# Convergence Analysis of Systems with Fixed Point Structure

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Let $X$ and $Y$ be two arbitrary sets, $P \subset X \times Y$ and $Q \subset X \times Y$. We consider the problem of finding a couple $(u, \eta) \in X \times Y$ such that $(u, \eta) \in P \times Q$. We prove that, under appropriate assumptions, the existence of the solution of this problem is equivalent to the existence of fixed points of some associated operators $\Lambda$ and $\Theta$. Moreover, the solution is unique if and only if the corresponding fixed points are unique. Then, we move to the framework of metric spaces $X$ and $Y$ and, under additional assumptions, we provide necessary and sufficient conditions which guarantee the convergence of an arbitrary sequence $\{(u_n, \eta_n)\} \subset X \times Y$ to the solution $(u, \eta)$. Our abstract results have many applications in the analysis of various nonlinear systems. We illustrate their use in some examples, proving existence and uniqueness results, together with convergence criteria.

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