

Fall 2003 – CSE 207 Digital Design Final Exam Review

Numbers, Representation, and Arithmetic.

(a) Represent the following decimal numbers as four-bit 2's-complement numbers:

i. $4 =$

ii. $-3 =$

iii. $-5 =$

(b) (3) Subtract 1110_2 from 0010_2 by adding the 2's complement of 1110_2 to 0010_2

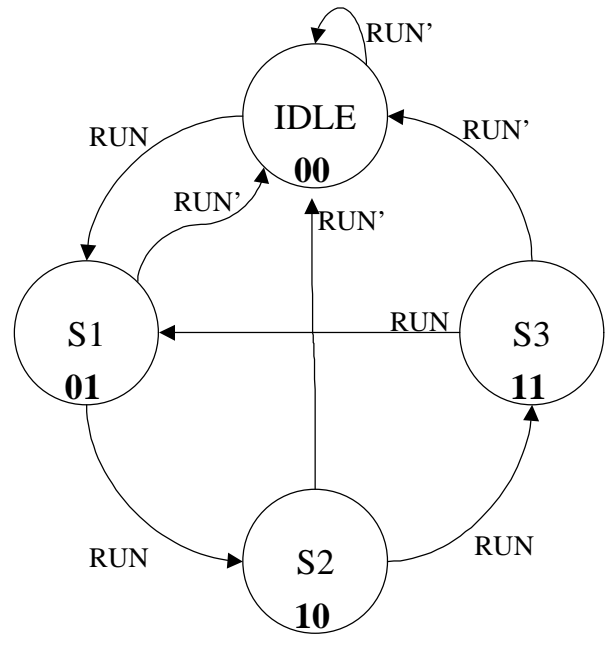
(c) (8) Using any technique generate the minimal sum of products. Box your final answer. You must show work for full credit.

C	B	A	F
0	0	0	1
0	0	1	1
0	1	0	0
0	1	1	1
1	0	0	1
1	0	1	1
1	1	0	1
1	1	1	1

Sequential Circuit Design

You are to design a circuit to implement the state transition diagram shown to the right.

This will be a Moore machine (outputs a function of the current state). It functions as follows: when RUN is true, the machine cycles through the states S1, S2, S3. As soon as RUN is false, the machine transfers to the idle state and waits there indefinitely. The system has the following outputs A, B, C. A is output when in state IDLE, S1, and S2. B is output when in state S2 and S3. C is output when in state S3 only.



a) Generate the truth table and excitation equations for the NextState $Q_1^* Q_0^*$ given the CurrentState $Q_1 Q_0$ and the input RUN.

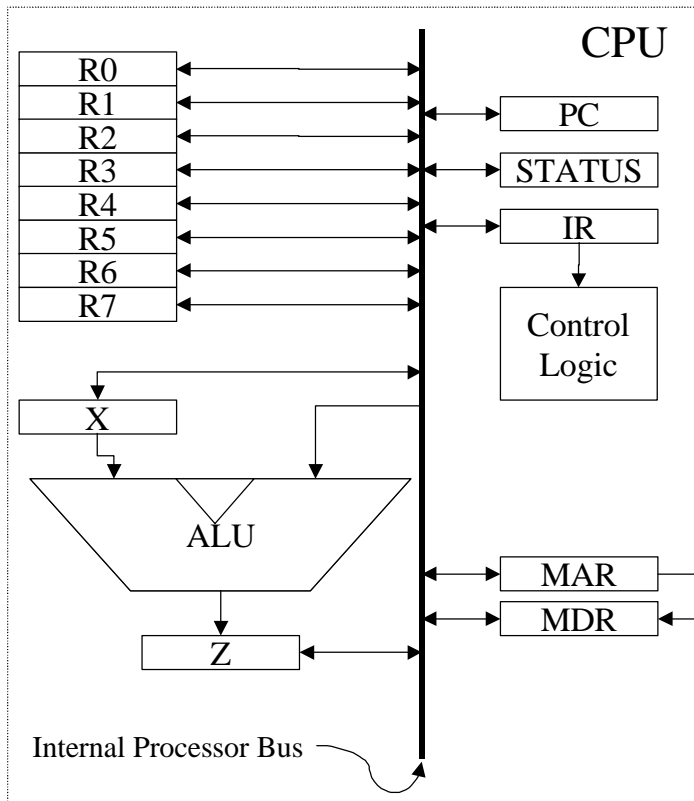
b) Generate the truth table and output equations A, B, and C given the CurrentState.

- c) Draw the circuit showing all inputs and outputs.

Microcode.

Management has decided that we need to implement the INC mem instruction as described in project #4. Generate the register transfers and list all control signals necessary to implement this instruction. You will not need to worry about active-high or active-low – just indicate which control lines are asserted. All valid control signals are listed on the following sheet. You will start your microcode at the completion of Fetch (i.e. the instruction is in the IR – what additional steps do you need to complete the execution of this instruction).

Information:



Control Signals:

PC_INC, PC_CLR, IR_CLR,
 ALU_S3..0, ALU_M, ALU_Cin, C_EN,
 Z_EN, Reset
 R0..7_OE, RX_OE, RZ_OE, MAR_OE,
 MDR_OE, MDR_MOE, IR_OE,
 PC_OE, RAM_OE
 R0..7_IE, RX_IE, RZ_IE, MAR_IE,
 MDR_IE, MDR_MIE, IR_IE, PC_IE,
 RAM_WE

Registers:

R0, R1, R2, R3, R4, R5, R6, R7, RX,
 RZ, MAR, MDR, PC, STATUS, IR

Other Signals:

IRdst, IRsrc, IRbits, RelAddr,
 ALUResult, RAM

ALU:

Selection				Active-High Data		
				M=H LOGIC FUNCTIONS	M=L; ARITHMETIC FUNCTIONS	
S3	S2	S1	S0		Cn' = H (no carry)	Cn' = L (with carry)
L	L	L	L	$F = A'$	$F = A$	$F = A \text{ PLUS } 1$
L	L	L	H	$F = (A+B)'$	$F = A + B$	$F = (A+B) \text{ PLUS } 1$
L	L	H	L	$F = A'B$	$F = A+B'$	$F = (A+B') \text{ PLUS } 1$
L	L	H	H	$F = 0$	$F = \text{MINUS } 1 \text{ (2's Cmp)}$	$F = \text{ZERO}$
L	H	L	L	$F = (AB)'$	$F = A \text{ PLUS } AB'$	$F = A \text{ PLUS } AB' \text{ PLUS } 1$
L	H	L	H	$F = B'$	$F = (A+B) \text{ PLUS } AB'$	$F = (A+B) \text{ PUS } AB' \text{ PLUS } 1$
L	H	H	L	$F = A \oplus B$	$F = A \text{ MINUS } B \text{ MINUS } 1$	$F = A \text{ MINUS } B$
L	H	H	H	$F = AB'$	$F = AB' \text{ MINUS } 1$	$F = AB'$
H	L	L	L	$F = A' + B$	$F = A \text{ PLUS } AB$	$F = A \text{ PLUS } AB \text{ PLUS } 1$
H	L	L	H	$F = (A \oplus B)'$	$F = A \text{ PLUS } B$	$F = A \text{ PLUS } B \text{ PLUS } 1$
H	L	H	L	$F = B$	$F = (A+B') \text{ PLUS } AB$	$F = (A+B') \text{ PLUS } AB \text{ PLUS } 1$
H	L	H	H	$F = AB$	$F = AB \text{ MINUS } 1$	$F = AB$
H	H	L	L	$F = 1$	$F = A$	$F = A \text{ PLUS } A \text{ PLUS } 1$
H	H	L	H	$F = A+B'$	$F = (A+B) \text{ PLUS } A$	$F = (A+B) \text{ PLUS } A \text{ PLUS } 1$
H	H	H	L	$F = A+B$	$F = (A+B') \text{ PLUS } A$	$F = (A+B') \text{ PLUS } A \text{ PLUS } 1$
H	H	H	H	$F = A$	$F = A \text{ MINUS } 1$	$F = A$