- **Essential BC = 1st Kind BC:** $u = g_1$ on Γ_1 $(\bar{V}_{gh}, V_{0h})$

1st Version: Homogenization

- $u_j = g_1(x^{(j)})$ $\forall j \in \gamma_h := \bar{\omega}_h \setminus \omega_h$
- update the RHS: $f^{(i)} := f^{(i)} - \sum_{j \in \gamma_h} K_{ij}\, g_1(x^{(j)})$
  $\forall i \in \omega_h$ $\quad (\forall i \in \bar{\omega}_h)$
- cancel the columns with the indices $j \in \gamma_h$
- cancel the rows with the indices $i \in \gamma_h$

2nd Version: Penalty technique

$K_{ii} := 10^s, \; f^{(i)} := 10^s g_1(x^{(i)})$ $\forall i \in \gamma_h$

$\Rightarrow u_i = g_i - 10^{-s} \sum_{j \neq i}! K_{ij} u_j$ with s - suff. large!

this corresponds to 3rd Kind BC with $\alpha = 10^s$!

3rd Version: $K_{ji} = K_{ij} = \delta_{ij}$ $\forall i \in \gamma_h$ $\forall j \in \bar{\omega}_h$ and

$f^{(i)} = g_1(x^{(i)})$ $\forall i \in \gamma_h$

- **RESULT:** System of FE equations for determining the unknown nodal values $u^{(i)}, i \in \omega_h$:

(i) Considering 1st Kind BC via 1st version:

$(\underline{4})_h$ Find $\underline{u}_h = [u^{(i)}]_{i \in \omega_h} \in \mathbb{R}^{N_h}$: $K_h \underline{u}_h = \underline{f}_h$ in $\mathbb{R}^{N_h}$

(ii) Considering 1st Kind BC via 2nd or 3rd version:

$(\underline{4})_h$ Find $\underline{u}_h = [u^{(i)}]_{i \in \bar{\omega}_h} \in \mathbb{R}^{\bar{N}_h}$: $K_h \underline{u}_h = \underline{f}_h$ in $\mathbb{R}^{\bar{N}_h}$