# RIS LAB 6

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Task 1.25

We know,

$$H_{ov} = \frac{k_t}{s D(s)}$$

$$D(s) = (R_a + L_a s)(Js + b) + k_e k_t$$

If $L_a$ is negligible, we get,

$$D(s) = R_a (Js + b) + k_e k_t$$

$$G(s) = K_p + K_I \frac{1}{s} + K_D s$$

We have

$$H_{er}(s) = \frac{1}{1 + H_{ov}(s) G(s)}$$

or

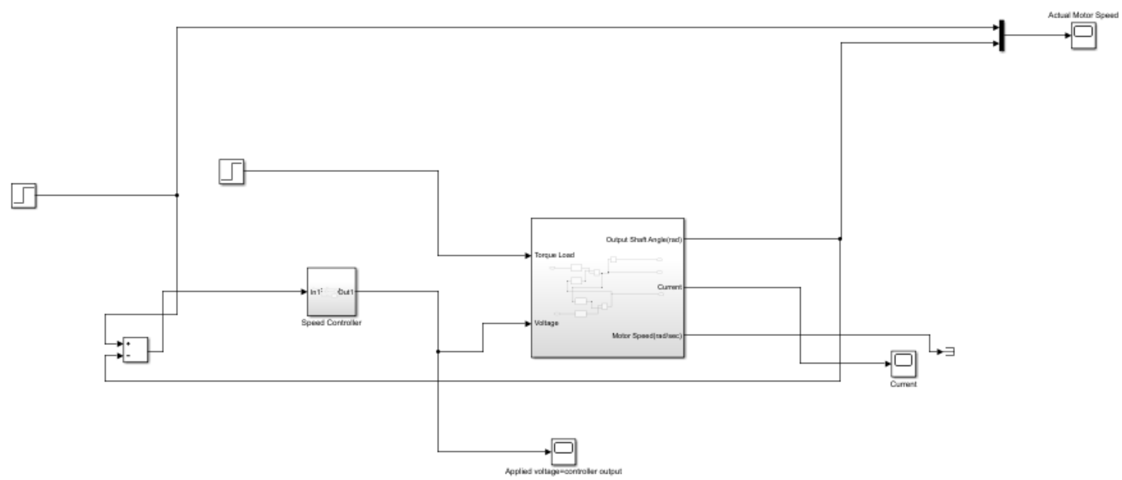
$$H_{er}(s) = \frac{1}{1 + \frac{k_t}{s D(s)} \left( \frac{s K_p + K_I + s^2 K_D}{s} \right)}$$

$$= \frac{s^2 D(s)}{s^2 D(s) + k_t K_p s + k_t K_I + s^2 K_D k_t}$$

$$= \frac{s^2 D(s)}{s^2 \{ R_a (Js + b) + k_e k_t \} + k_t K_p s + k_t K_I + s^2 K_D k_t}$$

$$= \frac{s^2 D(s)}{s^3 R_a J + s^2 (K_D k_t + k_e k_t + R_a b) + s K_p k_t + K_I k_t}$$ //.

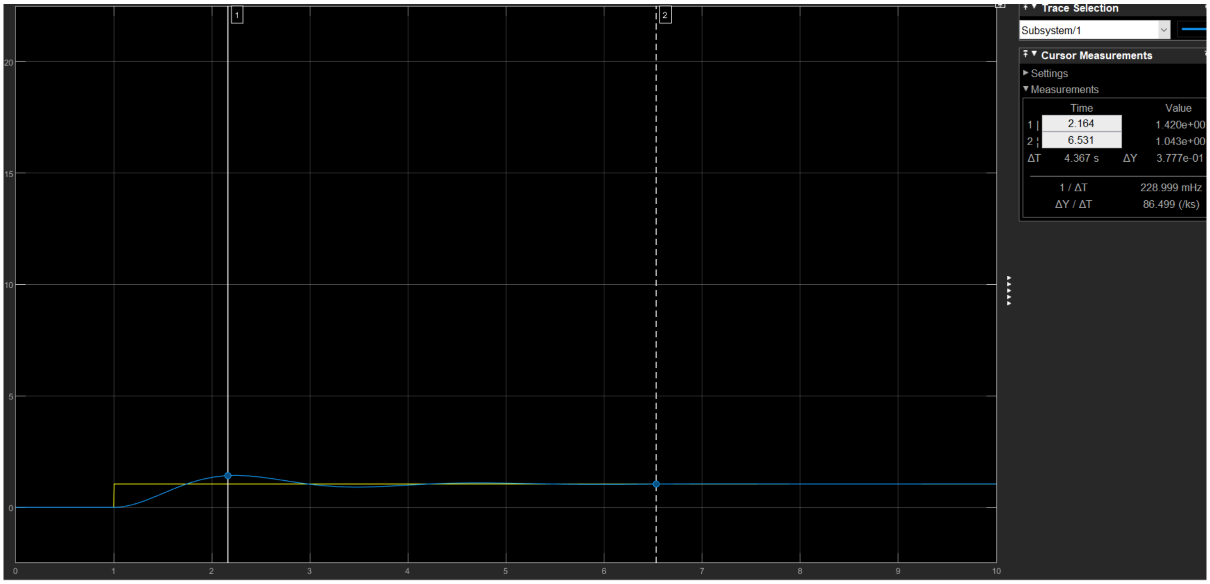
# 1 Task 1.26



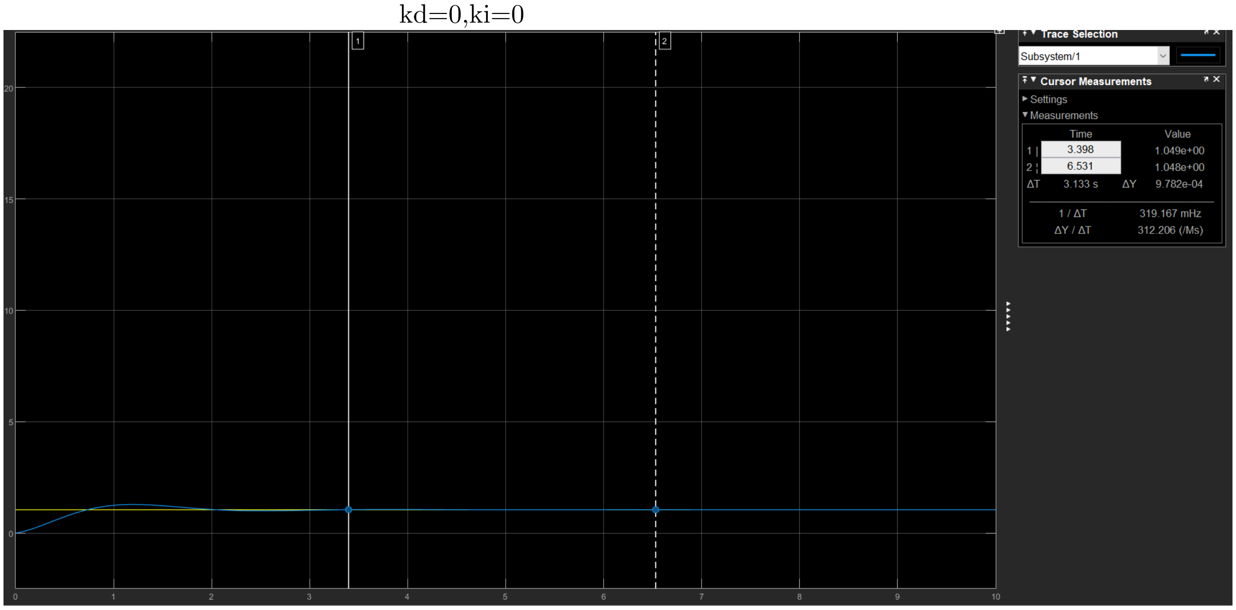

# 2 Task 1.27

## 2.1 Part 1, 2, 3

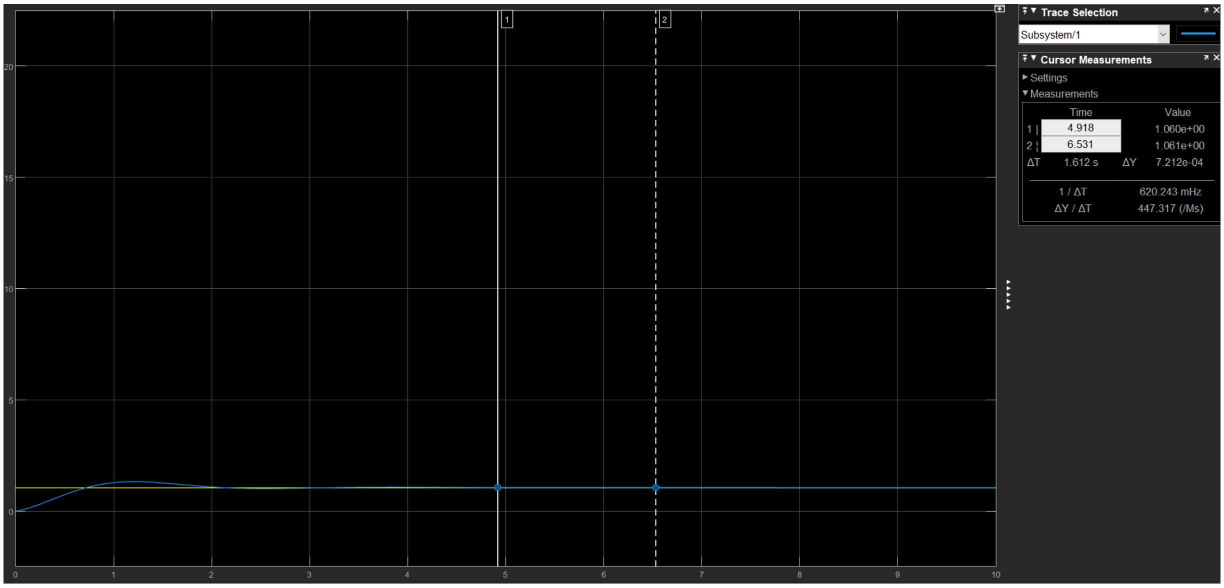
| KD | KI | KP | Max Current(A) | Max Voltage(V) | Max Overshoot(rad) | Settle time(s) |
|---|---|---|---|---|---|---|
| 0 | 0 | 1 | 0.42 | 1.047 | 1.420 | 6.5 |
| 0.1 | 0 | 1 | 3.56 | 9.65 | 1.28 | 3.4 |
| 0.1 | 0.1 | 1 | 4.85 | 11.52 | 11.31 | 4.9 |




kd=0,ki=0

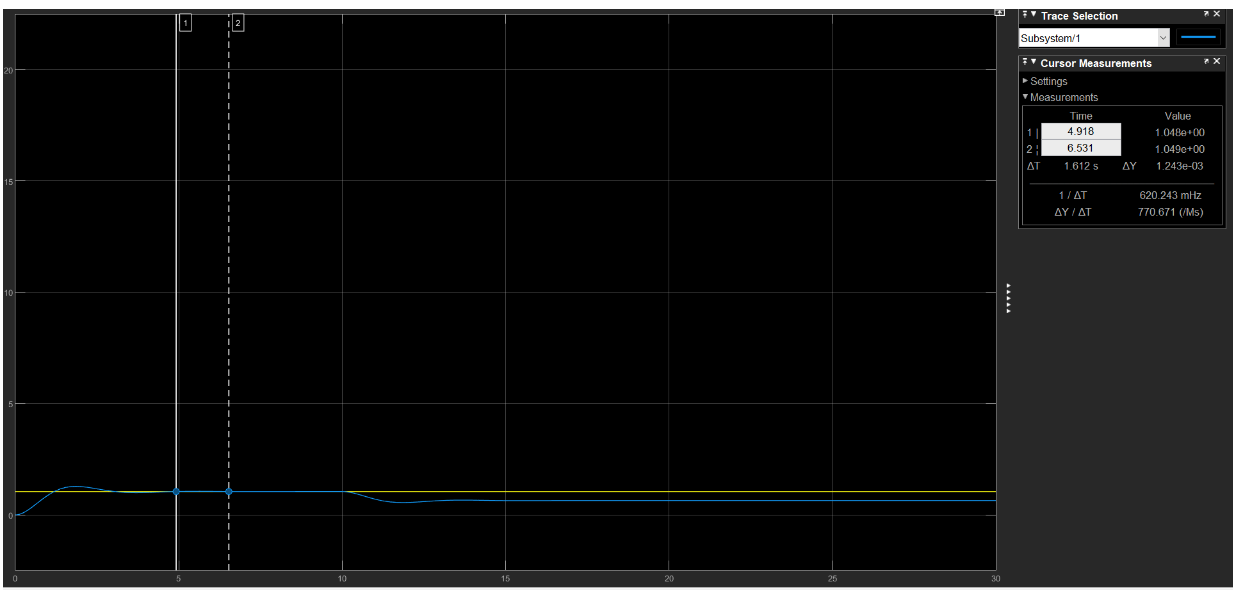



kd=0.1, ki=0



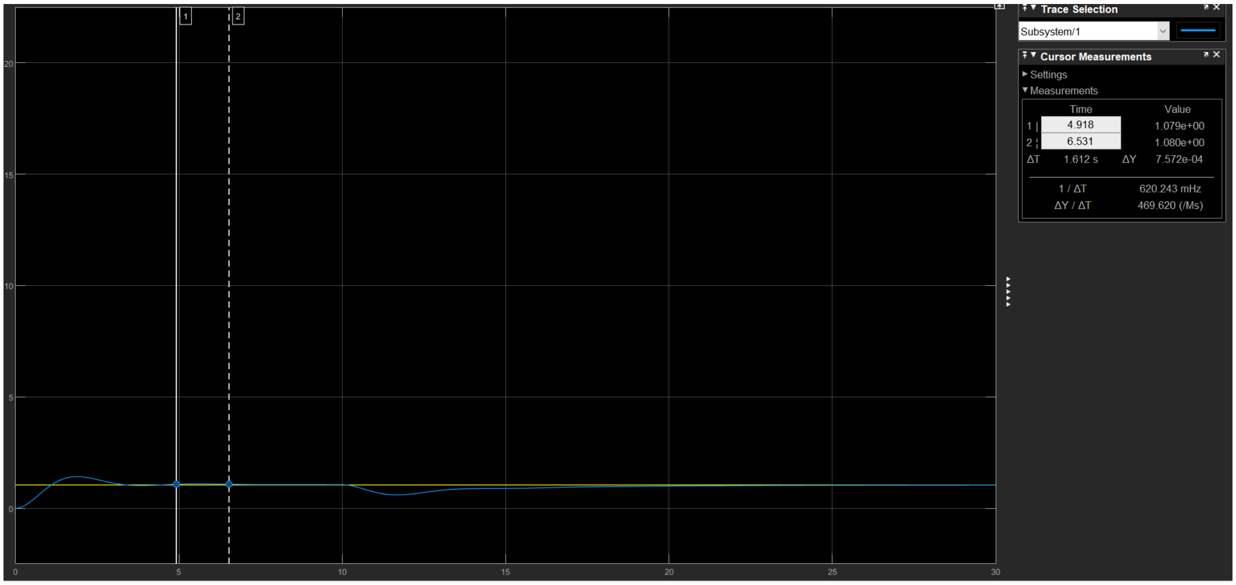
kd=0.1, ki=0.1

## 2.2 Part 4



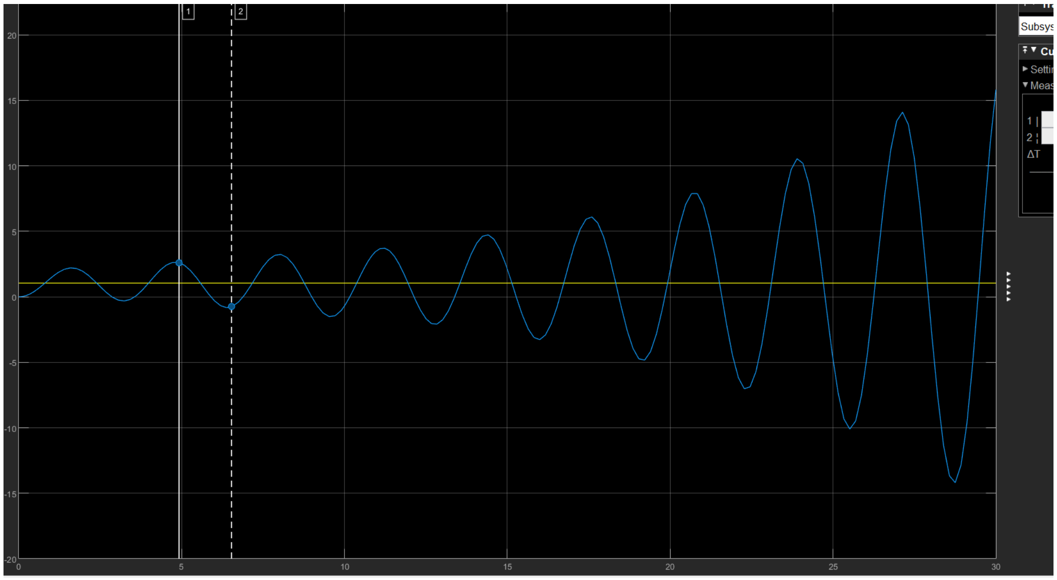

We can observe from the figure that due to the additional torque at 10 seconds, the system is not able to reach the reference value.

## 2.3 Part 5




We can see that the system eventually reaches the reference value when we increase Ki=0.1.

## 2.4 Part 6



The system becomes very unstable as we increase the value of Ki=1.

### 2.5 Part 7

With the values given in the part 6, we obtain the roots of Q(s) by using a matlab function.

We found the roots to be as follows:

$$0.0969 + 1.9679i$$

$$0.0969 - 1.9679i$$

$$-1.8185 + 0.000i$$

We can see that only the last root has the negative real part (in LHP). Other roots are not in LHP hence the system is not stable.