

COMP 1047 Lab Week 05

MIPS Instructions and Single Cycle CPU

- (1) Translate the instruction `add $s0, $s1, $s2` into machine code, and represent it into Hex format. Hint – The following info is provided: opcode = 0, funct = 32. For register numbering, please check it in the lecture notes. Note: During examination, either the above info will be directly given, or Tables B.1 and B.2 in the Harris & Harris book will be provided to answer this type of question.

Solution 0x0232 8020

- (2) Translate the instruction `addi $t0, $t6, -5` into machine code, and represent it into Hex format. Hint – The following info is provided: opcode = 8.

Solution 0x21C8 FFFB

- (3) Translate the instruction `lw $t2, 32($0)` into machine code, and represent it into Hex format. Hint – The following info is provided: opcode = 35.

Solution 0x8C0A 0020

- (4) Practice the following translations of the instructions `sw`, `sub`, `lb`, `sb`, `and`, `or`, `sll`, `srl`, `sra`.
- (5) Design an ALU which takes in two 32-bit input A and B, and drives one 32-bit output Y. The ALU should support the following operations: `add`, `sub`, `and`, `or`, `slt`, and “identical bit checking”. Identical bit checking means to bit-wisely check A and B: At each bit position, if the corresponding bits of A and B are the same, then output 1 at that position. Otherwise 0 is output. Example: with A = 1001 and B = 0101, the output of this operation is 0011. Design the ALU using the logic blocks mentioned in the lecture notes, and provide the corresponding ALUop control signal for each operation (i.e., provide a control table similar to the one in Slide 20 in the ‘ALU Design’ lecture notes.).

- (a) Provide the design if ALUop is required to be 4 bits.
- (b) Provide the design if ALUop is required to be 3 bits.

Solution See Figure 1 and Figure 2.

- (6) This question is about datapath design of the single cycle CPU. Recall that in Page 26 of this week’s lecture notes (“Single-Cycle CPU”), an animation of the data flow process of the `add` instruction has been illustrated, as shown below. Your task is to provide similar animations for the `lw`, `sw` and `beq` instructions.

Resources provided for assistance:

- A ppt template (pp. 26) extracted for you to design your own animation on. Available in Section “Week 5” in the Moodle page.
- We had a MIPS online learning & simulator tool designed by a group of your senior classmates taken SYS. [Wonderful job indeed!] Play with it, and use it as the guidance and reference for your design. The link is [here](#). The user manual is [here](#). Something for fun is [here](#).

Figure 1 Sample solution 5(a)

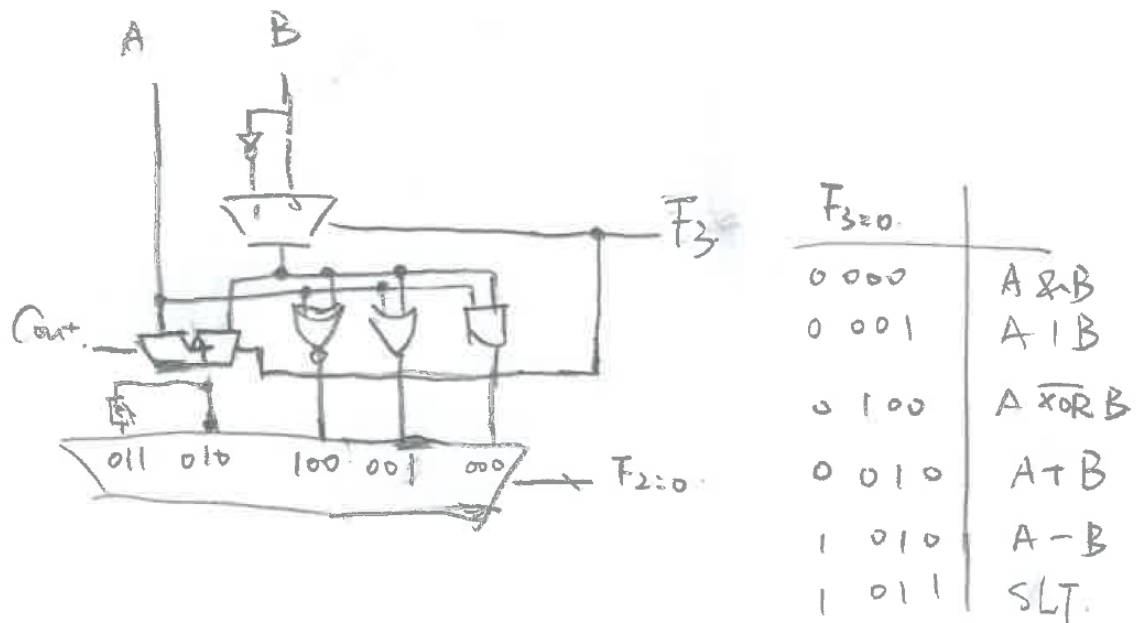
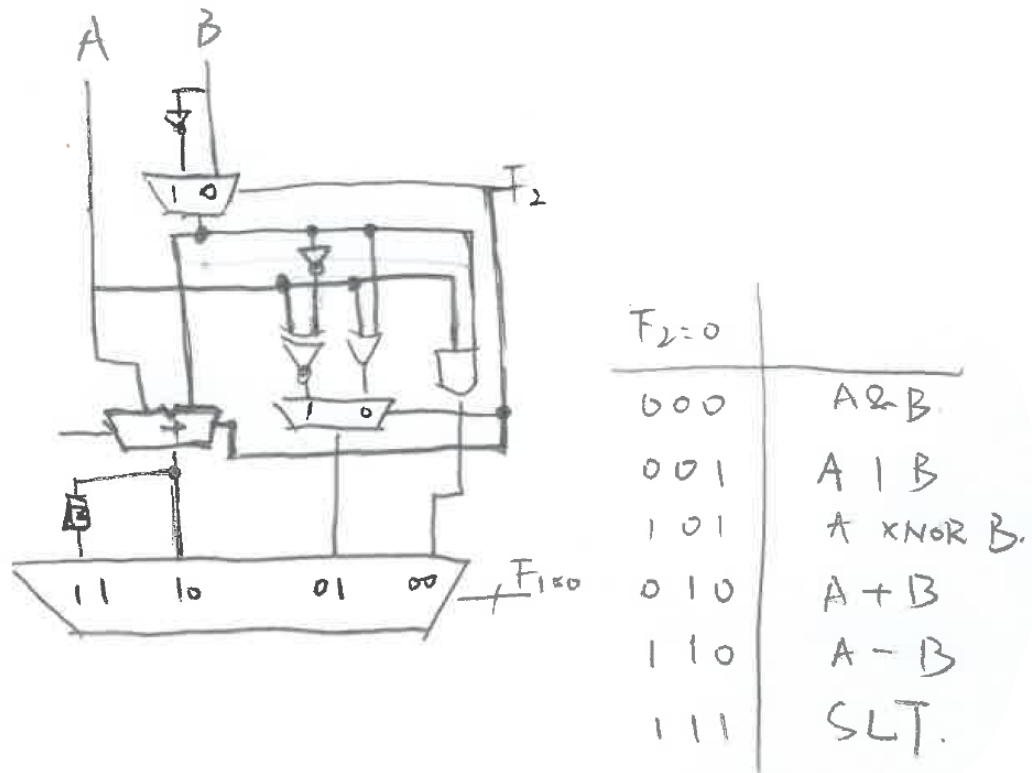


Figure 2 Sample solution 5(b)



Dataflow during **add**

