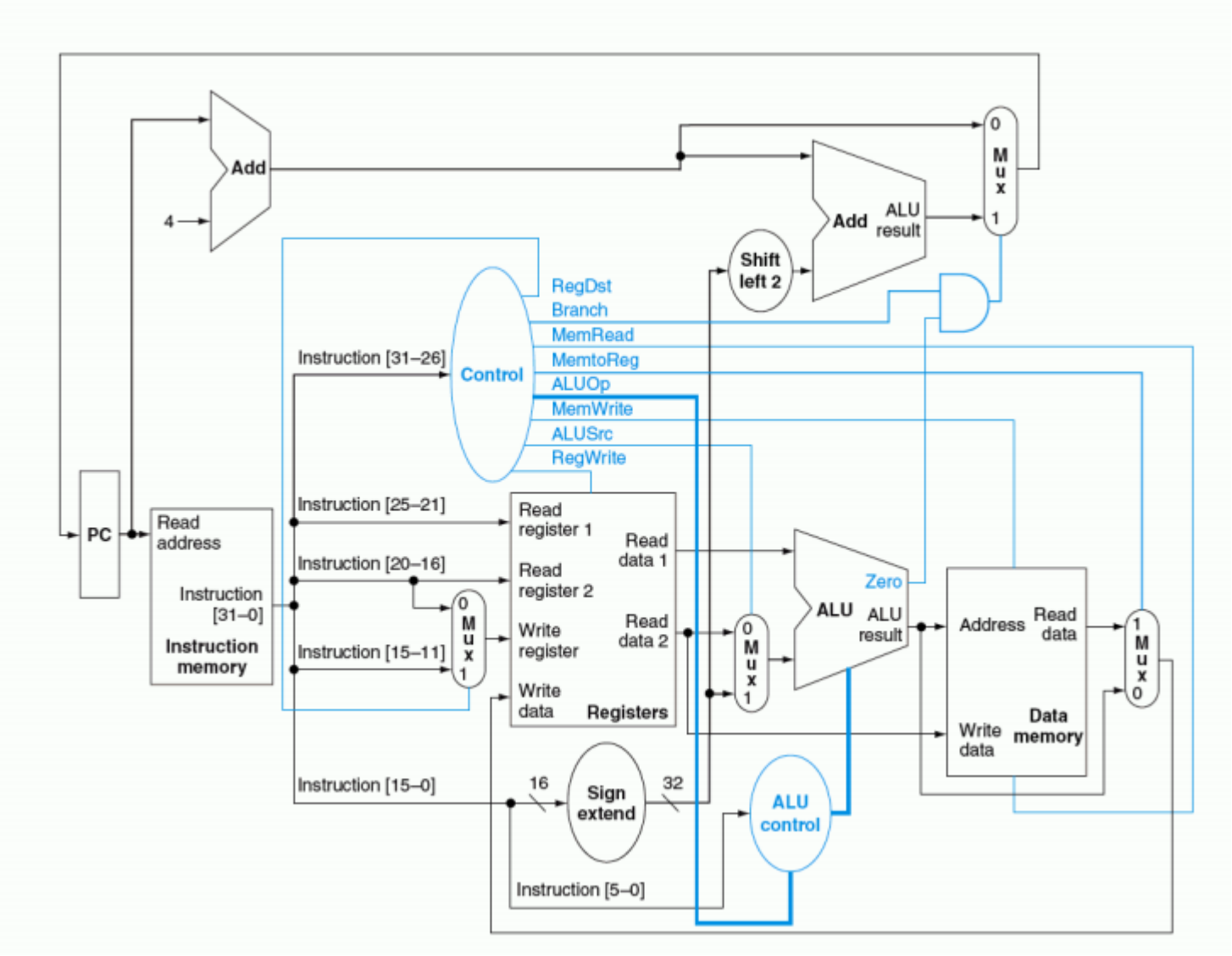
Datapath with multiplexors and control lines identified



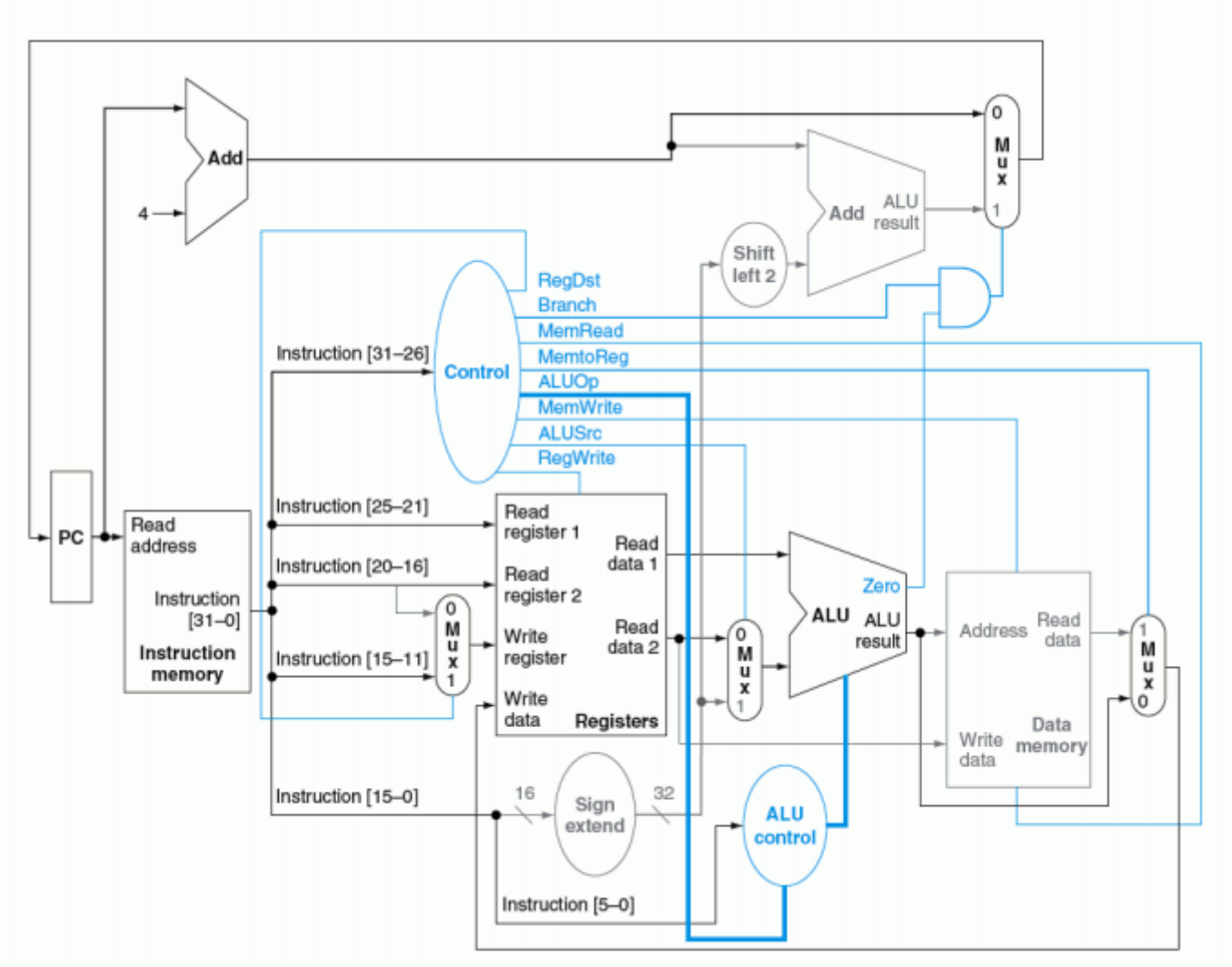
Effect of each seven control

Signal name	Effect when deasserted	Effect when asserted
RegDst	The register destination number for the Write register comes from the rt field (bits 20:16).	The register destination number for the Write register comes from the rd field (bits 15:11).
RegWrite	None.	The register on the Write register input is written with the value on the Write data input.
ALUSrc	The second ALU operand comes from the second register file output (Read data 2).	The second ALU operand is the sign-extended, lower 16 bits of the instruction.
PCSrc	The PC is replaced by the output of the adder that computes the value of PC + 4.	The PC is replaced by the output of the adder that computes the branch target.
MemRead	None.	Data memory contents designated by the address input are put on the Read data output.
MemWrite	None.	Data memory contents designated by the address input are replaced by the value on the Write data input.
MemtoReg	The value fed to the register Write data input comes from the ALU.	The value fed to the register Write data input comes from the data memory.

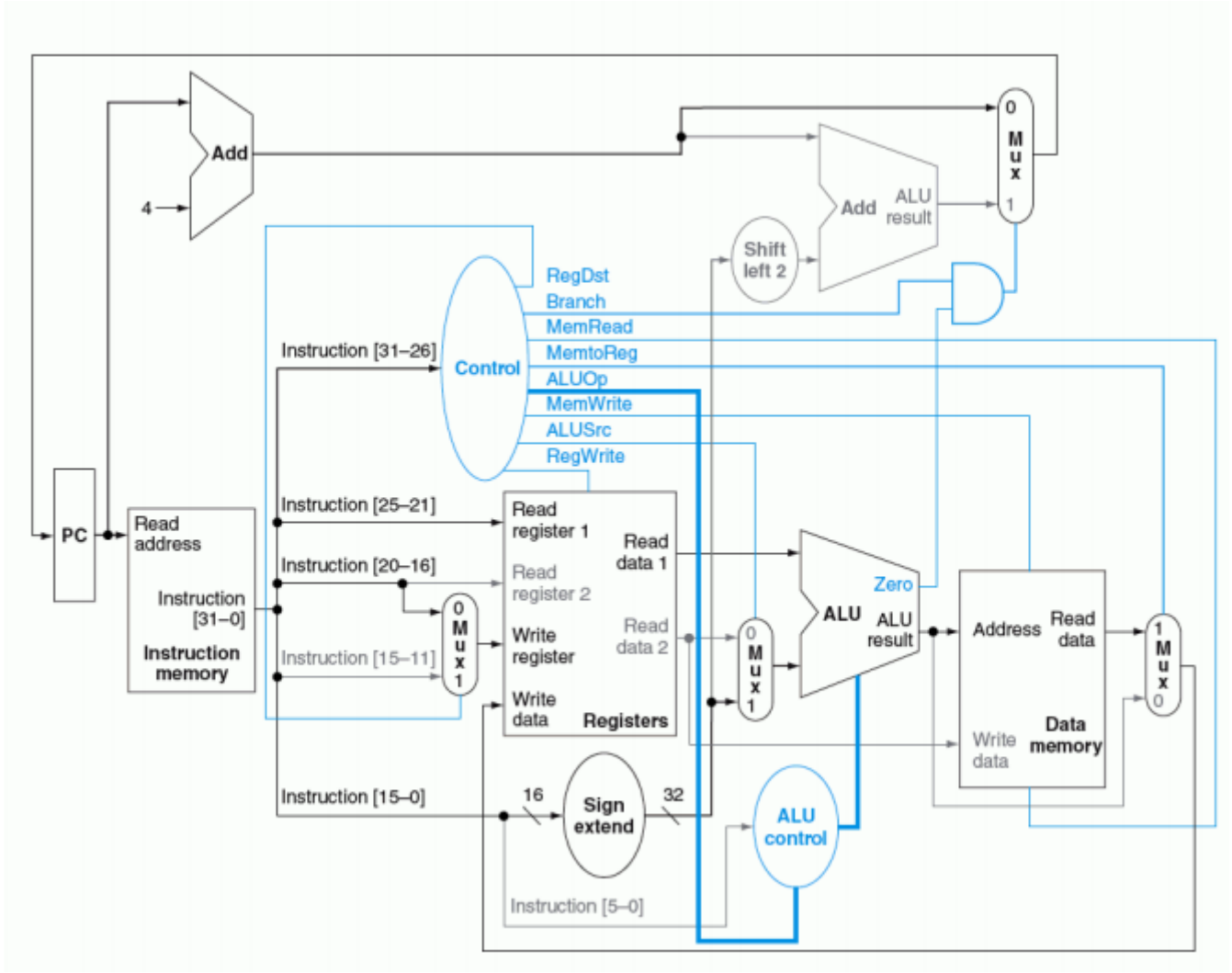
The simple datapath with control unit



The datapath in operation for an R-type instruction



The datapath in operation for a load instruction



The datapath in operation for a branch equal instruction