



Free body diagram of mass J_1 showing forces and resulting accelerations. Arrows indicate $\frac{1}{J_1}$, $\frac{1}{B_1}$, $\frac{1}{B_2}$, and $\frac{1}{SJ_2}$.

$$\frac{1}{Z_1} = \frac{1}{B_2} + \frac{1}{(SJ_2)^{-1}}$$

$$= B_2 + SJ_2$$

$$Z_1 = \frac{1}{B_2 + SJ_2}$$

Free body diagram of mass J_2 showing forces and resulting accelerations. Arrows indicate $\frac{1}{SJ_1}$, $\frac{1}{B_1}$, and $\frac{1}{B_2}$.

$$\frac{S}{K} + Z_1 = \frac{S}{K} + \frac{1}{B_2 + SJ_2}$$

$$= \frac{J_2 S^2 + B_2 S + K}{K (B_2 + SJ_2)}$$

Finally,

$$\begin{aligned}\frac{1}{Z(s)} &= \frac{1}{1/sJ_1} + \frac{1}{1/B_1} + \frac{k(B_2 + sJ_2)}{J_2 s^2 + B_2 s + k} \\ &= \frac{(B_1 + sJ_1)(J_2 s^2 + B_2 s + k) + k(B_2 + sJ_2)}{J_2 s^2 + B_2 s + k} \\ &= \frac{+ B_1 B_2 s + B_1 k}{J_1 J_2 s^3 + (J_1 B_2 + B_1 J_2) s^2 + (J_1 + J_2) k s + k B_2}\end{aligned}$$

Hence

$$Z(s) = \frac{J_2 s^2 + B_2 s + k}{J_1 J_2 s^3 + (J_1 B_2 + B_1 J_2) s^2 + (k J_1 + k J_2 + B_1 B_2) s + (B_1 + B_2) k}$$