CS2100 Assignment 2 Answer Book

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After completion, save this file as AxxxxxxxY.pdf and submit on Canvas together with your code as per the instructions given in the question paper.

If you do not fill your particulars above, or do not follow the submission instructions you will forfeit up to 3 marks.

Submission information: _____ / 3

Part A

Question 1. (7 MARKS)
(Use the space to describe the working/thinking behind your code. Think of it as your "working". Marks will be deducted for failure to do so, or simple answers like "Go see the code yourself!" This applies for Questions 1 to 3.)

(a) (3 marks)

These functions implement multiplexors that select one of two inputs based on a control signal. They use the **MUX_FUNCTION** macro to perform the selection and return the result. The **mux_u8** function works with 8-bit inputs, **mux_u32** with 32-bit inputs, and **mux_i32** with 32-bit signed inputs.

(b) (4 marks)

decode: This function decodes a 32-bit instruction into a **struct instr** data structure. It uses bit masks to extract the relevant values from the instruction and assignment them to each field appropriately. The decoded values are stored in the **struct instr** pointed to by the **insn** parameter.

Q1 Total: _____ / 7

Question 2. (10 MARKS)
(a) (3 marks)

Control: This function sets various control signals based on the provided opcode. It uses pointers to modify the values of control signals such as **_RegDst**, **_ALUSrc**, **_MemtoReg**, **_RegWrite**, **_MemRead**, **_MemWrite**, **_Branch**, and **_ALUOp**. It handles different instruction types (R-format, lw, sw, beq).

(b) (3 marks)

ALUControl: Given **ALUOp** and **funct** values, this function determines the ALU control signal based on the instruction type. It returns the appropriate ALU control signal to guide ALU operations for various instructions.

(c) (4 marks)

ALU: This function performs ALU operations based on two input values (**in0** and **in1**) and the ALU control signal. It also sets the **ALUiszero** boolean pointer to indicate if the result of the ALU operation is zero.

Q2 Total: _____ / 10

Question 3. (10 MARKS)

The **execute** function in the provided MIPS simulator performs multiple stages of instruction execution. First, it decodes the input instruction, extracting relevant opcode and operand information. Based on the opcode, it determines control signals that govern the instruction's execution. It then uses an Arithmetic Logic Unit (ALU) to perform calculations, considering the type of instruction (e.g., add, subtract, load, or store). Memory operations are handled as needed for load and store instructions, and the results are written back to the register file. Finally, the program counter is updated by either 4 or the immediate offset if it is a **beq** instruction. This function effectively simulates the core processing stages of a MIPS instruction and updates the global program state accordingly.

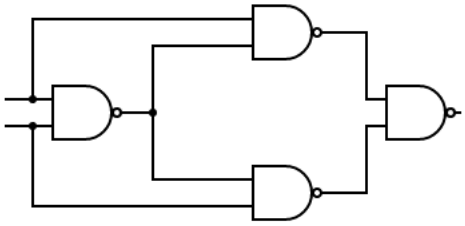
Q3 Total: _____ / 10

Part B

Question 4. (10 MARKS)
You are expected to show working for each of the questions, not merely the final result. Marks may be deducted for failure to do so. Expand on the space as required.

4a. Draw your logic diagram neatly below. (2 marks)

4 nand gates are the minimum required to implement exclusive or. Utilizing the fact that $((A \cdot B)' \cdot A)' = A' + B$



4b. $S_k = (\mathrm{A_k} \cdot \mathrm{B_k}) + (\mathrm{A_k}' \cdot \mathrm{B_k}')$ (1 mark)

4c. $F = S_0$ (1 mark)

4d. Prime implicants: $\mathrm{P}' \cdot \mathrm{S}'$, $\mathrm{R} \cdot \mathrm{S}$, $\mathrm{Q} \cdot \mathrm{S}$, $\mathrm{P}' \cdot \mathrm{Q}$, $\mathrm{P}' \cdot \mathrm{R}$ (1 mark)

4e. Essential prime implicants: $\mathrm{P}' \cdot \mathrm{S}'$, $\mathrm{S} \cdot \mathrm{R}$, $\mathrm{S} \cdot \mathrm{Q}$ (1 mark)

4f. Simplified POS for $G = (\mathrm{P}' + \mathrm{S}) \cdot (\mathrm{Q} + \mathrm{R} + \mathrm{S}')$ (2 marks)

4g. Simplified SOP for $H = (\mathrm{C}' \cdot \mathrm{D}' \cdot \mathrm{E}') + (\mathrm{A}' \cdot \mathrm{C} \cdot \mathrm{E}) + (\mathrm{B} \cdot \mathrm{C} \cdot \mathrm{E}) + (\mathrm{A} \cdot \mathrm{C}' \cdot \mathrm{E}')$ (2 marks)

Q4 Total: _____ / 10

Total Marks: _____ / 40 (To be filled by TA only)

=== END OF PAPER ===