Control Theory Assignment – Steady-State Error

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1 Find the steady-state error for the unity feedback system which has the following open-loop transfer function:

$$G(s) = \frac{450(s+8)(s+12)(s+15)}{s(s+38)(s^2+2s+28)}$$

for the following test inputs: $25u(t)$, $37tu(t)$, and $47t^2u(t)$.

2 Find the steady-state error for the unity feedback system which has the following open-loop transfer function:

$$G(s) = \frac{60(s+3)(s+4)(s+8)}{s^2(s+6)(s+17)}$$

for the following test input: $80t^2u(t)$.

3 Find the steady-state error for the unity feedback system which has the following open-loop transfer function:

$$G(s) = \frac{500}{(s+24)(s^2+8s+14)}$$

for the following test inputs: $30u(t)$, $70tu(t)$, and $81t^2u(t)$.

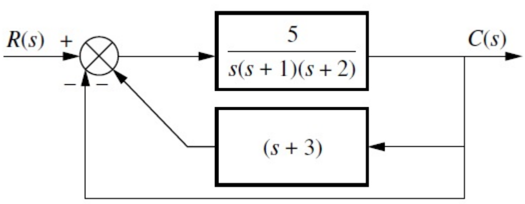
4 A system has $K_p = 4$. What steady-state error can be expected for inputs of $70u(t)$ and $70tu(t)$?

5 For a unity feedback system, with an open-loop transfer function of:

$$G(s) = \frac{K(s+2)(s+4)(s+6)}{s^2(s+5)(s+7)}$$

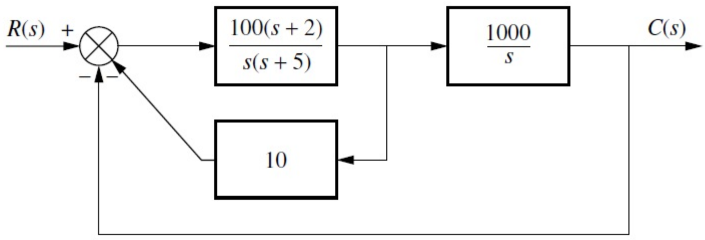
Find the value of K to yield a static error constant of 10000.

6 For the system shown in the Figure:

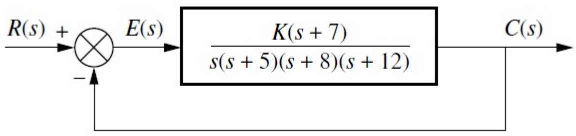


1. Find K_p, K_v, and K_a.
2. Find the steady-state error for an input of $50u(t)$, $50tu(t)$, and $50t^2u(t)$.
3. State the system Type.

7 Find the system Type for the system shown in the Figure.



8 For the system shown in the Figure:



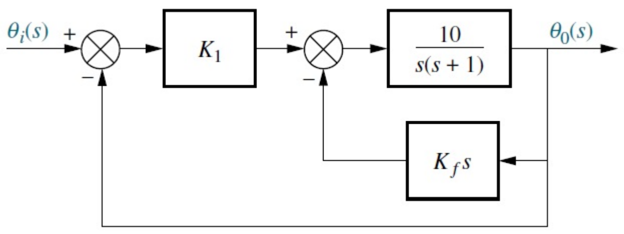
1. What value of K will yield a steady-state error in position of 1% for an input of $0.1t$?
2. What is the value of K_v for the value of K found in the first part?
3. What is the minimum possible steady-state position error for the input given in the first part?

9 Given a unity feedback system, with an open-loop transfer function of:

$$G(s) = \frac{K}{s^n(s+a)}$$

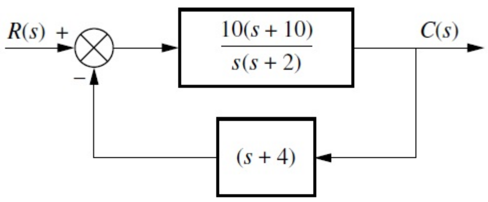
Find the values of n, K, and a in order to meet specifications of 12% overshoot and $K_v = 110$.

10 The system in the Figure should have the following specifications: $K_v = 10$, and $\zeta = 0.5$. Find the values of K_1 and K_f required to achieve that.

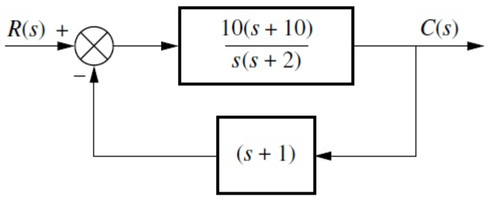


11 For the two systems shown in the Figures, find the following:

1. The system Type.
2. The appropriate static error constant.
3. The input waveform to yield a constant error.
4. The steady-state error for a unit input of the waveform found in Part (3).
5. The steady-state value of the actuating signal.

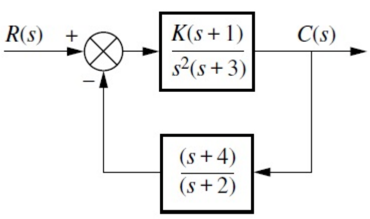


System 1



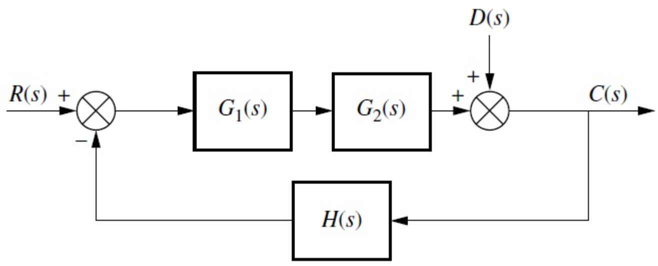
System 2

12 For the system shown in the Figure:



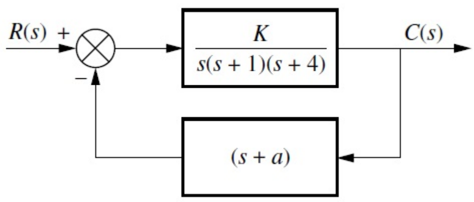
1. What is the system Type?
2. What is the appropriate static error constant?
3. What is the value of the appropriate static-error constant?
4. What is the steady-state error for a unit step input?

13 Given the system shown in the Figure, do the following:



1. Derive the expression for the error, $E(s) = R(s) - C(s)$ in terms of $R(s)$ and $D(s)$.
2. Derive the steady-state error $e(\infty)$, if $R(s)$ and $D(s)$ are unit step functions.
3. Determine the attributes of $G_1(s)$, $G_2(s)$, and $H(s)$ necessary for the steady-state error to become zero.

14 Given the system shown in the Figure, find the sensitivity of the steady-state error to parameter a. Assume a step input.



15 For the system shown in the Figure, find the sensitivity of the steady-state error for changes in K_1 and K_2, when $K_1 = 100$ and $K_2 = 0.1$. Assume step inputs for both the input and the disturbance.