PAGE No.
DATE / /

Assignment GT7

Aarish Shah
181100002

SECRET CODE: "DEV"

Using SCARA Manipulator with link lengths:

$l_1 = 0.25$
$l_2 = 0.25$
$l_3 = 0.25$

Answer 3 (a)

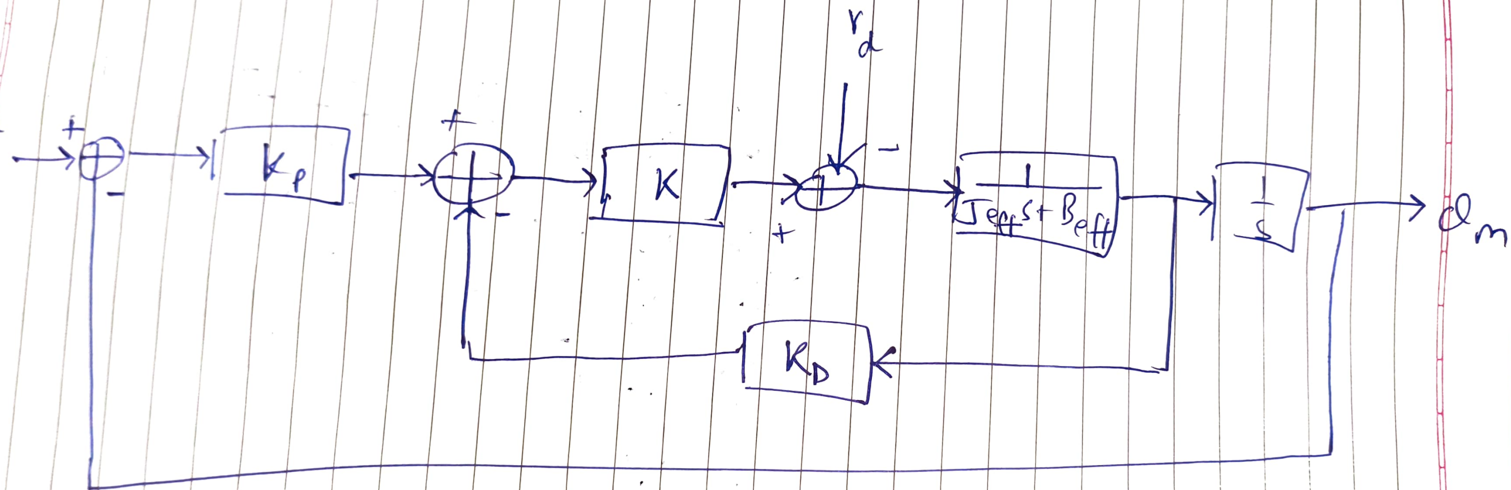
PD controller

Gains chosen:

$K_{p_1} = 0.5$
$K_{p_2} = 0.3$
$K_{p_3} = 0.5$
$K_{d_1} = 0.3$
$K_{d_2} = 0.2$
$K_{d_3} = 0.3$

$$J_{eff}\ddot{\theta}_{m_k} + B_{eff}\dot{\theta}_{m_k} = KV_k - r_k d_k$$

$$V_k = K_p(\theta_m^d - \theta_m) - K_d\dot{\theta}_m$$



Block Diagram for PD control

θ_m^d : desired motor angle

θ_m : motor angle

$q = r\,\theta_m$

$r =$ gear ratio

3(b)

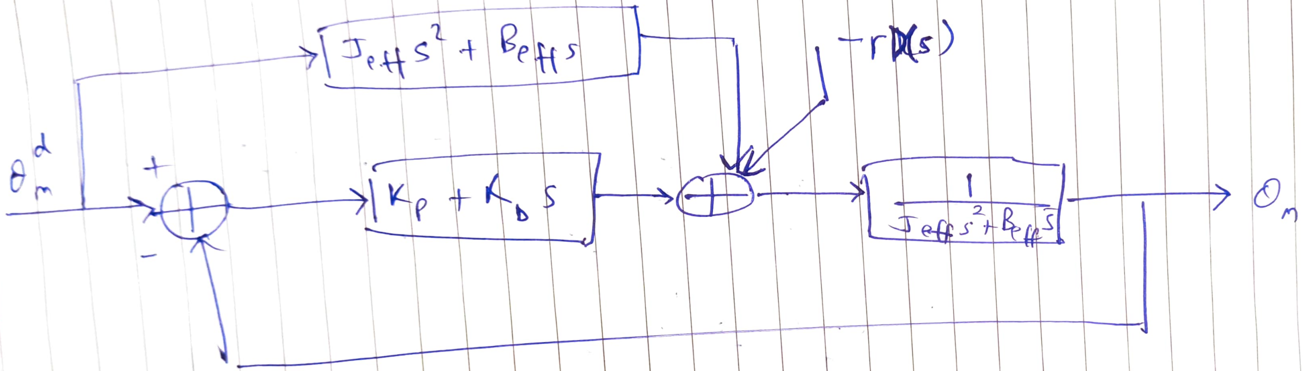
Gains:

$K_{p_1} = 0.45$
$K_{p_2} = 0.5$
$K_{p_3} = 0.5$
$K_{d_1} = 0.2$
$K_{d_2} = 0.3$
$K_{d_3} = 0.3$

$$J_{eff}\,\ddot{\theta}_m + B_{eff}\,\dot{\theta}_m = KV(t) - rd(t)$$

$$V(t) = f(t) + K_d(-\dot{\theta}_m) + K_p(\theta_m^d - \theta$$

$$f(t) = \frac{J_{eff}}{K}\,\ddot{\theta}_m^d + \frac{B_{eff}}{K}\,\dot{\theta}_m^d$$



Block Diagram for PD control w/ Feedforward compensation

3(c)

Gains:

$K_{p_1} = 0.45$
$K_{p_2} = 0.45$
$K_{p_3} = 0.5$
$K_{d_1} = 0.35$
$K_{d_2} = 0.35$
$K_{d_3} = 0.3$

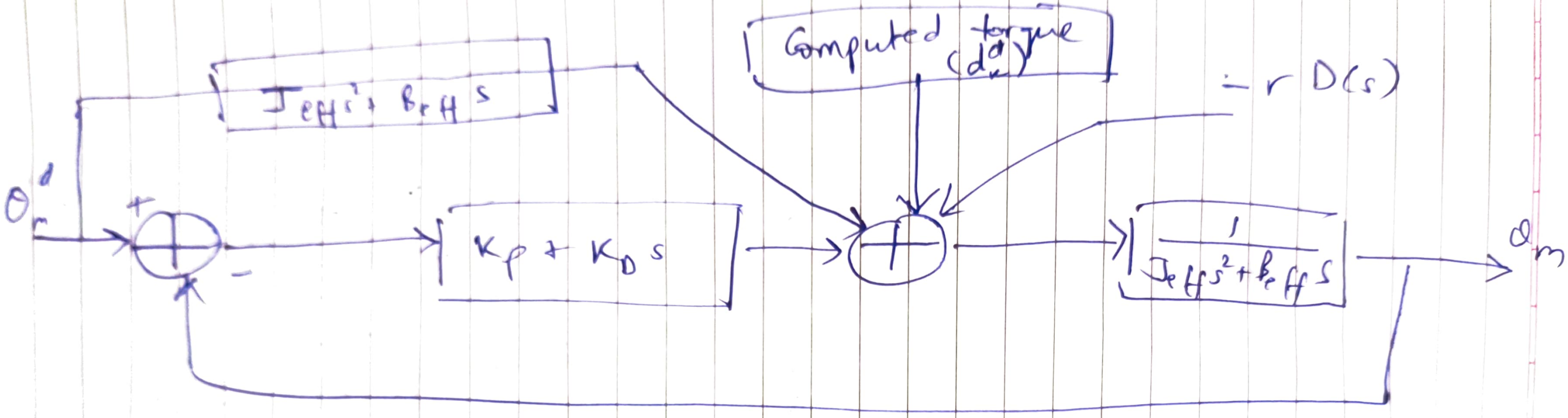
$$J_{eff}\ddot{\theta}_m + B_{eff}\dot{\theta}_m = K\,V(t) - r\,d(t)$$

$$V(t) = f(t) + d^d_k(t) + K_d(-\dot{\theta}_m) + K_p(\theta^d_m - \theta_m)$$

$\Rightarrow$

$$f(t) = \frac{J_{eff}}{K}\ddot{\theta}^d_m + \frac{B_{eff}}{K}\dot{\theta}^d_m$$

$$d^d_k(t) = \sum_j d_{kj}(q^d)\,\ddot{q}^d_j + \sum c_{ijk}(q^d)\,\dot{q}^d_i\,\dot{q}^d_j + g_k(q^d)$$



Block Diagram for PD control w/ feedforward computed torque compensation

Answer 7

~~B~~ All three controllers had some amount of steady-state error and none could track the trajectory perfectly, however, the feedforward computed torque compensation controller was closest to the trajectory out of the three controllers. The feedforward compensation controller was the second best while the simple PD controller had the worst performance with the most steady-state error as well as the most deviation from the trajectory shape overall.