# Chapter 2.3 Practice

Give state diagrams of PDAs that accepts the following languages. $\Sigma = \{0, 1\}$.

1. $\{a^n b^m a^n \mid m, n \geq 0\}$

2. $\{w \in \{0,1\}^* \mid$ the length of $w$ is odd and the middle symbol is $0\}$

Draw a PDA from the formal definitions of the languages below and determine the strings that the language recognizes.

3. $Q = \{q_1, q_2, q_3, q_4, q_5\}$
   $\Sigma = \{a, b\}$
   $\Gamma = \{\$, b\}$
   $q_0 = q_1$
   $F = \{q_5\}$
   $\delta =$

| Input | a | | | | b | | | | $\varepsilon$ | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Pop | a | b | $ | $\varepsilon$ | a | b | $ | $\varepsilon$ | a | b | $ | $\varepsilon$ |
| $q_1$ | | | | | | | | | | | | {(q₂,$)} |
| $q_2$ | | | | {(q₂,ε)} | | | | | | | | {(q₃,ε)} |
| $q_3$ | | | | | | | | {(q₃,b)} | | | | {(q₄,ε)} |
| $q_4$ | | {(q₄,ε)} | | | | | | | | | {(q₅,ε)} | |
| $q_5$ | | | | | | | | | | | | |

4. $Q = \{q_1, q_2, q_3, q_4, q_5\}$
   $\Sigma = \{a, b\}$
   $\Gamma = \{\$, a\}$
   $q_0 = q_1$
   $F = \{q_5\}$
   $\delta =$

| Input | a | | | | b | | | | $\varepsilon$ | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Pop | a | b | $ | $\varepsilon$ | a | b | $ | $\varepsilon$ | a | b | $ | $\varepsilon$ |
| $q_1$ | | | | | | | | | | | | {(q₂,$)} |
| $q_2$ | | | | {(q₂,$a$)} {(q₃,$a$)} | | | | | | | | {(q₄,$\varepsilon$)} |
| $q_3$ | | | | | | | | | | | | {(q₂,$a$)} |
| $q_4$ | | | | | {(q₄,$\varepsilon$)} | | | | | | {(q₅,$\varepsilon$)} | |
| $q_5$ | | | | | | | | | | | | |

5. $Q = \{q_1, q_2, q_3, q_4, q_5\}$
   $\Sigma = \{a, b, c\}$
   $\Gamma = \{\$, a, b\}$
   $q_0 = q_1$
   $F = \{q_5\}$
   $\delta =$

| In | a | | | | b | | | | c | | | | $\varepsilon$ | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Pop | a | b | $ | $\varepsilon$ | a | b | $ | $\varepsilon$ | a | b | $ | $\varepsilon$ | a | b | $ | $\varepsilon$ |
| $q_1$ | | | | | | | | | | | | | | | | {(q₂,$)} |
| $q_2$ | | | | {(q₂,$a$)} | | | | | | | | | | | | {(q₃,$\varepsilon$)} |
| $q_3$ | | | | | | | | {(q₃,$b$)} | | | | | | | | {(q₄,$\varepsilon$)} |
| $q_4$ | | | | | | | | | {(q₄,$\varepsilon$)} | {(q₄,$\varepsilon$)} | | | | | {(q₅,$\varepsilon$)} | |
| $q_5$ | | | | | | | | | | | | | | | | |