Exercise 1*

(Assume that A, B are process constants and a, b are channel names.)

- $a.b.A + B$ **Correct**
- $(a.Nil + \overline{a}.A) \smallsetminus \{a, b\}$ **Correct**
- $(a.Nil \,|\, \overline{a}.A) \smallsetminus \{a, \tau\}$ **False**, τ can not be used in a restriction
- $a.B + [a/b]$ **False**, relabelling can be applied only on a valid process expression
- $\tau.\tau.B + Nil$ **Correct**
- $(a.B + b.B)[a/b, b/a]$ **Correct**
- $(a.B + \tau.B)[a/\tau, b/a]$ **False**, the relabeling function should satisfy $f(\tau) = \tau$ but here $f(\tau) = a$
- $(a.B + \tau.B)[\tau/a]$ **Correct**, any action can be relabelled to τ
- $(a.b.A + \overline{a}.Nil) \,|\, B$ **Correct**
- $(a.b.A + \overline{a}.Nil).B$ **False**, only actions can be used as prefixes
- $(a.b.A + \overline{a}.Nil) + B$ **Correct**
- $(Nil \,|\, Nil) + Nil$ **Correct**

Exercise 2*

- Derivation of $(A \,|\, \overline{b}.Nil) \smallsetminus \{b\} \xrightarrow{\tau} (a.B \,|\, Nil) \smallsetminus \{b\}$.

$$
\text{RES}\;\dfrac{\text{COM3}\;\dfrac{\text{CON}\;\dfrac{\text{ACT}\;\dfrac{}{b.a.B \xrightarrow{b} a.B}}{A \xrightarrow{b} a.B}\;A \stackrel{\text{def}}{=} b.a.B \qquad \text{ACT}\;\dfrac{}{\overline{b}.Nil \xrightarrow{\overline{b}} Nil}}{(A \,|\, \overline{b}.Nil) \xrightarrow{\tau} (a.B \,|\, Nil)}}{(A \,|\, \overline{b}.Nil) \smallsetminus \{b\} \xrightarrow{\tau} (a.B \,|\, Nil) \smallsetminus \{b\}}\;\tau, \overline{\tau} \notin \{b\}
$$

- Derivation of $(A \,|\, \overline{b}.a.B) + (\overline{b}.A)[a/b] \xrightarrow{\overline{b}} (A \,|\, a.B)$.

$$
\text{SUM1}\;\dfrac{\text{COM2}\;\dfrac{\text{ACT}\;\dfrac{}{\overline{b}.a.B \xrightarrow{\overline{b}} a.B}}{A|\,\overline{b}.a.B \xrightarrow{\overline{b}} A|\,a.B}}{(A \,|\, \overline{b}.a.B) + (\overline{b}.A)[a/b] \xrightarrow{\overline{b}} (A \,|\, a.B)}
$$

- Derivation of $(A \,|\, \overline{b}.a.B) + (\overline{b}.A)[a/b] \xrightarrow{\overline{a}} A[a/b]$.

$$
\text{SUM2}\ \dfrac{\text{REL}\ \dfrac{\text{ACT}\ \dfrac{}{\overline{b}.A \xrightarrow{\overline{b}} A}}{(\overline{b}.A)[a/b] \xrightarrow{\overline{a}} A[a/b]}}{(A \,|\, \overline{b}.a.B) + (\overline{b}.A)[a/b] \xrightarrow{\overline{a}} A[a/b]}
$$

Exercise 3*

LTS for the process $Uni \overset{\text{def}}{=} (CM \mid CS) \setminus \{coin, coffee\}$.

$$
\begin{tikzcd}
Uni \arrow[d, "\overline{pub}"] \\
(CM \mid \overline{coin}.coffee.CS) \setminus \{coin, coffee\} \arrow[d, "\tau"] \\
(\overline{coffee}.CM \mid coffee.CS) \setminus \{coin, coffee\} \arrow[d, "\tau"] \\
(CM \mid CS) \setminus \{coin, coffee\} \arrow[uu, bend left=60, "\overline{pub}"]
\end{tikzcd}
$$

Exercise 4

Transition system for $A \overset{\text{def}}{=} (a.A) \setminus \{b\}$.

$$
A \xrightarrow{\quad a \quad} A \setminus \{b\} \xrightarrow{\quad a \quad} (A \setminus \{b\}) \setminus \{b\} \xrightarrow{\quad a \quad} \big((A \setminus \{b\}) \setminus \{b\}\big) \setminus \{b\} \xrightarrow{\quad a \quad} \cdots
$$

One solution could be the CCS defining equation $B \overset{\text{def}}{=} a.B$ which generates a finite LTS with (intuitively) the same behavior as A.