Midterm Practise Questions

1. a) Design (i.e. give the transition diagram for) a Turing machine M that decides the language $L = \{1^j 0^k : j,k \geq 1\}$, where $1^2 = 11, 1^3 = 111, \ldots$

   b) Give the computation sequences of your machine, i.e. the lists of configurations the machine passes through until it halts, on inputs 110, 01, and ε (the empty input string).

2. Which of the following claims are true and which are false? (No proofs are needed, just indicate your choice by the letter T or F.)

   (a) All languages accepted by deterministic Turing machines are recursive.

   (b) All languages accepted by nondeterministic Turing machines are recursively enumerable.

   (c) The complement of any language accepted by a deterministic Turing machine is recursively enumerable.

   (d) The intersection of any two recursively enumerable languages is recursively enumerable.

   (e) The Turing machine Halting Problem belongs to the complexity class NP.

   (f) A problem A can be shown to be undecidable by devising a reduction mapping t from A to the Halting Problem.

   (g) The problem of determining if a Turing machine accepts all inputs x of length $|x| \leq 100$ is undecidable.

   (h) The problem of determining if a Turing machine runs for at least 100 steps on the input ε (empty string) is undecidable.

3. (a) Define the formal language L_{101} representing the decision problem:

   Given a Turing machine M; does M accept *only* the string 101?

   (b) Prove, without appealing to Rice's theorem, that the language L_{101} is not recursive.