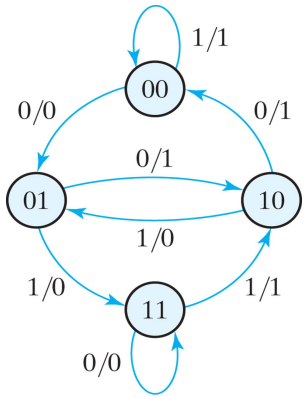
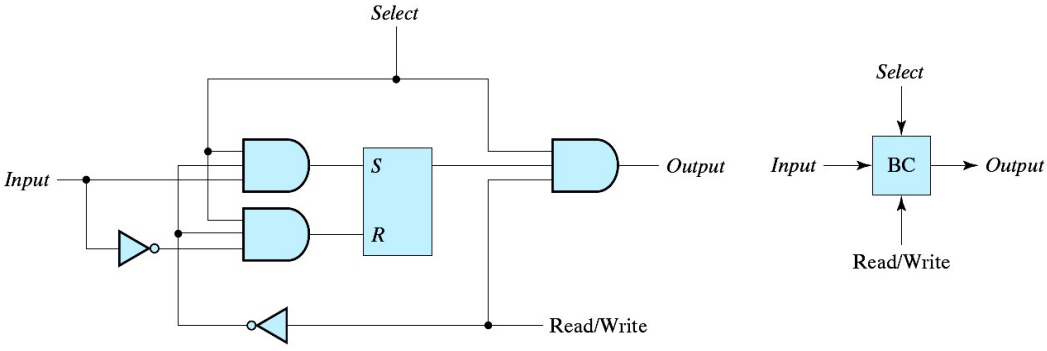
Department of Computer Science
National Chiao Tung University
Digital System Design
Final Exam 1/17/2013

1. (10%) Design a *JK* flip-flop with a *T* flip-flop.
2. (10%) Derive the state diagram of a circuit that will generate a Gray code sequence for an input binary sequence. The circuit can be reset asynchronously to start and end the operation. (Note that for an m-bit binary sequence, $a_{m-1}, \cdots a_0$, its Gray code representation, $g_{m-1}, \cdots g_0$, can be determined by: $g_{m-1} = a_{m-1}$ and $g_i = a_i \oplus a_{i+1}$ for $i \le m-2$.)
3. (12%) Consider the state diagram shown below. Design a sequential circuit with *D* flip-flops *A* and *B*, with one input *x* and one output *y*.



4. (10%) Consider the SRAM memory cell shown below. Show that we can connect four such cells to form a 4-bit shift register and describe how a 4-bit binary number can be store in such a register.



5. (8%) Include a clear input to the shift register discussed above.
6. (8%) Briefly explain advantages (and disadvantages) of using a ripple counter, versus a synchronous counter, as a binary counter.
7. (8%) Construct a mod-14 counter with a four-bit binary synchronous counter with parallel load, and a logic gate.

8. (8%) Briefly describe how 64K×8 RAM chips should be connected to provide a memory capacity of 256K bytes. You may use a block diagram to explain.

9. (8%) Derive the Hamming code word for the 12-bit data: 001110011011.

10. (10%) Find different ways of using a PLA to implement the following functions if only four product terms (AND gates) are allowed. (There is no need to provide the PLA programming table.)

$$F_1(A,B,C) = \sum(0,2,3,6),$$

$$F_2(A,B,C) = \sum(2,4,5,7)$$

11. (8%) Specify the minimum size of a ROM that will accommodate the truth table for each of the following combinational circuit components. You may use an additional gate to reduce the ROM size.
    (a) a code converter that converts a decimal digit from the 2421 code to the Excess-3 code, with $d(w,x,y,z) = \sum(5,6,7,8,9,10)$.
    (b) a binary multiplier that multiplies two 8-bit binary words.