CS2214 COMPUTER ARCHITECTURE & ORGANIZATION FALL 2011

EXAM II ANSWERS

1) a) Based on the given high level state diagram, we see that we read a memory location, then NAND it with a register and then store the result on the same register.

Thus, this is a NAND between a memory location and a register : NANDMR (NAND Memory Register) :

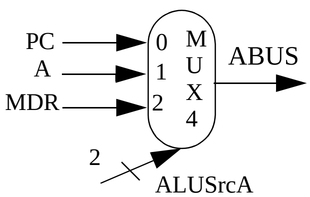
Syntax : NANDMR Rt, Disp(Rs)

Semantics : $Rt \longleftarrow \overline{(M[Rs + Disp^{+}] \; \& \; Rt)}$

Format, etc. :

- The **I** format is used since Disp is needed
- We make **two** memory accesses for the new instruction :
  - One to fetch the instruction (state 0) and one to read a data element (state 3).

b) The datapath modification for the new instruction is as follows :

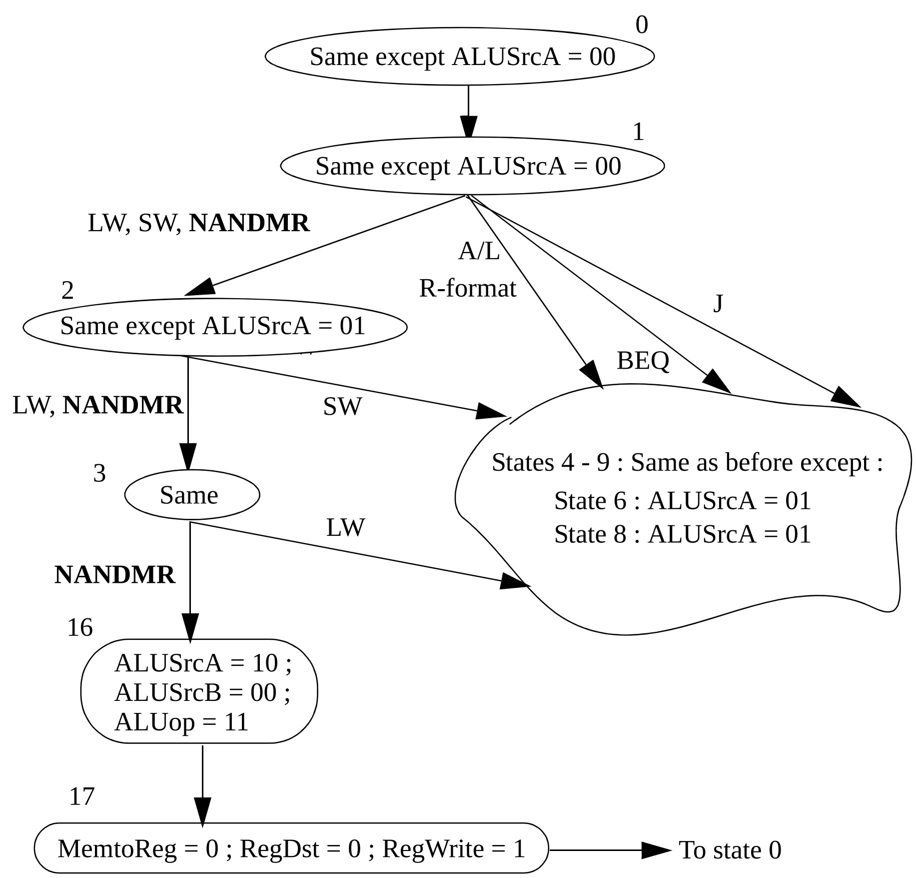


The ALU is also modified so that it can perform a NAND operation. In order to indicate that it is a NAND, an ALUcontrol bit combination must be assigned the NAND operation. We select combination 1000 for it.

ALUop combination "11" indicates that we will perform a NAND operation for a **non-R-type** instruction :

ALUop	ALU operation	ALUcontrol
00	Add	0010
01	Sub	0110
10	indicated by function field of IR :	
	Add	0010
	Sub	0110
	And	0000
	Or	0001
	SLT	0111
11	NAND	1000

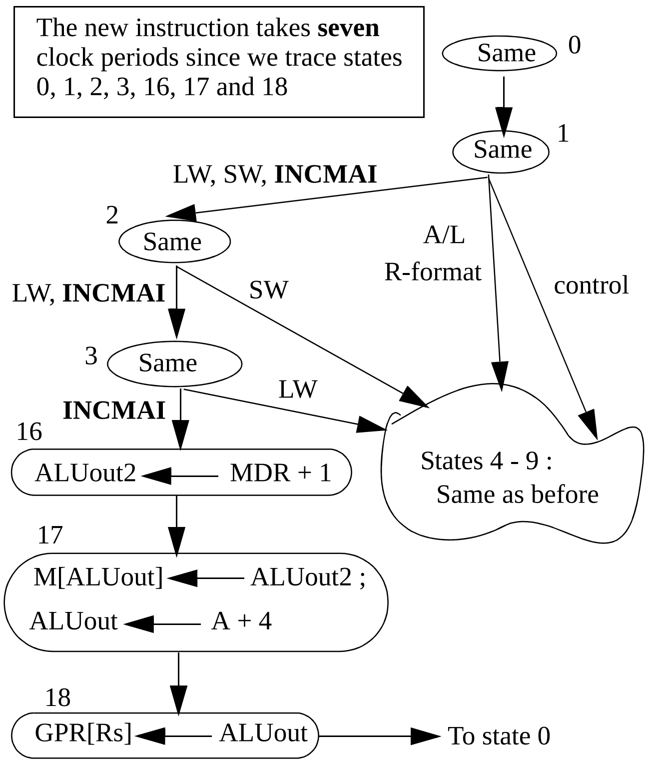
c) The modified low-level state diagram is as follows :



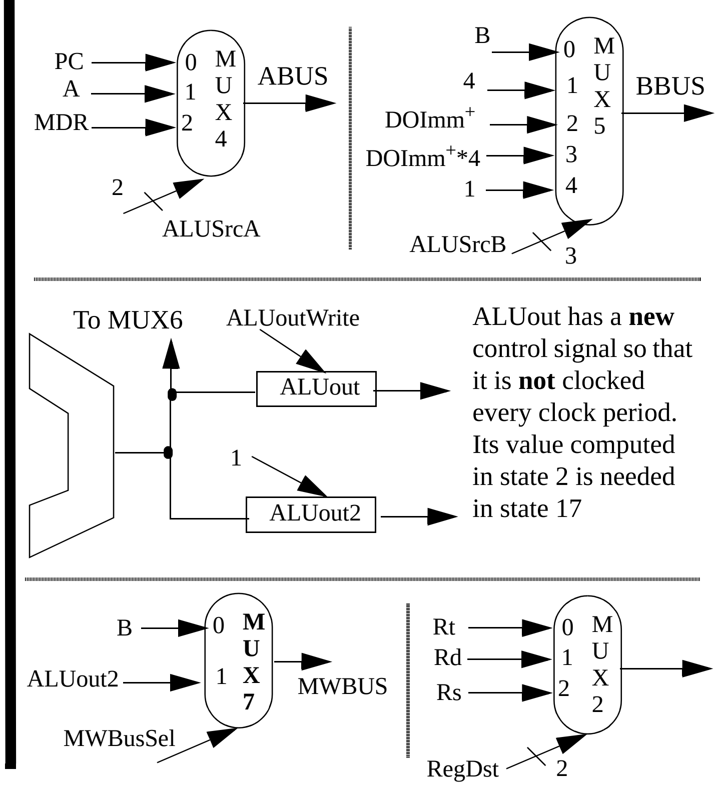
CPI_{NANDMR} = **6** since we trace states 0, 1, 2, 3, 16, and 17

2)

a) The modified high-level state diagram is as follows :



b) The datapath modification for the new instruction is as follows :



c) The modified low-level state diagram is as follows :