

The objective of this homework is to test your understanding of the content of Module 6. Due date of the homework is: **Monday, March 7th, 2016, @ 18h00.**

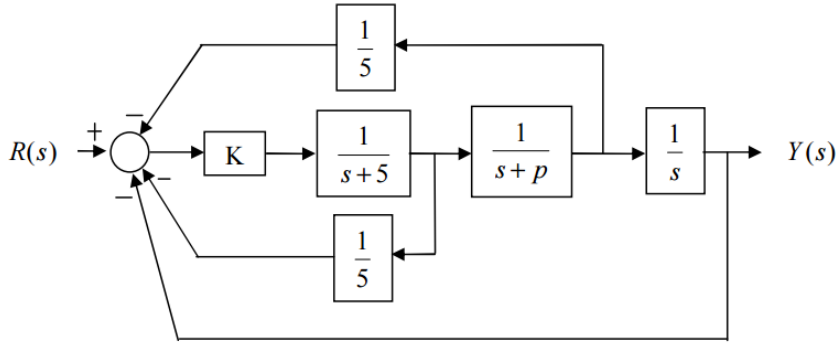


Figure 1: Spark ignition system — a block diagram representation.

- Using the Routh-Array method we discussed in Module 6 (in addition to the two special cases we discussed), determine whether the following system has any poles in the right half plane. Determine the number of these RHP poles.

$$H(s) = \frac{1}{s^4 + s^3 + 12s^2 + 12s + 36}.$$

- For this CLTF,

$$H(s) = \frac{1}{s^3 + 7s^2 + 11s + (5 + K)},$$

determine the range of K (which could include negative numbers, for this problem only) such that the system has no poles in the RHP. Consider all the cases.

- The system shown in Figure 1 is a typical block diagram representation depicting a simplified spark ignition system of an engine. Two parameters of this system are the gain K and performance parameter p . The performance parameter can take two values: $p_1 = 0$ and $p_2 = 2$. The objective of this problem is to design a gain K to stabilize the initially unstable system. Answer the following questions.

- Find the overall closed loop transfer function $\frac{Y(s)}{R(s)}$ in terms of p and K . You should end up with a typical TF with polynomials on the denominator and numerator. Your CLTF should be third order TF. Make sure that your answer is correct before you move to the next question.
- Obtain a value (or values) for K that would make the CLTF stable for the two given values of p , **simultaneously**. In other words, your design should stabilize the system whether $p = 0$ or $p = 2$.

Hint: you should end up with two Routh-Arrays in terms of p and K .

4. For the unity feedback system in shown in Figure 2, the open-loop TF is given as follows:

$$G(s) = \frac{K(s + \alpha)}{s(s + \beta)},$$

where K , α and β are parameters that I want you to design. The design objectives are:

- Steady-state error $\frac{1}{10}$;
- Closed-loop poles are: $p_{1,2} = -1 \pm j$.

Find α , β and K such that the above design objectives are satisfied.

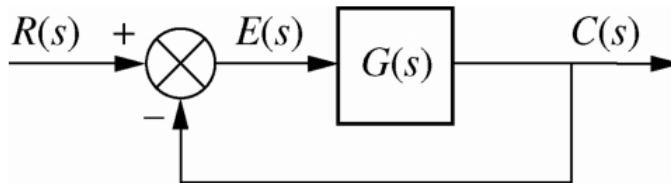


Figure 2: Unity feedback system.