(1) Derive DC Gain of P(s) in terms of a, b, T

$$P(s) = \frac{bT}{s + aT}, \quad a, b > 0$$

$$T \in \{10, 100\}$$

$$\boxed{P(0) = \frac{bT}{aT} = \frac{b}{a}}$$

$$P(s) = \frac{k}{\tau s + 1}, \quad k \text{ is DC Gain}$$

$$P(s) = \frac{bT}{s + aT} = \frac{\frac{bT}{aT}}{\frac{1}{aT}s + 1}$$

$$= \frac{b/a}{\frac{1}{aT} \cdot s + 1} \Rightarrow \boxed{k = \frac{b}{a}}, \quad \tau = \frac{1}{aT}$$

(2) Derive formula for b.w. of $P(s)$ in terms of a, b, T

$$\frac{\|P(j\omega)\|}{\|P(0)\|} = \frac{1}{\sqrt{2}} \Rightarrow \left\| \frac{bT}{j\omega + aT} \right\| \cdot \frac{a}{b} = \frac{1}{\sqrt{2}}$$

$$\Rightarrow \frac{bT}{\sqrt{a^2T^2 + \omega^2}} \cdot \frac{a}{b} = \frac{1}{\sqrt{2}}$$

$$\Rightarrow a^2T^2 + \omega^2 = 2a^2T^2$$

$$\Rightarrow \omega^2 = 2a^2T^2 - a^2T^2 = a^2T^2$$

$$\Rightarrow \boxed{\omega = aT}$$

(3) Estimate a, b, T from measured bandwidth & DC Gain in Procedures 1.1 and 1.2 using $\omega_{BW} = aT$ and $K = \frac{b}{a}$ (ω_{BW} := bandwidth freq., K := DC Gain)

From Procedure 1.1, $K = 0.9127$

From Procedure 1.2, $f = 35.6$ Hz

$$\Rightarrow \omega_{BW} \doteq 223.68 \text{ rad/s}$$

$$\Rightarrow T = 100 \Rightarrow a \doteq 2.2368, \quad b \doteq 2.0415$$

(4) Compare these estimates with actual simulation params.

$a_{sim} \doteq 2.0646$, $b_{sim} \doteq 1.8846$, $T_{sim} = 100$

$$\Rightarrow a_{err} = \frac{|a - a_{sim}|}{a_{sim}} \doteq 8.34\%$$

(absolute relative true error)

$$\Rightarrow b_{err} = \frac{|b - b_{sim}|}{b_{sim}} \doteq 8.33\%$$

(absolute relative true error)

$$\Rightarrow T_{err} = 0\%$$

(5)