

CA313 Algorithms and Complexity

Spring 2009

Attempt **three** questions. All questions carry equal marks.

Q 1.

(i) Explain each term in the quadruple $\langle V_t, V_n, P, S \rangle$ by which a grammar for any language is defined.

(ii) Define the constraints on α and β in a rewrite rule $\alpha \longrightarrow \beta$ for the four classes of grammar in the Chomsky Hierarchy.

(iii) Assume the following ruleset:

NP \rightarrow D, newspaper

NP \rightarrow Bertie

VP \rightarrow V

VP \rightarrow V,NP

D \rightarrow the

V \rightarrow bought

Bertie bought the newspaper \rightarrow the newspaper was bought by Bertie

the newspaper bought Bertie \rightarrow Bertie was distraught

(a) State which type of grammar this is, and why;

(b) State which rules in the grammar could be rules in a less powerful grammar, and why.

(iv) For each of the four grammar types in the Chomsky Hierarchy, give the:

- class of grammar name,
- language name,
- automaton

associated with each type.

Q 2.

(i) Describe in your own words:

- What a Turing machine consists of?
- What it is useful for?

(ii) Give a formal definition of a Turing machine in terms of the 5-tuple $M = (Q, \Sigma, \Gamma, q_0, \delta)$.

(iii) How are Turing machines useful in the definition of different classes of complexity problems?

(iv) Construct a Turing Machine which erases the input string.

(v) For the initial configuration $(q_0, \underline{1}1\#)$, show how the Turing machine you provided in (iv) copes with that input tape.

Q 3.

Q 4.

Q 5.