**Introduction to Digital Computers / Computer Structure - Spring 2003**
Assignment No. 12

**Firm Deadline: June 8th (submit in mailbox 50 near room 124, Labs Building)**

1. Consider the ALU environment in the DLX datapath.
   (a) List the tasks performed by the ALU in every control state.
   (b) List the control signals that are input to the ALU by the control.
   (c) Implement the ALU environment.
2. Answer one of the following:
   (a) Specify the connectivity of the datapath:
      i. Consider the following datapath environments: GPR, IR, PC, ALU, Shifter, Memory. For each environment, list the origins of the inputs and destinations of the outputs needed to support DLX instructions in each control state (don't forget MDR and the MAR).
      ii. Show that the datapath of the DLX supports the connectivity required in part (i).
   (b) Consider the instructions: lw, sw, addi, and, sgti, beqz, slli, add, j, jalr. Depict the dataflow in the datapath during the execution of these instructions (no need to deal with Fetch and Decode).
3. Consider all the instructions of the DLX. Register B in the datapath is loaded during the Decode state without taking into consideration the current instruction.
   (a) Specify the instructions in which register B must be loaded.
   (b) Explain why the functionality is correct if register B is loaded also during instructions in which it need not be loaded.
   (c) Can you explain the decision to always load register B.
4. Alice suggested to connect permanently the CE signal of register B to a logical one signal.
   (a) Is the functionality of the DLX damaged due to this change? Explain your answer.
   (b) Now, Bob suggests to remove Register B, and connect the B output terminal of the GPR Environment directly to the S1MUX. Is the functionality of the DLX damaged due to Bob's change? Explain your answer.
   If the functionality is not damaged, why is register B needed?
5. We would like to add a new instruction to the DLX instruction set:

$$swap\ RS1\ RS2.$$

The instruction has the following effect:

$$\begin{aligned} RS1_{new} &\leftarrow RS2_{old} \\ RS2_{new} &\leftarrow RS1_{old}. \end{aligned}$$

Suggest an extension for the state diagram of the DLX Control in order to support the execution of the new instruction (without changing the datapath!). Draw the path of control states in which the DLX control state machine passes through during the execution of the new instruction. For every control state in the path (old and new), specify the executed RTL instructions.