(i) Use a NAND implementation decoder with external NAND gates only to implement F and G in **their sum of products form.** (Assume NAND gates with any number of inputs are available).

(ii) Use a multiplexer to implement G.

Question 3: (15 points)

Design a modulo-5 ripple (asynchronous) up-counter with JK flip-flops and draw the corresponding logic circuit. (from "EXAM PAGE 2" in dropbox)

(i) Build the state diagram
(ii) Draw the logic circuit
(iii) What is the maximum modulus of the counter?

Question 4: (25 points)

Design a "**synchronous** BCD counter". Use negative edge-triggered D flip-flops provided with a clock. (From "EXAM 1 PAGE 2" in dropbox and Winter 2007 Final exam)

(i) Draw the state diagram of the counter.
(ii) Build the counter's state table showing the synchronous inputs of the D flip-flops as well.
(iii) Using Karnaugh maps, find the minimal sum-of-products form of the equations for the inputs to the flip-flops; assume the next states of the unused combinations to be "don't care states"
(iv) Draw the logic diagram of the counter
(v) Modify your diagram (of (iv)) to show how your BCD counter can be cleared when it reaches the value 7. Use active low clear and NAND gate.

Question 5: (10 points)

(From "EXAM 1 PAGE 2" in dropbox)

a) Design a serial Adder with T Flip Flop and draw the corresponding logic circuit. The two binary numbers to be added, X and Y, are stored in two shift registers A and B respectively. Y is stored in its 1's complement. Before adding X to Y you should obtain the 1's complement of Y. The result (sum) of the adder must be stored in a third shift register C. Use a full adder to add X and the 1's complement of Y. Answer the following questions:

(i) Give a table that shows
   a. the inputs and outputs for the full adder
   b. the states (present and next) for the T flip Flop
   c. The T Flip Flop inputs
(ii) Obtain the logic expressions for the T inputs and the outputs of the full adder
(iii) draw the logic circuit of the serial Adder (use a diagram to represent the full adder and the registers)