1999 Paper 6 Question 11

Complexity Theory

Explain what is meant by a deterministic and a non-deterministic Turing Machine and the idea of such machines solving a decision problem. [7 marks]

If a non-deterministic Turing Machine solves a certain problem in at most N time-steps, what information must be noted to document the exact state of the machine at each stage as it performs the calculation? [5 marks]

Part of the information you have just identified will be the sequence of states $q_0, q_1, \ldots$ that the machine goes through. Taking account of the fact that the machine is non-deterministic show how

(a) this part of the information can be represented by the values of a number of boolean variables, and

(b) a formula in the style used in the problem 3-SAT can be written down to ensure that the sequence of states is one that does correspond to a valid computation of the machine.

[*Marks will be deducted if you attempt to document how to extend your demonstration to cover other aspects of the machine's behaviour.*] [8 marks]