



- Exam duration: 90 Minutes.
- This exam has 2 parts. Part A has 3 pages (9 points) and Part B 5 pages (15 points). Check that you have **9 pages**, including this cover page.
- Books, notes, blank sheets, calculators or any other electronic equipment including cell phones are not allowed.
 - Use a **black** or **blue PEN** for writing your final answers for Part A. Writing in pencil in these booklets will be ignored!
 - Part B consists of multiple choice questions only. You must enter your answers to this part in the scan sheet provided with the exam booklet. Make sure to fill out your information and the answers in appropriate circles on the scan sheet using **PENCIL** only.
 - Use any space on your exam booklets for your rough work: it will be ignored. **ONLY** the scan sheet answer will be marked for Part B.
- You must hand in Part A, Part B, and the scan sheet.
- Do not detach or attach any pages; **do not bend the scan sheet.**

Table for Instructor's use

Problem	Points	Notes
Part A – Q1		
Part A – Q2		
Part A – Q3		
Part B		



Part A

1. Given any sets P and Q of strings, their *symmetric difference*, denoted as $SD(P, Q)$, is defined as the set which contains every string that belongs to either P or Q , but not to both. For instance, if $P = \{00, 101\}$ and $Q = \{11, 00\}$, then $SD(P, Q) = \{11, 101\}$.
 - (a) (1.5 points) Let $L_1 = L(0^*1^*)$ and $L_2 = L(1^*0^*)$. List every string in $SD(L_1, L_2)$ whose length is 3 or less.

- (b) (1.5 points) Give a regular expression for the language $SD(L_1, L_2)$ defined above in part (a).

2. Let L be the language over the alphabet $\Sigma = \{a, b\}$ that includes every string w in which the number of a 's plus twice the number of b 's is a multiple of 3. That is,

$$L = \{w : w \in \Sigma^* \text{ and } n_a(w) + 2n_b(w) \text{ is a multiple of } 3\}.$$

- (a) (2 points) Give a DFA for L .

- (b) (1 point) Give a regular grammar for the language L defined above.

3. (3 points) Let $L = \{w : w \in \{a, b\}^* \text{ and } n_a(w) > n_b(w)\}$. That is, for every string w in L , the number of a 's is more than the number of b 's. Prove or disprove that L is regular.