For a unit-feedback system with the open-loop transfer function, \( G(s) = \frac{K(s + 4)}{s(s + 1)(s + 2)} \),

(1) Find the range of \( K \) so that the steady-state error of the unit-step input, \( u_s(t) \), is less than 10%.

(2) Find the range of \( K \) so that the steady-state error of the unit-ramp input, \( tu_s(t) \), is less than 10%.
Quiz #4 Solution

Char. Eq.: \( 1 + G(s) = 0 \) \( \Rightarrow \) \( s^3 + 3s^2 + (K + 2)s + 4K = 0 \)

\[
\begin{array}{ccc}
\text{s}^3 & 1 & K + 2 \\
\text{s}^2 & 3 & 4K \\
\text{s} & (6-K)/3 & \therefore \text{For stability, } 0<K<6. \\
1 & 4K & \\
\end{array}
\]

(1) System type=1 \( \Rightarrow \) \( e_{ss} = 0 \) for step inputs and stable systems
So if \( 0<K<6 \), then the steady-state error<10%.

(2) System type=1 \( \Rightarrow \) \( K_v = 2K \) \( \therefore \) \( e_{ss} = 1/K_v = 1/2K \)
for ramp inputs and stable systems.
\( e_{ss} = 1/2K < 10\% \) \( \Rightarrow \) \( K > 5 \). \( \therefore \) \( 5<K<6 \).