Problem 1: As described in class, SPARC v7 integer branch instructions use a 22-bit immediate field for the displacement. Branches are typically used in loops and if/else constructs, and so the ± 2097152 instruction range might be more than is needed. So did the computer engineers at Sun Microsystems (now part of Oracle). Look up the v7 integer branch instruction in the SPARC Joint Programming Specification (JPS1), linked to the course references page (look for JPS1). You'll find SPARC v7 integer branch under Instruction Definitions in the Deprecated Instructions section. Then look up the replacement integer branch instructions (not in the deprecated section).

(a) Sketch (or cut-and-paste, take a picture with your cell phone, etc.) the format of the three instructions (one old, two new).

(b) Describe how `BPr` is different than the original v7 integer branch instruction, and point out two benefits.

(c) Describe how `BPcc` is different than the original v7 integer branch instruction. This instruction shares one benefit with `BPr`, but it has lost 2 bits of displacement in order to accommodate 64-bit register values. (The other third lost bit has nothing to do with 64-bit register values). Explain.

Problem 2: For the following assignment familiarize yourself with the VAX ISA by looking in the VAX-11 Architecture Reference Manual (linked to the course references page). In particular, see Section 2.6 for a summary of the instruction format, and Chapter 3 for details on the operand specifiers used in the instruction formats. For examples, look at some past homework assignments in this course: `http://www.ece.lsu.edu/ee4720/2010f/hw04_sol.pdf`, `http://www.ece.lsu.edu/ee4720/2007f/hw03_sol.pdf`, and `http://www.ece.lsu.edu/ee4720/2002/hw02_sol.pdf`.

The VAX format is simple, it consists of a one- or two-byte opcode followed by some number of *operand specifiers* and any additional fields they may use. The operand specifiers are 8 bits, and are followed by a possible extension and immediates. (See Section 2.6 and Chapter 3 of the VAX-11 Architecture Reference Manual.)

(*a*) The VAX operand specifier is 8 bits, it includes a 4-bit mode field, and for literal addressing, a 6-bit literal field. (A *literal* in VAX is a small immediate.) Explain how it's possible to fit a 4-bit mode field and a 6-bit literal field into 8 bits.

(*b*) Find the best VAX replacement for each of the two MIPS instructions below and show their encoding. The two VAX instructions will be different.

```
 addi r1, r2, 1

 addi r1, r1, 1
```

(*c*) Find a VAX instruction to replace the following sequence of MIPS instructions, and show its encoding.

```
 lw r1, 0(r2)
 lui r3, 0x2abb
 ori r3, r3, 0xccdd
 add r1, r1, r3
 sw r1, 0x100(r2)
```

(*d*) Compare the size of the VAX instruction from the problem above to the size of the MIPS instructions.