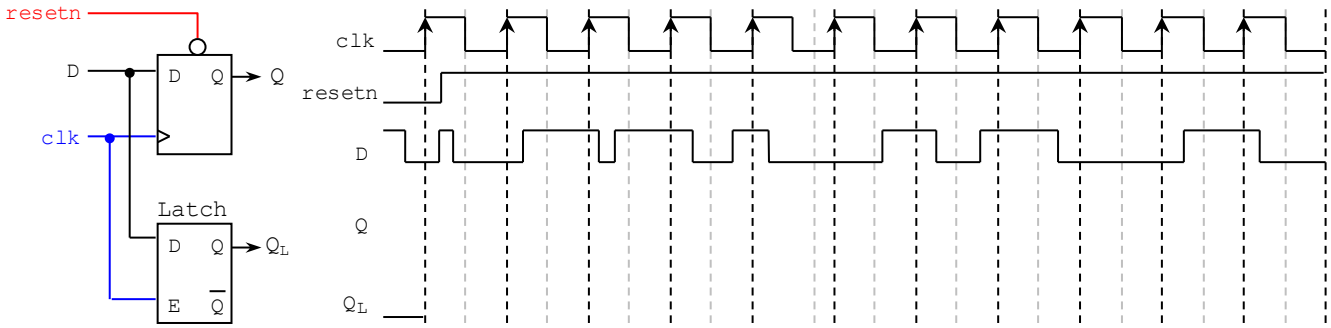
Homework 3

(Due date: November 3rd @ 5:30 pm)

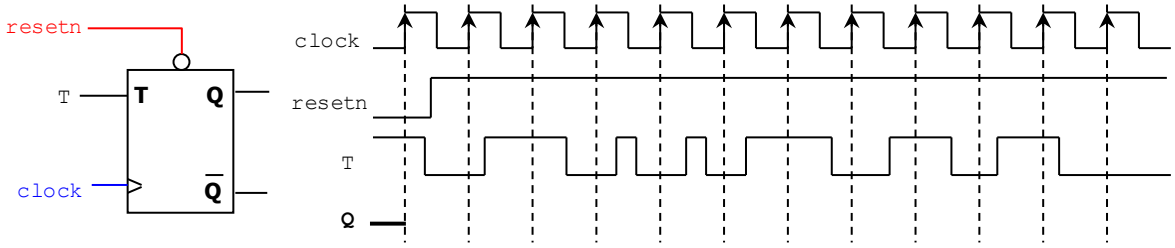
Presentation and clarity are very important! Show your procedure!

PROBLEM 1 (10 PTS)

- Complete the timing diagram for the flip flop and the latch shown below: (6 pts)

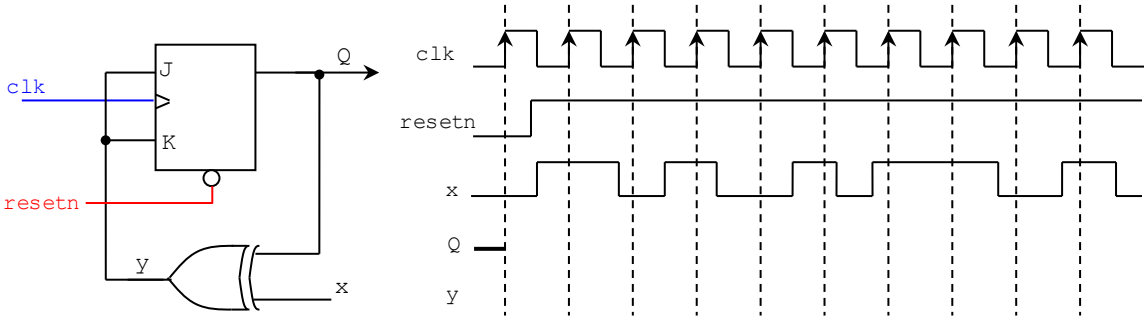


- Complete the timing diagram of the circuit shown below. (4 pts)

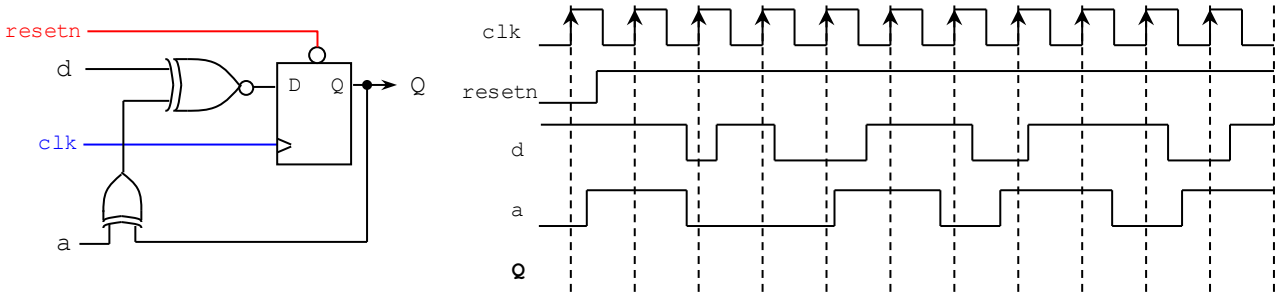


PROBLEM 2 (23 PTS)

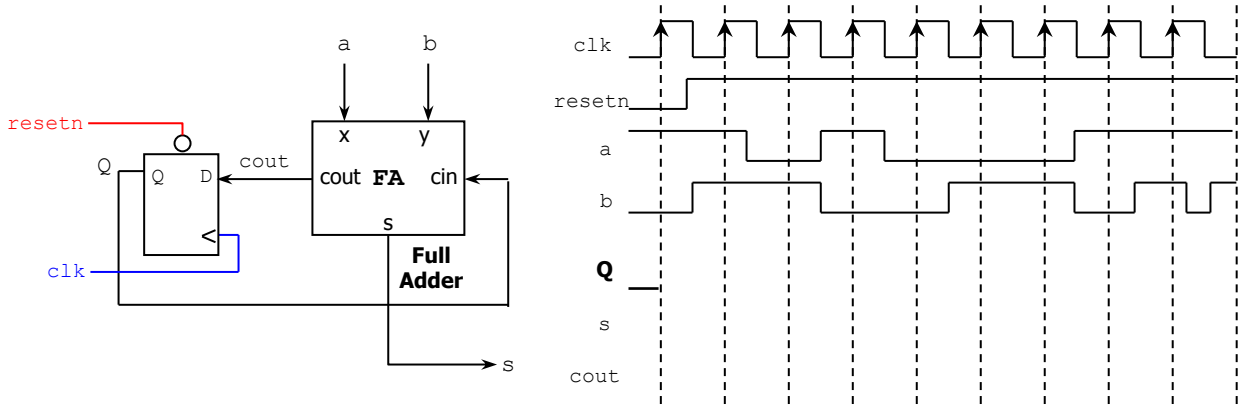
- Complete the timing diagram of the circuit shown below: (7 pts)



- Complete the timing diagram of the circuit shown below: (6 pts)



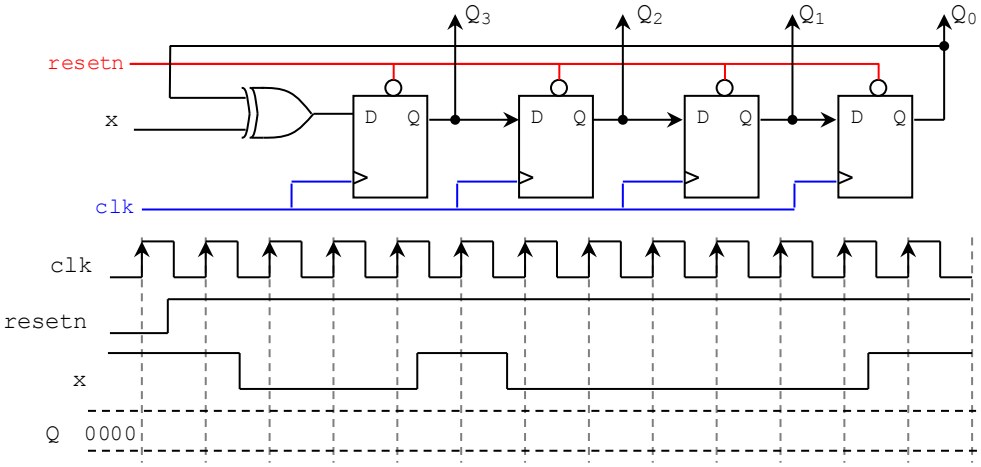
- Complete the timing diagram of the circuit shown below: (10 pts)



PROBLEM 3 (17 PTS)

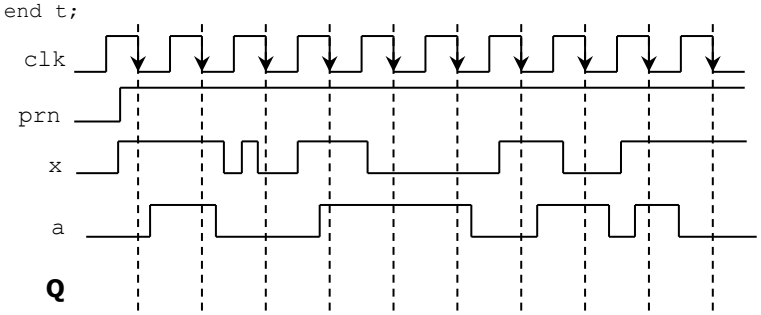
- With a D flip flop and logic gates, sketch the circuit whose excitation equation is given by (4 pts):
  - ✓ $Q(t+1) \leftarrow x\overline{Q(t)} + (\bar{y} \oplus \overline{Q(t)})$

- Given the following circuit: (8 pts)
  - ✓ Get the excitation equations for each flip flop output.
  - ✓ Complete the timing diagram of the circuit. $Q = Q_3Q_2Q_1Q_0$.



- Complete the timing diagram of the circuit whose VHDL description is shown below. Also, get the excitation equation for q.

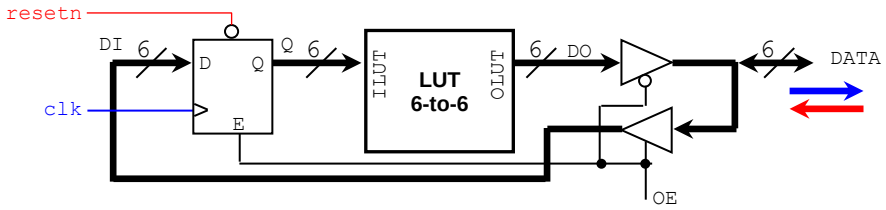
```
library ieee;
use ieee.std_logic_1164.all;

entity circ is
  port ( prn, a,x,clk: in std_logic;
         q: out std_logic);
end circ;

architecture t of circ is

   signal qt: std_logic;

begin
   process (prn, clk, a, x)
   begin
     if prn = '0' then
         qt <= '1';
      elsif (clk'event and clk = '0') then
         if x = '0' then
             qt <= qt xor not(a);
         end if;
      end if;
   end process;
   q <= qt;
end t;
```

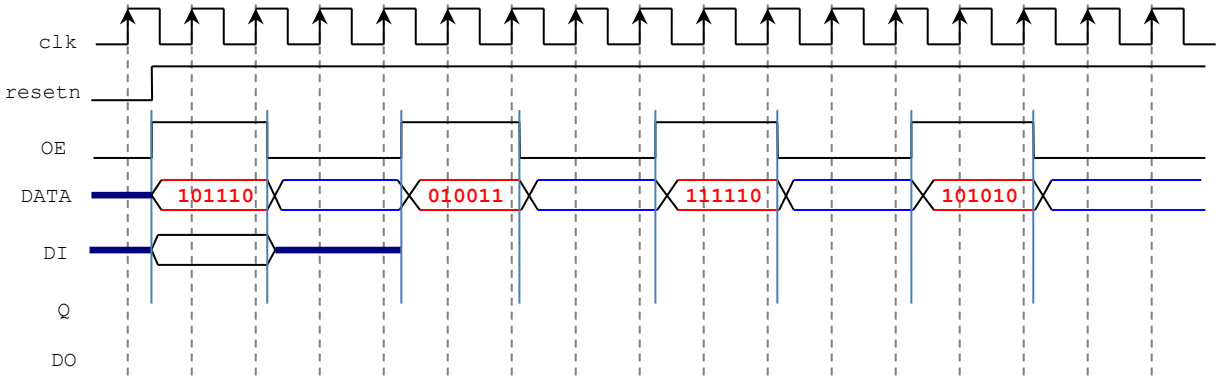


$q(t+1) \leftarrow$

PROBLEM 4 (14 PTS)

- Given the following circuit, complete the timing diagram (signals DO, Q, and $DATA$).
  The LUT 6-to-6 implements the following function: $OLUT = \lceil ILUT^{0.79} \rceil$, where $ILUT$ is a 6-bit unsigned number.
  For example: $ILUT = 35\ (100011_2) \rightarrow OLUT = \lceil 35^{0.79} \rceil = 17\ (010001_2)$

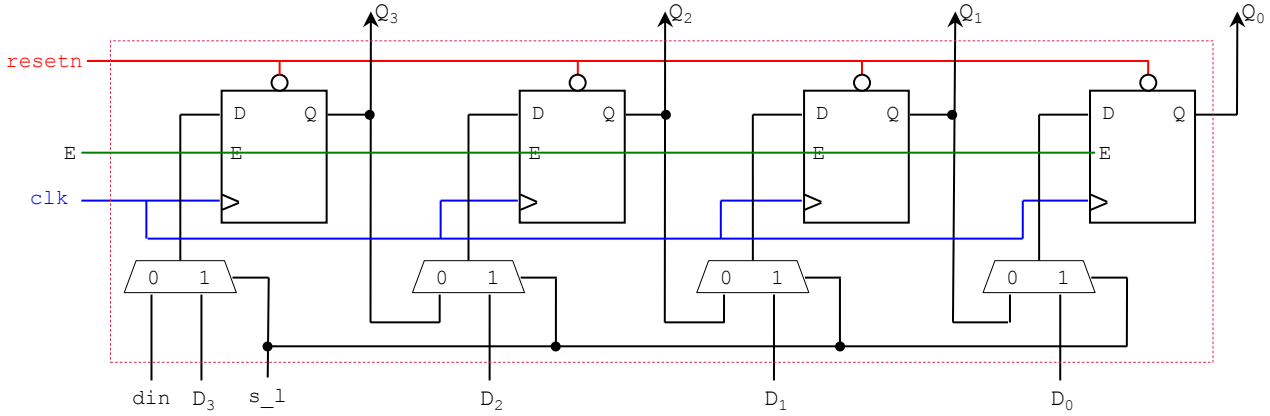


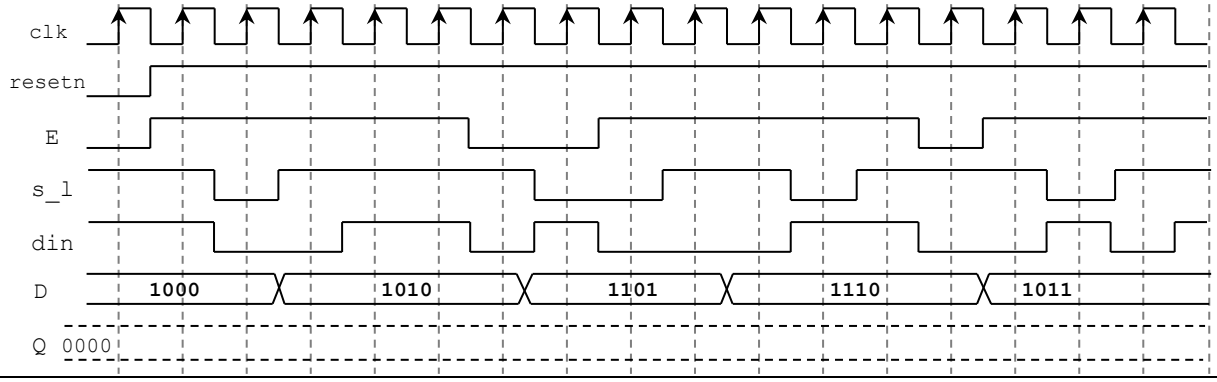


PROBLEM 5 (20 PTS)

- For the following circuit (4-bit parallel/serial load shift register with enable input) we have: $Q = Q_3Q_2Q_1Q_0$. $D = D_3D_2D_1D_0$.
  When `E=1`: If `s_l=0` (shifting operation). If `s_l=1` (parallel load).
  - ✓ Write structural VHDL code. You MUST create a file for: i) flip flop, ii) MUX 2-to-1, and iii) top file (where you will interconnect the flip flops and MUXes). (10 pts)
  - ✓ Write a VHDL testbench according to the timing diagram shown below. Complete the timing diagram by simulating your circuit (Behavioral Simulation). The clock frequency must be 100 MHz with 50% duty cycle. (10 pts)

- Upload (as a .zip file) the following files to Moodle (an assignment will be created):
  - ✓ VHDL code files and testbench
  - ✓ A screenshot of your simulation showing the results for Q (this is on top of you completing the timing diagram below).



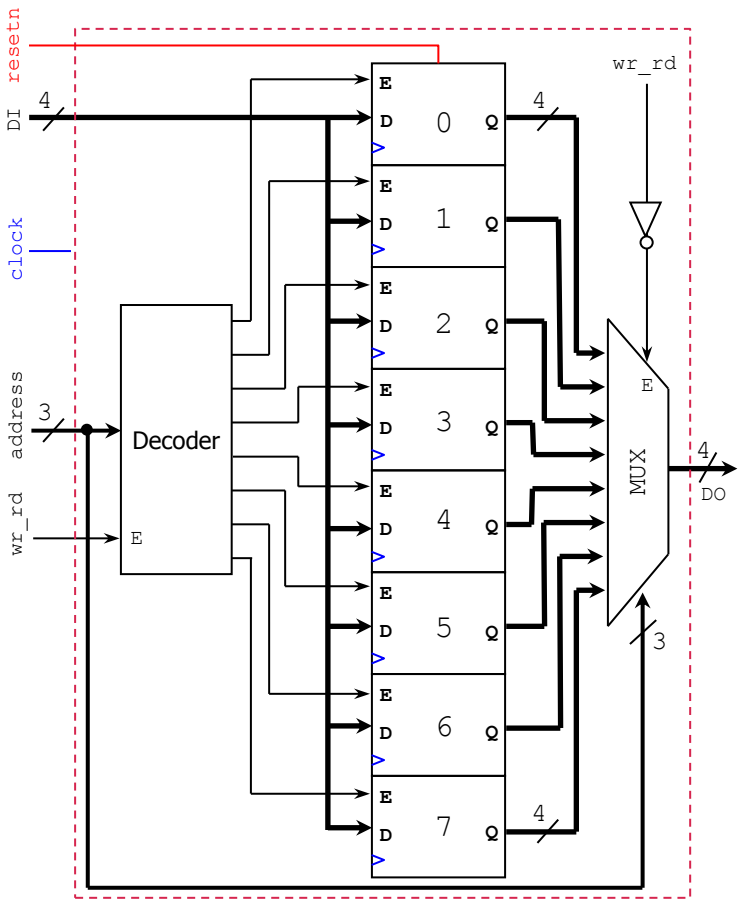


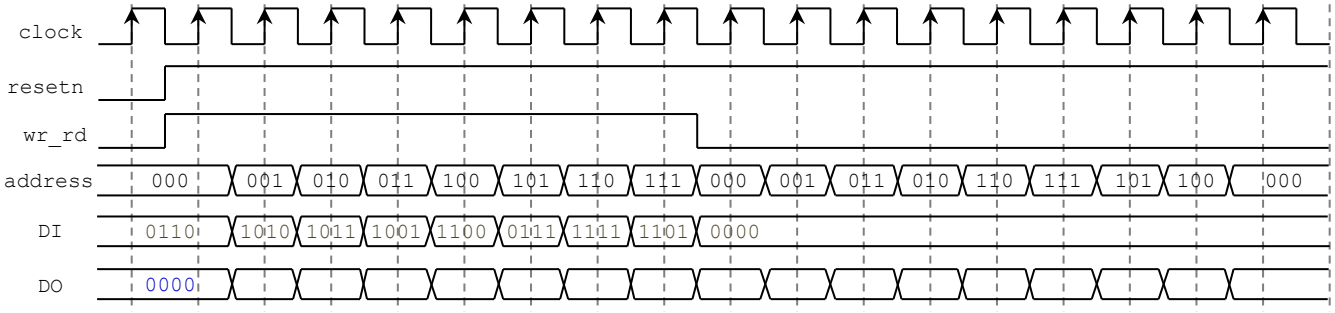
PROBLEM 6 (8 PTS)

- Complete the timing diagram (output DO) of the following Random Memory Access (RAM) Emulator.

- RAM Emulator: It has 8 addresses, where each address holds a 4-bit data. The memory positions are implemented by 4-bit registers. The *resetn* and *clock* signals are shared by all the registers. Data is written or read onto/from one of the registers (selected by the signal address).

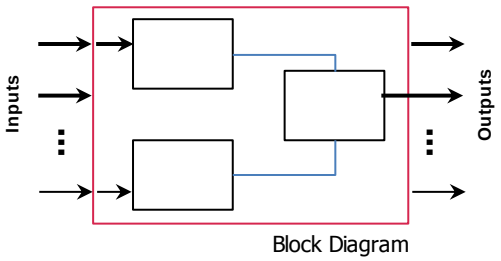
- Operations:
  - ✓ Writing onto memory (wr_rd='1'): The 4-bit input data (DI) is written into one of the 8 registers. The address signal selects which register is to be written.
    - For example: if address = "101", then the value of DI is written into register 5.
    - Note that because the BusMUX 8-to-1 includes an enable input, if wr_rd=1, then the BusMUX outputs are 0's.
  - ✓ Reading from memory (wr_rd='0'): The address signal selects the register from which data is read. This data appears on the BusMUX output.
    - For example: If address = "010", then data from register 2 appears on BusMUX output.





PROBLEM 7 (8 PTS)

- Attach your Project Status Report (no more than 1 page, single-spaced, 2 columns, only one submission per group). This report should contain the initial status of your project. For formatting, use the provided template (`Final Project - Report Template.docx`). The sections included in the template are the ones required in your Final Report. At this stage, you are only required to:
  - ✓ Include a (draft) project description and title.
  - ✓ Include a draft Block Diagram of your hardware architecture.



Block Diagram

- As a guideline, the figure shows a simple Block Diagram. There are input and output signals, as well as internal components along with their interconnection.
  - ✓ At this stage, only a rough draft is required. There is no need to go into details: it is enough to show the tentative top-level components that would constitute your system as well as the tentative inputs and outputs.

- Only student is needed to attach the report (make sure to indicate all the team members).