Formal Languages and Automata Theory (CS303)

Mid-Semester Examination
Indian Institute of Technology, Patna
September, 2019
Full marks- 60, Duration- 120 min

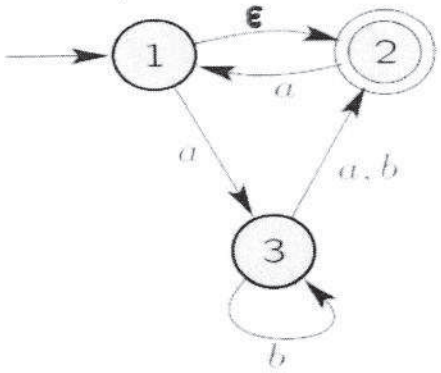
1. Answer all the questions: [4X5]

(a) Prove that, if M is a DFA that recognizes language B, swapping the accept and non-accept states in M yields a new DFA that recognizes $\overline{B}$, the complement of B. Conclude that the class of regular languages is closed under complement.

(b) We say that a DFA M for a language A is minimal if there does not exist another DFA M′ for A such that M′ has strictly fewer states than M. Suppose that M = (Q, ∑, δ, q0, F) is a minimal DFA for A. Using M, we construct a DFA $\overline{M}$ for the complement $\overline{A}$ as $\overline{M}$ = (Q, ∑, δ, q0, Q−F). Prove that $\overline{M}$ is a minimal DFA for $\overline{A}$.

(c) Prove or disprove, if M is an NFA that recognizes language C, swapping the accept and non-accept states in M doesn't necessarily yield a new NFA that recognizes $\overline{C}$.

(d) Convert the following NFA N into an equivalent DFA.



2. Answer all the questions: [4+8+8]

(a) Prove that if we remove a finite set of strings from a regular language, the result is a regular language.

(b) Prove that the languages A1 = {www | w ∈ {a, b}*} and A2 = { w ∈ {a, b}* | w = w^R} are non-regular using pumping lemma.

(c) Give context free grammars for following two languages: L1 = { $a^i b^j c^k$ | i, j, k ≥ 0, and i = j or i = k } and L2 = { $a^i b^j c^k$ | i, j, k ≥ 0 and i+j = k }. Please write the logic behind the production rules of your grammars precisely.

3. Answer all the questions: (6+8+6)

(a) Show that the intersection of a context-free language with a regular language is always context-free.

(b) Give PDAs for L1 from Q. 2.c with at most eight states and for L2 from Q. 2.c with at most five states. Also write concise descriptions for your PDAs.

(c) Prove that PDAs have more power than DPDAs.