BME 444
HW 7 - Due Apr 11, 2023

1. A first-order system, $G(s)$, which has a time constant of $\tau = 25$ sec is added to a closed-loop control system. Assume $C(s) = K_C = 12$ and $H(s) = K_F = 3$ in the control system. What is the new time constant that results from incorporating $G(s)$ into a closed-loop system? (Hint: use the Lesson 15 summary posted under Lesson 16).

2. Load the Simulink file containing the mechanical ventilator control system from Lessons 15 and 16. Add a PID controller to the closed-loop system. Run the lung mechanics model with the following parameters:

   Step input
   R = 1 cmH20 sec/L
   C = 0.01 L/cmH20
   L = 0.01 cmH20 sec^2/L
   $K_P = 1$
   $K_D = 1$
   $K_I = 1$
   $H(s) = 1$
   $P_D(s) = 0$

   How does the steady-state response compare to a system with just a proportional controller (i.e., $K_D = 0$ and $K_I = 0$)?

3. Given a unity feedback system with $G(s) = \dfrac{(s+2)}{s(s+3)(s+4)}$, find the steady-state errors for unit step, ramp, and parabolic inputs.

4. Imagine a feedback control system with a disturbance. Find the total steady-state error if

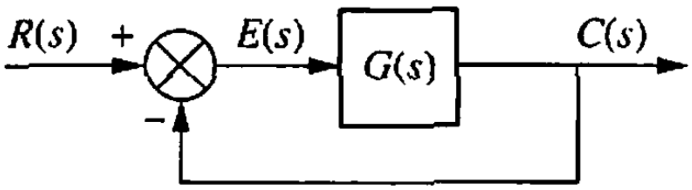
   $r(t) = 3u(t)$ and $d(t) = -u(t)$

   $C(s) = 5$ and $G(s) = \dfrac{7}{s+2}$ and $H(s) = 1$

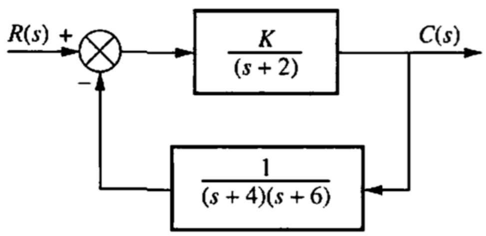
5. Given a feedback system with $G(s) = \dfrac{K(s^2 + 3s + 30)}{s(s+5)}$, no disturbance, and unity feedback ($H(s) = 1$), find K so that the steady-state error is 1/6000 for a ramp input of $y_{in} = 10tu(t)$.

6. Determine whether the unity feedback system shown below is stable if

$$G(s) = \frac{240}{(s+1)(s+2)(s+3)(s+4)}$$



7. For the system shown below, find the gain margin if
   a. $K = 0.1$
   b. $K = 1$
   c. $K = 100$



System 1