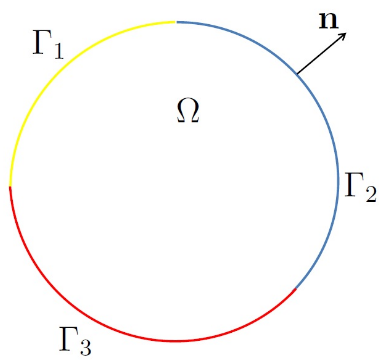
Initial-boundary value problem:

$$u_t - \nabla \cdot (a\nabla u) = f, \quad x \in \Omega \tag{1}$$

$$u|_{\Gamma_1} = g, \qquad \frac{\partial u}{\partial n}\Big|_{\Gamma_2} = 0, \qquad a\frac{\partial u}{\partial n} + b(u - u_b)\Big|_{\Gamma_3} = 0. \tag{2}$$

$$u(x,0) = u_0. \tag{3}$$



Time discretisation: $t_k = k\tau, \quad k = 0, 1, .., N; \quad u_k = u(k\tau)$.

$$u_k \in H^1(\Omega), \qquad v \in H_0^1(\Omega) := \{v \in H^1(\Omega), \;\; v|_{\Gamma_1} = 0\},$$

Weak form $(k = 1, 2, ..., N)$:

$$(u_k, v) - (u_{k-1}, v) + \tau(a\nabla u_k, \nabla v) + \tau \int_{\Gamma_3} b(u_k - u_b) v d\Gamma = \tau(f, v), \qquad u|_{\Gamma_1} = g.$$