

Marks

- [10] 1. Describe a Turing machine that takes as input,  $x \in \{0, 1\}^*$ , and (1) accepts  $x$  if  $x$  somewhere has two consecutive 1's, and (2) rejects  $x$  if not. You should **explicitly write** and **explain** each of  $Q, \Gamma, q_0, q_{\text{accept}}, q_{\text{reject}}, \delta$ .

[10] 2. Let  $f$  be the functions defined by

$$f(\text{yes}) = \text{yes}, \quad f(\text{no}) = \text{no}, \quad f(\text{loops}) = \text{no}.$$

Consider the axiom: For all  $P \in \mathcal{P}$  there is a  $P' \in \mathcal{P}$  such that for all  $x \in \mathcal{I}$  we have

$$\text{Result}(P', x) = f(\text{Result}(P, x)).$$

Argue in a few sentences either that the axiom is reasonable (i.e., achievable for a Turing machine, C language program, etc.) or unreasonable (i.e., would lead to a contradiction involving what we know from the other axioms).

- [10] **3.** Axiom 2 asserts the existence of a “universal program,”  $U \in \mathcal{P}$  such that for each  $P$  and  $x$  we have

$$\text{Result}(U, \text{EncodeBoth}(P, x)) = \text{Result}(P, x).$$

- (a) Why is this called a universal program? Answer in one sentence.
- (b) Describe in one sentence the relevance of  $U$  to  $L_{\text{yes}}$ ; recall that

$$L_{\text{yes}} = \{\text{EncodeBoth}(P, x) \mid P \in \mathcal{P}, x \in \mathcal{I}, \text{ and } \text{Result}(P, x) = \text{yes}\}.$$

- (c) Describe in one or two paragraphs how you would construct a universal program for your favourite standard programming language (e.g., C, Java, etc.) or a Turing machine.

- [10] 4. Let  $L_1$  and  $L_2$  be languages that are decidable in polynomial time.
- (a) Argue in one or two sentences that  $L_1 \cap L_2$  is decidable in polynomial time.

(b) Argue in one paragraph that  $L_1^*$  is decidable in polynomial time.

**The End**

Be sure that this examination has 6 pages including this cover

The University of British Columbia

Midterm Examinations - November 2010

Computer Science 421/501

Closed book examination

Time: 50 minutes

Name \_\_\_\_\_ Signature \_\_\_\_\_

Student Number \_\_\_\_\_ Instructor's Name \_\_\_\_\_

Section Number \_\_\_\_\_

### Special Instructions:

Calculators, notes, or other aids may not be used. Answer questions on the exam. This exam is two-sided!

### Rules governing examinations

**1. Each candidate should be prepared to produce his library/AMS card upon request.**

**2. Read and observe the following rules:**

No candidate shall be permitted to enter the examination room after the expiration of one half hour, or to leave during the first half hour of the examination.

Candidates are not permitted to ask questions of the invigilators, except in cases of supposed errors or ambiguities in examination questions.

CAUTION - Candidates guilty of any of the following or similar practices shall be immediately dismissed from the examination and shall be liable to disciplinary action.

(a) Making use of any books, papers or memoranda, other than those authorized by the examiners.

(b) Speaking or communicating with other candidates.

(c) Purposely exposing written papers to the view of other candidates. The plea of accident or forgetfulness shall not be received.

**3. Smoking is not permitted during examinations.**

1		10
2		10
3		10
4		10
Total		40