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**A-PRIORI ESTIMATES AND THE FEM FOR THE NEUMANN  
AND TRANSMISSION PROBLEMS**

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It is well known that the solution of an elliptic boundary value problem loses the full regularity in Sobolev spaces at the points where the boundary or the coefficients are not smooth, and at the points where the boundary condition changes. Singularities of these types give rise to numerous problems in the theoretical analysis and in the numerical approximations. In particular, we establish well-posedness, regularity, and Fredholm results of the solution in weighted Sobolev spaces for the Neumann and transmission problems. Our weighted Sobolev space is derived by augmenting the weighed Sobolev space for the homogeneous Dirichlet problems, so that it covers the local constant near the singular point. Meanwhile, we propose a simple and explicit construction of the finite subspace for the finite element method to recover the quasi-optimal rate of convergence of the numerical solution for the Neumann and transmission problems.

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