Automata Theory - Midterm

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1 Instructions

1. Attempt as many problems as you can. You will be given partial credit.

2 Problems

1. Consider the $\epsilon - NFA$ defined below:

\[
\begin{array}{|c|c|c|c|}
\hline
 & \epsilon & a & b \\
\hline
p & \phi & \{p\} & \{r\} \\
q & \{p\} & \{q\} & \{r\} \\
*r & \{q\} & \{r\} & \phi \\
\hline
\end{array}
\]

(a) Compute the $\epsilon$-closure of each state. (3 points)
(b) Convert the automaton to a DFA. (4 points)

2. Let $\Sigma = \{a, b, c\}$. Write a regular expression for the language consisting of the set of strings containing at least one $a$ and at least one $b$. (4 points)

3. Let $\Sigma = \{0, 1\}$. Which of the following languages is regular? Provide an explanation in each case. (6 points)

(a) $L = \{0^n1^m | n \leq m, n, m \geq 0\}$
(b) $L = \{0^n1^m | n \geq m, n, m \geq 0\}$
(c) $L = \{0^n1^m | n, m \geq 0\}$

4. Let $\Sigma = \{0, 1\}$. Let $L$ be the language that consists of strings having either 01 repeated one or more times or 010 repeated one or more times. Is $L$ regular? Explain. (4 points)

5. Assume that a regular language $L$ is provided to you as a DFA $A = \langle Q, \Sigma, \delta, q_0, F \rangle$. How would you check whether $L$ is infinite? (5 points).

\textit{Hint: Pumping Lemma.}

6. Let $\Sigma = \{0, 1\}$. We showed in class that the language $L = \{0^n1^m | n \geq 0\}$ is not regular. Argue using closure properties of regularity, that $L' = \{0^i1^j | i \neq j\}$ is not regular. (4 points)