

THE UNIVERSITY OF BRITISH COLUMBIA
CPSC 421: MIDTERM EXAMINATION – October 30, 2019

Full Name: xLASTNAMEx

Exam ID: xFIRSTNAMEx

Signature: _____

UBC Student #: XXXXXXXXXXXXX

Important notes about this examination

1. You have **50** minutes to complete this examination.
2. One two sided (8.5" x 11") sheet of notes is allowed.
3. Good luck!

Student Conduct during Examinations

1. Each examination candidate must be prepared to produce, upon the request of the invigilator or examiner, his or her UBCcard for identification.
2. No questions will be answered in this exam. If you see text you feel is ambiguous, make a reasonable assumption, write it down, and proceed to answer the question.
3. No examination candidate shall be permitted to enter the examination room after the expiration of one-half hour from the scheduled starting time, or to leave during the first half hour of the examination. Should the examination run forty-five (45) minutes or less, no examination candidate shall be permitted to enter the examination room once the examination has begun.
4. Examination candidates must conduct themselves honestly and in accordance with established rules for a given examination, which will be articulated by the examiner or invigilator prior to the examination commencing. Should dishonest behaviour be observed by the examiner(s) or invigilator(s), pleas of accident or forgetfulness shall not be received.
5. Examination candidates suspected of any of the following, or any other similar practices, may be immediately dismissed from the examination by the examiner/invigilator, and may be subject to disciplinary action:
 - i. speaking or communicating with other examination candidates, unless otherwise authorized;
 - ii. purposely exposing written papers to the view of other examination candidates or imaging devices;
 - iii. purposely viewing the written papers of other examination candidates;
 - iv. using or having visible at the place of writing any books, papers or other memory aid devices other than those authorized by the examiner(s); and,
 - v. using or operating electronic devices including but not limited to telephones, calculators, computers, or similar devices other than those authorized by the examiner(s)—(electronic devices other than those authorized by the examiner(s) must be completely powered down if present at the place of writing).
6. Examination candidates must not destroy or damage any examination material, must hand in all examination papers, and must not take any examination material from the examination room without permission of the examiner or invigilator.
7. Notwithstanding the above, for any mode of examination that does not fall into the traditional, paper-based method, examination candidates shall adhere to any special rules for conduct as established and articulated by the examiner.
8. Examination candidates must follow any additional examination rules or directions communicated by the examiner(s) or invigilator(s).

Please do not write in this space:



0. IDENTIFICATION

Please make sure that the following is your 5-character ugrad email id:

xFIRSTNAMEx

Your answer to each problem should be written on its page; if needed, you can use the back side of the page as well.

1. (10 POINTS)

Circle either T for true, or F for false, for each of the statements below:

If L is regular, then L^* is regular. T F

The set of languages over the alphabet $\{a, b\}$ is countable. T F

The set of Turing machines, M , such that for some $q, \gamma \in \mathbb{N}$, the state set of M is $\{1, \dots, q\}$ and the tape alphabet of M is $\{1, \dots, \gamma\}$, is countable. T F

The union of two nonregular languages is nonregular. T F

If L is decided by some 5-tape Turing machine, then it is decided by some 1-tape Turing machine. T F

2. (10 POINTS)

Let $\Sigma = \{a, b\}$, and let L be the language over Σ given by

$$L = \{s \in \Sigma^* \mid s \text{ contains } ba \text{ as a substring}\}.$$

Describe a Turing machine that decides L , and explain how it works; specify Q and δ either by (1) a list of values or (2) a state diagram. What is your work tape Γ ? Clearly indicate which state is your accept state, which is your reject state, and which is your initial state.

3. (10 POINTS)

Give an NFA recognizing the language $(aba)^*(abaa)^*$; i.e., give a state diagram for the NFA and explain how your NFA works.

4. (10 POINTS)

Let $\Sigma = \{a, b, c\}$. Use the Myhill-Nerode theorem to show that the language

$$L = \{s \in \Sigma^* \mid \text{Exactly half of the symbols in } s \text{ are } c\text{'s}\}$$

is nonregular, by showing that there are an infinite number of values of $\text{AccFut}_L(s)$ where s varies over Σ^* .