

## General Linearization Procedure

- ▶ Why do we require that  $f(x_0, u_0) = 0$  in equilibrium?
- ▶ This requires some thought. Indeed, we may talk about a *linear approximation* of any smooth function  $f$  at any point  $x_0$ :

$$f(x) \approx f(x_0) + f'(x_0)(x - x_0) \quad - \quad f(x_0) \text{ does not have to be } 0$$

- ▶ The key is that we want to approximate a given nonlinear system  $\dot{x} = f(x, u)$  by a *linear* system  $\dot{x} = Ax + Bu$  (may have to shift coordinates:  $x \mapsto x - x_0, u \mapsto u - u_0$ )

Any linear system *must* have an equilibrium point at  $(x, u) = (0, 0)$ :

$$f(x, u) = Ax + Bu \quad f(0, 0) = A0 + B0 = 0.$$