1 Trajectory Generation

Prior to the implementation of the MPC algorithm for reference tracking, it's compulsory to properly define the reference trajectories that the system should follow. In particular, any desired trajectory should be feasible for the given system. Formally, given a continuous-time reference trajectory identified by the vector $\begin{bmatrix}\mathbf{x}_{ref}(t) & \mathbf{u}_{ref}(t)\end{bmatrix}^T$, in order for it to be feasible, it must satisfy the differential equations of the system dynamics within the given constraints:

$$\begin{aligned} &\dot{\mathbf{x}}_{ref}(t) = \mathbf{f}(\mathbf{x}_{ref}(t), \mathbf{u}_{ref}(t)) \\ &\mathbf{x}_{ref} \in \mathcal{X} \\ &\mathbf{u}_{ref} \in \mathcal{U} \end{aligned} \tag{1.1}$$

where $\mathcal{X}$ and $\mathcal{U}$ are the sets of feasible states and inputs for the system.
In this study two main approaches have been considered for the feasible trajectory generation task. Both strategies rely on the definition of *differential flatness* introduced in the work by *Murray* [**?**]. Formally, a non-linear system is *differentially flat* if there exists a function $\Gamma(\cdot)$ such that

$$\mathbf{z} = \Gamma(\mathbf{x}, \mathbf{u}, \dot{\mathbf{u}}, \dots, \mathbf{u}^{(p)})$$