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General first order Cauchy problem on a smooth manifold

Let M be a smooth manifold and

$$J^1M := \mathbb{R} \times T^*M$$

be the 1-jet bundle of M .

Theorem 22.39 (The General First-Order Cauchy Problem). *Suppose M is a smooth manifold, $W \subseteq J^1M$ is an open subset, $F: W \rightarrow \mathbb{R}$ is a smooth function, $S \subseteq M$ is an embedded hypersurface, and $\varphi: S \rightarrow \mathbb{R}$ is a smooth function. If the Cauchy problem (22.29)–(22.30) is noncharacteristic, then for each $p \in S$ there is a smooth solution on some neighborhood of p in M .*

Proof. Problem [22-26](#). □

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- [structures based on sets](#)
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 - [Functions from smooth manifolds to \$\mathbb{R}\$](#)
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 - [Linear first-order Cauchy_problem on a smooth manifold](#)