3.1) $\frac{H(s)}{Q_i(s)} = \frac{R}{RCs+1}$

$$\frac{Q_o}{Q_i} = \frac{Q_o}{H} \cdot \frac{H}{Q_i}$$

$$q_o = \frac{h}{R} \qquad \mathcal{L}[q_o] = Q_o(s) = \mathcal{L}\left[\frac{h}{R}\right] = \frac{H(s)}{R}$$

$$\frac{Q_o}{H} = \frac{1}{R}$$

$$\frac{Q_o(s)}{Q_i(s)} = \frac{1}{R} \cdot \frac{R}{RCs+1} = \boxed{\frac{1}{RCs+1}}$$

3.2)

Poles of $\frac{H}{Q}$: $\quad RCs+1=0$

$$s = \frac{-1}{CR} = -\sigma \quad , \tau = \frac{1}{\sigma}$$

$\therefore \underline{\tau = CR}$

Final value theorem of $\frac{H}{Q}$ to Unit step response input $(\frac{1}{s})$:

$$\lim_{s\to 0}[sF(s)] = \lim_{s\to 0}\left[(s)\left(\frac{R}{RCs+1}\right)\left(\frac{1}{s}\right)\right] = \lim_{s\to 0}\left[\frac{R}{RCs+1}\right] = R$$

$\therefore \underline{f(\infty) = R}$

From MATLAB: $\boxed{R = 2 \ \text{s/m}^2 \ , \ \tau = 10\ \text{s} \ , \ C = 5\ \text{m}^2}$

Scanned with CamScanner