Answers to Problem Set 1

Problem 1.
Part 1.a. Regular, not atomic.

Part 1.b. None of the above.

Part 1.c. Atomic.

Problem 2. Consider the transformation from binary MRSW safe registers to binary MRSW regular registers, given in class.

Part 2.a. Prove that the transformation does **not** generate multi-valued MRSW regular registers (by providing a counterexample that breaks regularity).
If the registers are multi-valued, then two consecutive reads on the safe register *Reg* may return arbitrary values, breaking regularity of the register implementation. Since the safe register is binary in the correct implementation (and thus limited to two values), this does not occur in the transformation given in class.

Part 2.b. Also, prove that the resulting registers are not binary atomic (by providing a counterexample that breaks atomicity).
The counterexample can be easily built by scheduling two distinct reads during a write(1) operation on the register. Since the underlying register is safe, we can ensure that the first operation returns 1, while the second (non-overlapping) operation returns 0, contradicting atomicity.

Problem 3. Consider the transformation from binary regular to M-valued MRSW regular registers given in class. Prove that:
Part 3.a. The resulting registers are regular.
For this, please follow the steps of the proof as outlined in class. In particular, prove that any read operation starting after a write must return the last written value, and that any concurrent read operation must either return the current value, or the previous value.

Part 3.b. The transformation would not work if the Write operation would first write 0, and then 1. (You should provide a counterexample that breaks regularity.)
For this, notice that if the writer first clears the array by writing 0's, it is possible for the value of the array to be all 0's, which is not a valid state (in particular, it might cause a reader to read forever).

Part 3.c. The resulting registers are not atomic. (You should provide a counterexample execution that breaks atomicity.)
Please see Chapter 3 of the lecture notes on the website, page 14 (paragraph entitled "*A counterexample for atomicity*").