Problem 1.

[Linz, Section 3.2, Exercise 4c.]

L((a^+(a+b)^+ + a^*(a+b+c))(a+b)^*)

[Linz, Section 3.2, Exercise 9.]
[Linz, Section 3.2, Exercise 15.]

$$(+ + - + \lambda) \\
(0 + 1 + 2 + 3 + 4 + 5 + 6 + 7 + 8 + 9) \\
(0 + 1 + 2 + 3 + 4 + 5 + 6 + 7 + 8 + 9)^* \\
(0 + 1 + 2 + 3 + 4 + 5 + 6 + 7 + 8 + 9)^* \\
(\lambda + (E(0 + 1 + 2 + 3 + 4 + 5 + 6 + 7 + 8 + 9)^*))$$

[Linz, Section 3.3, Exercise 6.]

$$S \rightarrow aaA|\lambda \\
A \rightarrow bA|abS$$

[Linz, Section 3.3, Exercise 10.]

$$S \rightarrow Aab|\lambda \\
A \rightarrow Ab|Saa$$

[Linz, Section 3.3, Exercise 14.]

Let $L$ be a regular language accepted by a dfa $M = (Q, \Sigma, \delta, q_0, F)$. Since $M$ does not contain $\lambda$, $q_0 \notin F$.

Then $L$ can be defined by a right-linear grammar $G = (Q, \Sigma, q_0, P)$, where $P$ is defined as the following:

$q_k \rightarrow aq_i$, where $q_k, q_i \in Q$, $a \in \Sigma$, and $\delta(q_k, a) = q_i$

$q_k \rightarrow a$, where $q_k \in Q$, $a \in \Sigma$, and $\delta(q_k, a) \in F$. 

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Problem 2.

Problem 3.

Construction of the DFA:
Given a DFA $M = (Q, \Sigma, \delta, q_0, F)$, we construct $\widehat{M}$ that accepts $\text{chop}(L(M))$.

$\widehat{M} = (Q, \Sigma, \delta, q_0, \widehat{F})$, where $\widehat{F} = \{ q \in Q : \exists a \in \Sigma \text{ for which } \delta(q, a) \in F \}$.

Show that $L(\widehat{M}) = \text{chop}(L(M))$ by showing $x \in L(\widehat{M}) \iff x \in \text{chop}(L(M))$:

If $w \in L(\widehat{M})$, then $\delta^*(q_0, w) \in \widehat{F}$. That means there should exist an $a \in \Sigma$ such that $\delta^*(q_0, wa) \in F$ and $wa \in L(M)$. Thus, $w \in \text{chop}(L(M))$ and $L(\widehat{M}) \subset \text{chop}(L(M))$.

If $w \in \text{chop}(L(M))$, then $\exists a \in \Sigma$ such that $wa \in L(M)$. That means

$\delta(\delta^*(q_0, w), a) \in F$ and $\delta(q_0, w) \in \widehat{F}$. Thus, $w \in L(M)$ and $\text{chop}(L(M)) \subset L(\widehat{M})$.

Since $L(\widehat{M}) \subset \text{chop}(L(M))$ and $\text{chop}(L(M)) \subset L(\widehat{M})$, $L(\widehat{M}) = \text{chop}(L(M))$.

We have shown that $L$ is regular and that there is a DFA that accepts $\text{chop}(L)$. Thus, regular languages are closed under the $\text{chop}$ operation.