The expansion of $u \in L^2(0,\pi)$ in the base $(\phi_k)_{k\geq 1}$ is defined as

$$u = \sum_{k\geq 1} c_k(u)\phi_k, \qquad \text{where } c_k(u) := \int_0^\pi u(x)\varphi_k(x)dx,$$