Max Stein
MTKNR: 383687

1.

1.1

Let $(s_1, s_2) \in R_1 \cup R_2$ and let $(s_1, a, t_1)$ be a transition, then the following holds
case $(s_1, s_2) \in R_1$:
since $R_1$ is a bisimulation there exists a transition $(s_2, a, t_2)$ such that $(t_1, t_2) \in R_1$ and hence $(t_1, t_2) \in R_1 \cup R_2$
case $(s_1, s_2) \in R_1$:
analogously

1.2

Let $R$ be a bisimulation then $R$ and $R^{-1}$ are simulations and hence $R^{-1}$ and $\left(R^{-1}\right)^{-1} = R$ are also simulations which implies that $R^{-1}$ is a bisimulation.

Let $R$ be a bisimulation, let $(s_1, s_n) \in R^*$ with $(s_i, s_{i+1}) \in R$ for $i = 1 \ldots n-1$ and let $(s_1, a, t_1)$ be a transition. Then since $R$ is a bisimulation there is a transition $(s_2, a, t_2)$ with $(t_1, t_2) \in R$ and continuing like that there must be transitions $(s_i, a, t_i)$ with $(t_{i-1}, t_i) \in R$ for $i = 2 \ldots n$. Hence one has a transition transitions $(s_n, a, t_n)$ and $(t_1, t_n) \in R^*$.

1.3

$R := \{(A(x,y), B(x,y)), (?y.A(x,y), ?y.B(x,y))\}$

1.4

$$\begin{aligned}\tau.B(a,b) \ \mid \ (v\ x)\ A(x,a) &= \tau.B(a,b) \ \mid \ (v\ x)\ !x.?a.A(x,a) \\ &= \tau.B(a,b)\end{aligned}$$

$$\begin{aligned}(v\ y\ z)\ \ (!y.0 \mid \tau.A(a,b)) &= (v\ y)\ \ (!y.0 \mid \tau.A(a,b)) \\ &= ((v\ y)\ !y.0 \mid \tau.A(a,b)) \\ &= (0 \mid \tau.A(a,b)) \\ &= \tau.A(a,b)\end{aligned}$$

and $\tau.A(a,b)$ and $\tau.B(a,b)$ are bisimular since $A(a,b)$ and $B(a,b)$ are bisimular because of 1.3.

2.1

$$C() = ?inc.\,(C() \mid !dec)$$

the number of appearances of dec on the right will be equal to the counted number

3.1

Only Center and initial state change.

$Center\,(t_1, \ldots, t_n, s_1, \ldots, s_n, g_1, \ldots, g_n, a_1, \ldots, a_n) =$
$g_1(t_2, s_2).a_2.Center(t_2, \ldots, t_n, t_1, s_2, \ldots, s_n, s_1, g_2, \ldots, g_n, g_1, a_2, \ldots, a_n, a_1)$

and initial state

$Car(talk_1, switch_1) \mid$
$Base(talk_1, switch_1, alert_1, give_1), \ldots, Base(talk_n, switch_n, alert_n, give_n) \mid$
$Center\,(talk_1, \ldots, talk_n, switch_1, \ldots, switch_n, give_1, \ldots, give_n, alert_1, \ldots, alert_n)$