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## Homework 5: Due 2/17/2020

1. A certain op-amp has a unity-gain frequency of 2MHz. For a *noninverting* amplifier, calculate the closed-loop 3-dB bandwidth for each of the following ideal values of closed loop gain:
    1. $A_{CL} = 500$

    $$B_{CL} = B\beta; A_{CL} = \frac{1}{\beta} = K_n \tag{1}$$
    $$\therefore$$
    $$B_{CL} = \frac{B}{A_{CL}} = \frac{2MHz}{500}$$
    $$\underline{\overline{|B_{CL} = 4kHz|}}$$

    2. $A_{CL} = 50$

    $$B_{CL} = B\beta; A_{CL} = \frac{1}{\beta} = K_n \tag{2}$$
    $$\therefore$$
    $$B_{CL} = \frac{B}{A_{CL}} = \frac{2MHz}{50}$$
    $$\underline{\overline{|B_{CL} = 40kHz|}}$$

    3. $A_{CL} = 5$

    $$B_{CL} = \frac{B}{A_{CL}} = \frac{2MHz}{5} \tag{3}$$
    $$\underline{\overline{|B_{CL} = 400kHz|}}$$

    4. $A_{CL} = 1$

    $$B_{CL} = B\beta; A_{CL} = \frac{1}{\beta} = K_n \tag{4}$$
    $$\therefore$$
    $$B_{CL} = \frac{B}{A_{CL}} = \frac{2MHz}{1}$$
    $$\underline{\overline{|B_{CL} = 2MHz|}}$$

3. A certain op-amp has a unity-gain frequency of 2MHz. For an inverting amplifier, calculate the closed-loop 3-dB bandwidth for each of the following ideal values of closed loop gain:
    1. $|A_{CL}| = 500$

$$B_{CL} = B\beta;\ |A_{CL}| = \frac{R_f}{R_i};\ \beta = \frac{R_i}{R_f + R_i} \tag{5}$$

$$A_{CL} = 500;\ \therefore\ \beta = \frac{1}{501}$$

$$B_{CL} = \frac{B}{\beta} = \frac{2MHz}{501}$$

$$\boxed{B_{CL} = 3.99kHz \approx 4kHz}$$

2. $|A_{CL}| = 50$

$$B_{CL} = B\beta;\ |A_{CL}| = \frac{R_f}{R_i};\ \beta = \frac{R_i}{R_f + R_i} \tag{6}$$

$$A_{CL} = 50;\ \therefore\ \beta = \frac{1}{51}$$

$$B_{CL} = \frac{B}{\beta} = \frac{2MHz}{51}$$

$$\boxed{B_{CL} = 39.2kHz \approx 40kHz}$$

3. $|A_{CL}| = 5$

$$B_{CL} = B\beta;\ |A_{CL}| = \frac{R_f}{R_i};\ \beta = \frac{R_i}{R_f + R_i} \tag{7}$$

$$A_{CL} = 5;\ \therefore\ \beta = \frac{1}{6}$$

$$B_{CL} = \frac{B}{\beta} = \frac{2MHz}{6}$$

$$\boxed{B_{CL} = 333.\bar{3}kHz}$$

4. $|A_{CL}| = 1$

$$B_{CL} = B\beta;\ |A_{CL}| = \frac{R_f}{R_i};\ \beta = \frac{R_i}{R_f + R_i} \tag{8}$$

$$A_{CL} = 1;\ \therefore\ \beta = \frac{1}{2}$$

$$B_{CL} = \frac{B}{\beta} = \frac{2MHz}{2}$$

$$\boxed{B_{CL} = 1MHz}$$