

## Recommended Assessment

# Routh Hurwitz Stability

1. Given the feedback loop diagram in the lab, determine the closed-loop transfer function  $\frac{Y(s)}{R(s)}$  in terms of  $k_p$ . Then substitute provided values for  $K$  and  $\tau$  in, or use the values found in any of the modeling labs.

Use the following definitions for Transfer Functions:

$$P(s) = \frac{K}{s(\tau s + 1)}$$

$$C(s) = \frac{1}{s + 10}$$

2. Create a Routh Table for the closed-loop transfer function:

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$s^3$	
$s^2$	
$s^1$	
$s^0$	

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3. From the previous two answers, calculate the range of  $k_p$  for which the system is marginally stable. Explain any reasoning used.
4. Is there a  $k_p$  for which the system is marginally stable? Explain any reasoning.
5. Show a screenshot of the behaviour of the Qube-Servo 3 when  $k_p = 1$ . Describe the behaviour observed and what happens when perturbed. What is the steady state error (approximately)?

6. Attach a screenshot of the response when  $k_p = 5$ . Compared to  $k_p = 1$  describe any differences between the responses. What is the difference in steady state error?
7. Attach the response for the theoretical value of  $k_p$  where the system is marginally stable. What are the differences in responses between this value of  $k_p$  and  $k_p = 5$ ? If the system is still stable, give an explanation why.
8. If the system was not marginally stable for the theoretical value of  $k_p$ , what value was it marginally stable for. Attach a screenshot of the marginally stable response. Describe the behaviour of the marginally stable system. Give a reason why the theoretical value for  $k_p$  was not marginally stable.