1. (10 points) Exercise 2.15.1, 2.15.2. Perform these exercises on the following two instructions instead of the instructions in the book:

   ```
   a) not $t1, $t2      # bit-wise invert
   b) orn $t1, $t2, $t3  # bit-wise OR of $t2 and !$t3
   ```

   Make sure you use only MIPS instructions, not pseudoinstructions.

2. (5 points) Translate the following HLL code into MIPS

   ```
   if (x > 1009904)    // 1009904 = estimated population of Rhode Island, 2016
       x = 1009904
   ```

3. (5 points) Suppose MIPS did not have the sub instruction. Find a minimal set of instructions to implement sub $t0, $t1, $t2. Do NOT use any pseudo instrustions.

4. (10 points) Consider the following pseudoinstruction

   ```
   rotl  $t1, $t2, shamt
   ```

   This command will rotate the bits of $t2 by shamt bits to the left, replacing the low order bits with the high order bits that are shifted off, and storing the results in $t1. For example if $t2=0xFEDCBA98 and shamt=8, then the value of $t1 will become 0xDCBA98FE.

   (a) Determine the value of $t1 (in hex) using the value of $t2 above, but with a shamt value of 1.

   (b) Translate the above pseudoinstruction into 1 or more MIPS instructions, using as few instructions as possible.

5. (5 points) Exercise 2.17.4, pg. 196. Use only code **b**.

6. (10 points) Exercise 2.31.1, pg. 211. Use only code **b**. This is similar to an example on page 143 in the text, and your answer should look like the diagram on page 144. You should treat the first two instructions in procedure A as storing the *address* of variable X into $a0, i.e. X is actually an array and what we are storing in $a0 is the base address of the array.

7. (10 points) Suppose we needed to jump to the memory address 0xAE87698C.

   (a) If the current PC value is 0xAF70018B show the j instruction to perform the jump (display it as both a 32-bit binary number and as an equivalent hex value).

   (b) If the current PC value is 0x8F70018B explain why we cannot use a j instruction to perform the jump. Explain how to to solve this problem by using a different unconditional jump instruction.

8. (15 points) Exercises 2.39.1 through 2.39.6. Use the data in line **b** in both tables.