

Disclaimer

These slides are intended as presentation aids for the lecture. They contain information that would otherwise be too difficult or time-consuming to reproduce on the board. But they are incomplete, not self-explanatory, and are not always used in the order they appear in this presentation. As a result, these slides should not be used as a script for this course. I recommend you take notes during class, maybe on the slides themselves. It has been shown that taking notes improves learning success.

Reading for this set of slides

- Craig – Intro to Robotics (3rd Edition)
 - 1 Introduction
 - 2 Spatial descriptions and transformations (2.1 – 2.9)
 - 3 Manipulator kinematics (3.1 – 3.6)
 - 7 Trajectory generation

Please note that this set of slides is intended as support for the lecture, not as a stand-alone script. If you want to study for this course, please use these slides in conjunction with the indicated chapters in the text books. The textbooks are available online or in the TUB library (many copies that can be checked out for the entire semester. There are also some aspects of the lectures that will not be covered in the text books but can still be part of the homework or exam. For those It is important that you attend class or ask somebody about what was covered in class.



Robotics

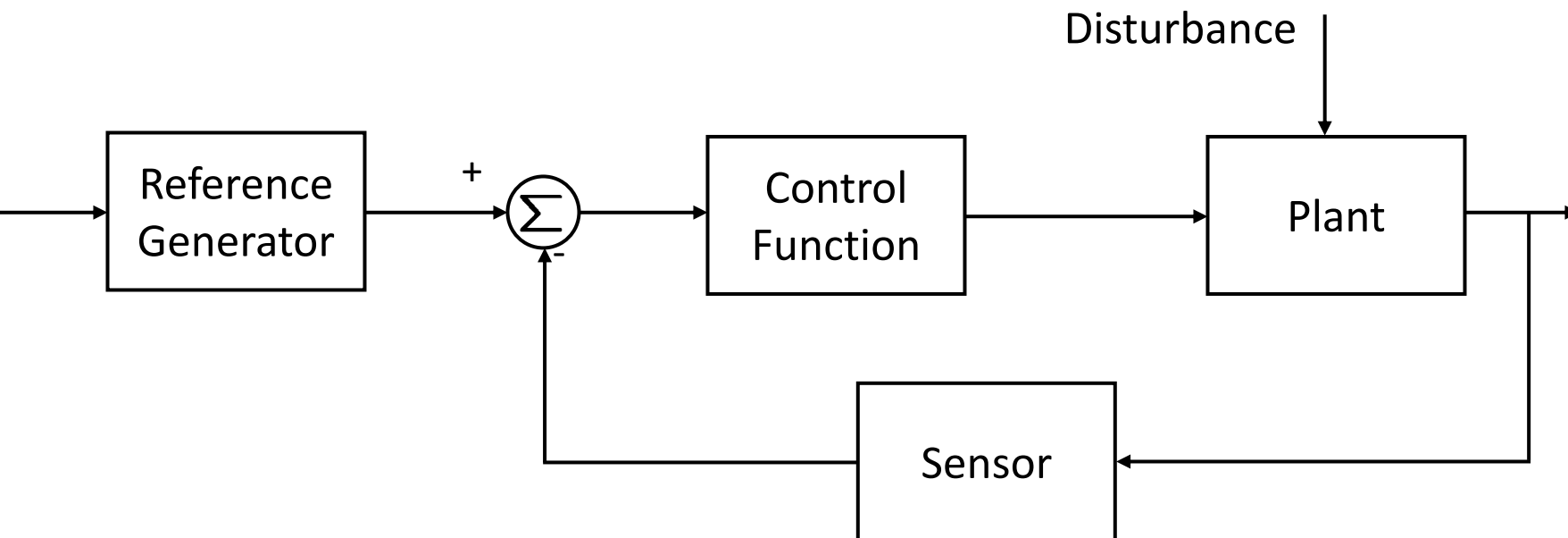
Basics of Control – A Second Look

TU Berlin

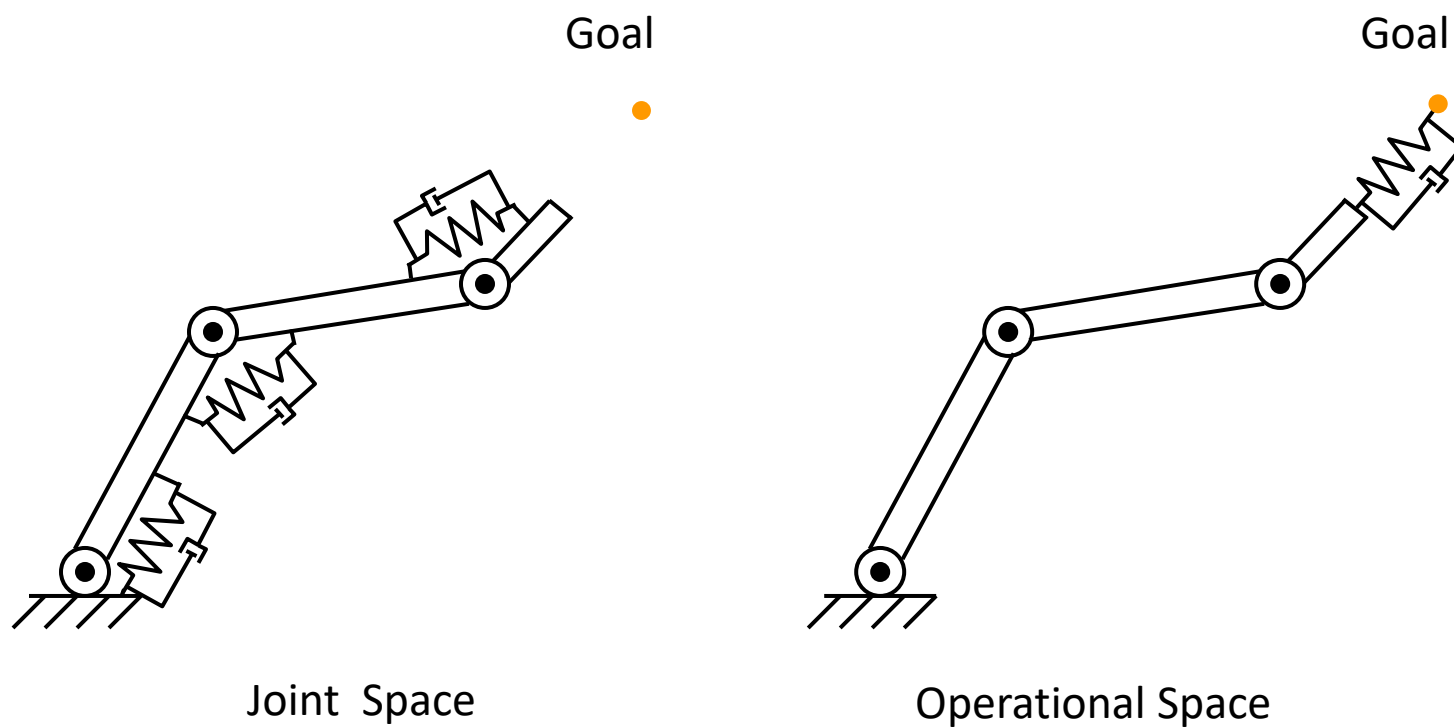
Oliver Brock

Control

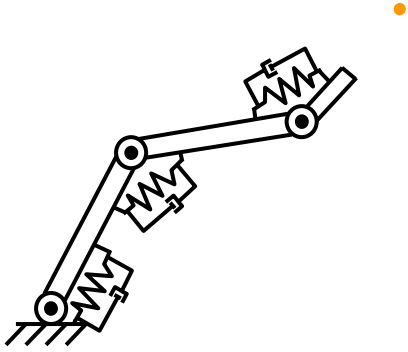
- **Control** is the process of causing a *system variable* to conform to some desired value, called a *reference value*.
- Feedback and feed-forward



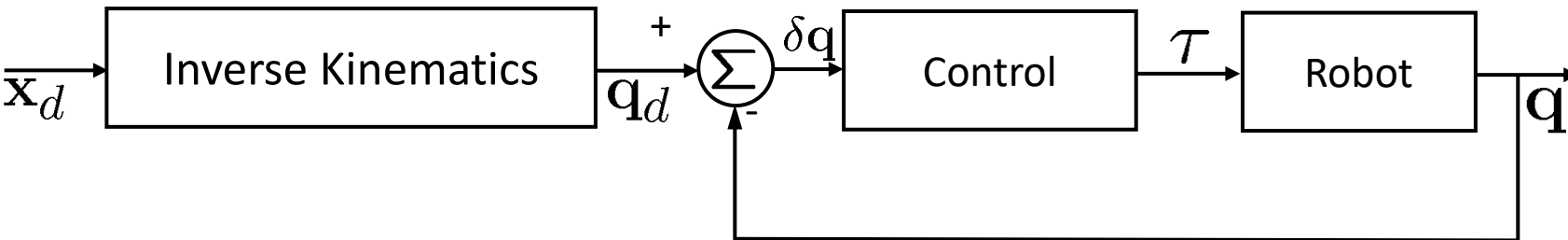
Controlling a Robot



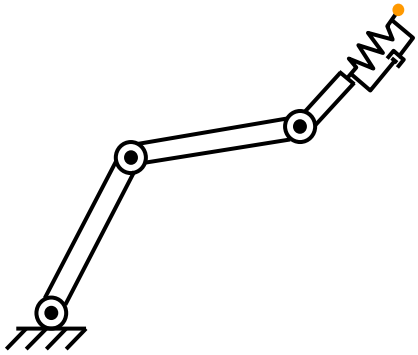
Control with Inverse Kinematics



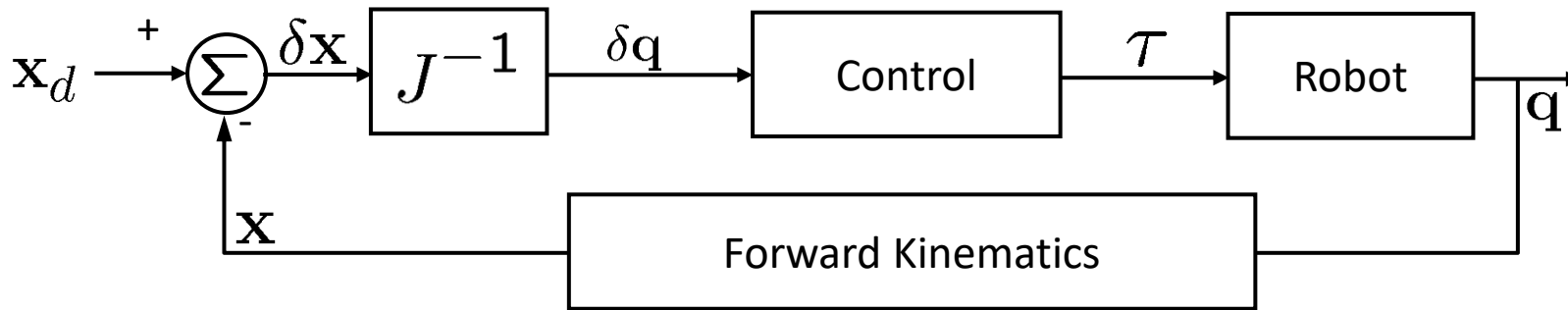
$$\mathbf{q}_{t+1} = \mathbf{q}_t + \delta \mathbf{q}$$



Operational Space Control with J^{-1}

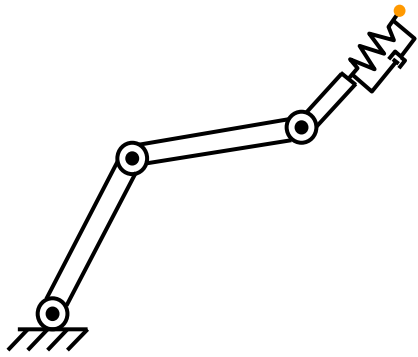


$$\delta \mathbf{q} = J^{-1}(\mathbf{q}) \delta \mathbf{x}$$



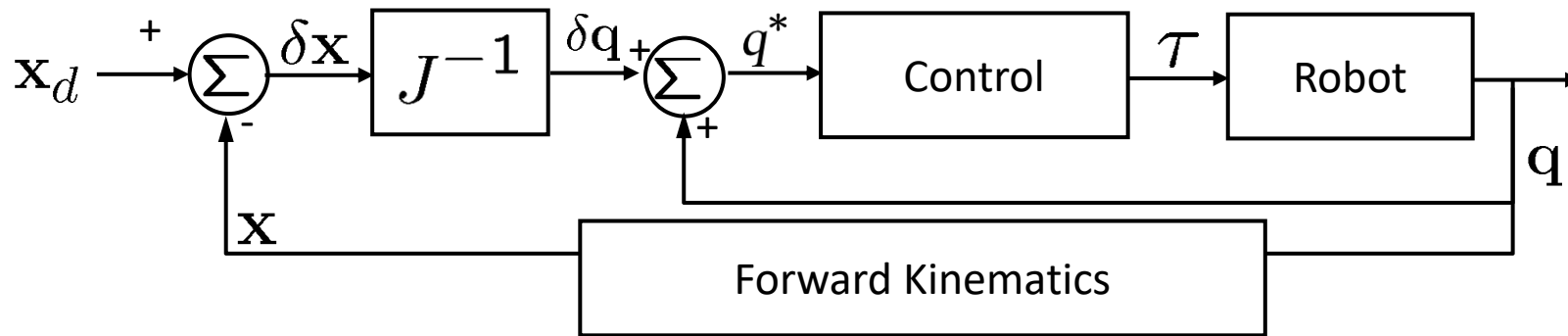
Operational Space Control with J^{-1}

Resolved-Rate Motion Control

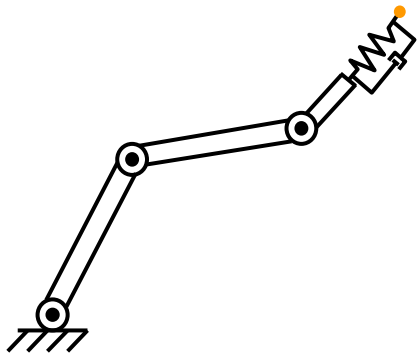


$$\dot{\mathbf{q}}^* = J(\mathbf{q})^{-1} \dot{\mathbf{x}}^*$$

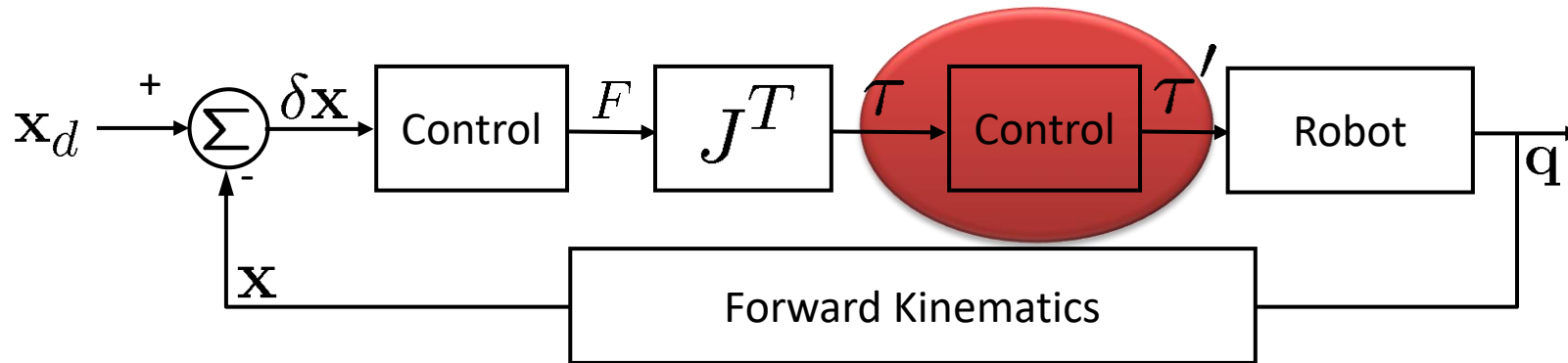
$$\mathbf{q}_{t+1}^* = \mathbf{q}_t + \delta t \dot{\mathbf{q}}_t^*$$



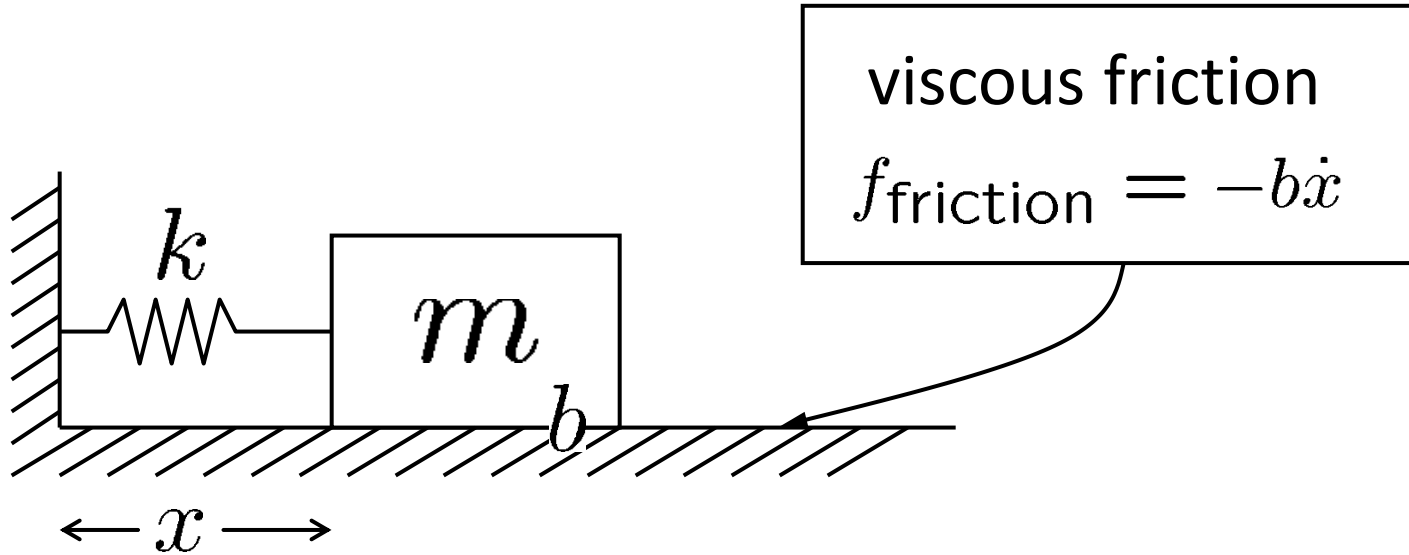
Operational Space Control with J^T



$$\tau = J^T(\mathbf{F})$$



Spring/Mass/Damper System



Equation of motion

$$m\ddot{x} + b\dot{x} + kx = 0$$

Possible Behaviors

