Find variational formulation: mult. (D) by test function $v \in V$ & integrate:

$$(f,v) = -\int_\Omega \Delta u \, v \, dx = \int_\Omega \nabla u \cdot \nabla v \, dx - \int_\Gamma \partial_n u \, v \, ds$$

$$= \int_\Omega \nabla u \cdot \nabla v \, dx + \int_{\Gamma_2} \varkappa u v \, ds - \int_{\Gamma_2} g v \, ds$$

<u>Variational formulation</u>: Find $u \in V$ s.t.

$$(*) \quad (\nabla u, \nabla v) + \int_{\Gamma_2} \varkappa u v \, ds = (f,v) + \int_{\Gamma_2} g v \, ds \quad \forall v \in V$$

From $(*)$ we have that

$$\int_\Omega (-\Delta u - f) v \, dx + \int_{\Gamma_2} (\partial_n u + \varkappa u - g) v \, ds = 0$$

Since $-\Delta u = f$ we have

$$\int_{\Gamma_2} (\partial_n u + \varkappa u - g) v \, ds = 0 \quad \forall v \in V$$

- Robin (and Neumann) b.c. enforced <u>weakly</u> through the variational form.
- Dirichlet b.c. typically enforced <u>strongly</u> by the choice of space V