

OLLSCOIL NA hÉIREANN, GAILLIMH
THE NATIONAL UNIVERSITY OF IRELAND, GALWAY

SUMMER EXAMINATIONS 1999

B.A., B.Sc., and THIRD SCIENCE EXAMINATION

COMPUTER STUDIES

CS304=(MA325+MA326)=CS310=Second Paper of CS320

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Time allowed: *Three* hours.

Candidates taking CS304 should attempt *four* questions, two from each section.

Candidates taking only MA325 should attempt *two* questions from Section A.

SECTION A

A 1 (a) Describe the NOT, OR and NOR gates, and express each of NOT and OR in terms of NOR.

(b) Construct the logic table for the Boolean expression

$$(x_1 \vee x_2) \wedge \sim (x_1 \wedge x_2)$$

(c) The logic table for certain Boolean expression is given below:

x_1	x_2	y
0	0	1
0	1	0
1	1	1
1	0	1

Write down an expression for y in disjunctive normal form (DNF). Explain, briefly, why the DNF takes the value 1 precisely when y has value 1.

(d) There are three main symptoms associated with a certain disease. A doctor will judge that a patient has this disease if two of the symptoms are present. Construct a basic machine which models this diagnosis, and explain the notation you use.

p.t.o.

A 2 (a) A judge hears the following evidence:

- Alan or Bob were responsible.
- If Bob is guilty so is Clare.
- Clare is innocent.

The judge concludes that Alan is guilty. Using a to represent "Alan is guilty", b to represent "Bob is guilty" and c for "Clare is guilty", construct the argument underlying the judges reasoning. Test the validity of the argument.

(b) Define what it means to say that an argument $P, Q \therefore R$ is (i) *valid*, (ii) *sound*.

Give an example of a valid argument that is not sound. Show that the argument you gave is valid and explain why it is not sound.

(c) A certain questionnaire has the following two part question:

- (i) Give your height in centimeters.
- (ii) Describe yourself as either 'tall' or 'short'.*

*Note: If your height is 200cm or more you should answer 'tall'.

The researcher studying the responses finds four cases where the answers given to this question are incomplete. The answers given are:

A:- 206 cm

B:- short

C:- tall

D:- 159 cm

The researcher is, in fact, only interested in seeing if people followed the instruction in the note correctly. Which of the four people, if any, must she ask to complete their answers?

If the instruction had been "Answer 'tall' only if your height is 200 cm or over", then who would she have had to contact?

A 3 (a) Describe the tableau method for testing a collection of well-formed formulae (compound propositions) for consistency/inconsistency.

(b) Use the tableau method to show that the following collection of well-formed formulae (WFFs) is consistent:

$$p \rightarrow q, \quad q \vee r, \quad \sim (p \rightarrow r)$$

Read off, from the tableau, an assignment of values for p , q and r which makes all three WFFs take the value 1.

(c) Use the tableau method to show that the following argument is valid:

$$(b \vee c) \rightarrow (a \rightarrow c), \quad (\bar{b} \rightarrow c) \wedge \bar{c} \therefore \bar{a}$$

SECTION B

- B 1** (a) Construct a finite state machine that operates on strings of a 's and b 's as follows: Gives an output of 1 in response to every second b and outputs 0 in response to anything else. Explain the notation you use and run the machine on the input sequence $babbbbaab$.
- (b) Construct an acceptor that accepts a word of 1's and 0's if and only if it is a number divisible by 3, written in binary. Show how the acceptor accepts 1001 but rejects 1110.
- (c) Write down the regular grammar corresponding to the non-deterministic acceptor (NDA) in Figure 1. Show how the grammar generates $aaaba$.

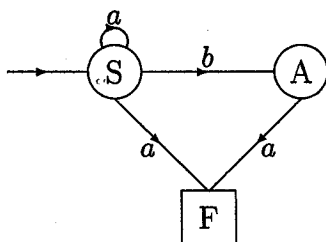


Figure 1: The NDA for question B1(c) and B2(a)

- B 2** (a) Convert the non-deterministic acceptor (NDA) in Figure 1 to an ordinary acceptor.
- (b) Construct an NDA corresponding to the following regular grammar:

$$V = \{S, A, B, F\}, \quad T = \{a, b\}, \quad P = \{S \rightarrow aA, A \rightarrow bB, B \rightarrow aA|bF\}$$

Find the language L_1 that is accepted by the NDA and check that this is the language generated by the grammar.

- (c) Explain, briefly, why there is no acceptor for the language $L_2 = \{a^n b^n : n \geq 1\}$. Say whether or not there is a regular grammar that generates L_2 and give reasons for your answer.

- B 3** (a) Construct a Turing machine (TM) to compute $f(n)$ when

$$\begin{aligned} \text{(i)} \quad & f(n) = 0 \text{ for all } n \geq 1. \\ \text{(ii)} \quad & f(n) = \begin{cases} 0 & \text{if } n \text{ is even} \\ 2 & \text{if } n \text{ is odd} \end{cases} \end{aligned}$$

Show how each TM runs the tape $\dots 01110\dots$

- (b) Construct a TM to compute $g(n, m) = n + m$ for $n \geq 0$ and $m \geq 0$ and run the TM on the tape $\dots 0101110\dots$. Modify this TM so that it computes $h(n, m) = n + m + 1$ and check the computation of $h(1, 3)$.

END OF PAPER