Assignment 6 and 7

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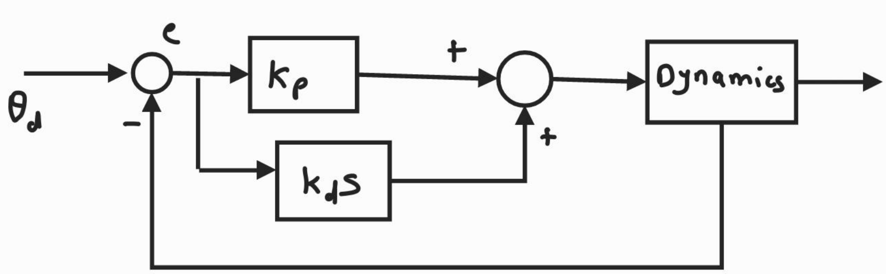
Task 3

A. PD control



Considering dynamics $\frac{1}{s^2}$

The Transfer function is

$$tf = \frac{1}{1 + G(s)}$$

$$G(s) = (k_p + k_d s)\ \frac{1}{s^2}$$

$$tf = \frac{s^2}{s^2 + k_d s + k_p}$$

Comparing with second order equation $s^2 + 2\zeta\omega_n s + \omega_n^2$

let $\omega_n = 3$

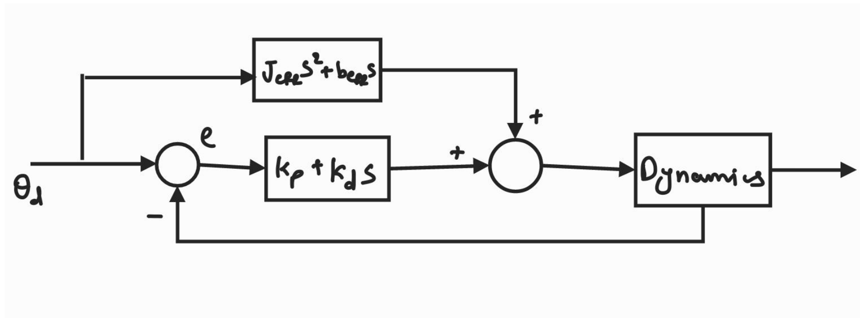
$k_p = \omega_n^2 = 9$ $\qquad \zeta \approx 1$

$k_d = 2\zeta\omega_n$

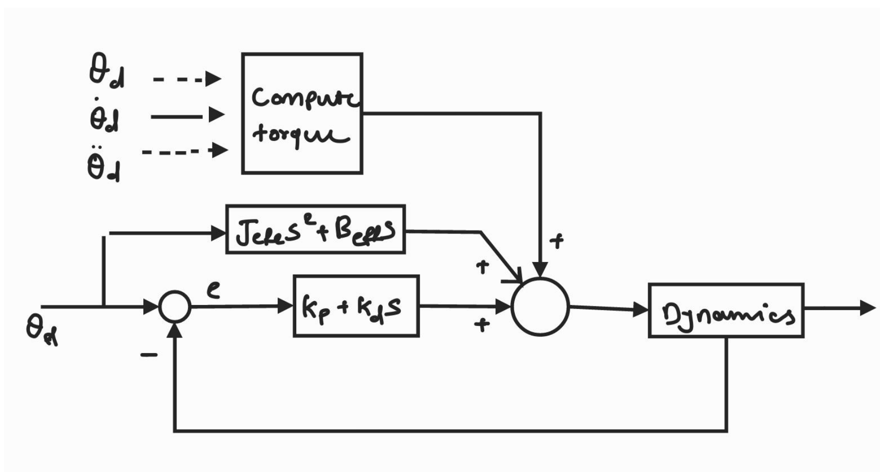
$\therefore\ k_d = 2 \times 1 \times 3 = 6$

$\rightarrow k_p = 9,\ k_d = 6$

B. PD Feedforward control



C. PD feedforward control with computed torque joints



Task 7

From the question sequence and types of controls in this assignment, every modification to the control system and the reason behind it can be understood.
A simple PD control follows the desired trajectory very well but has a non zero steady state error. Also, the simple PD controller cannot react to any disturbances.
To compensate for these disturbances, a feedforward controller is implemented which considers both links and motor dynamics in account.
Again for more accuracy and stability, a computed torque controller is implemented which calculates the desired torque beforehand using dynamics equations so that the final torque is adjusted to keep the manipulator on desired trajectory if there are any disturbances.