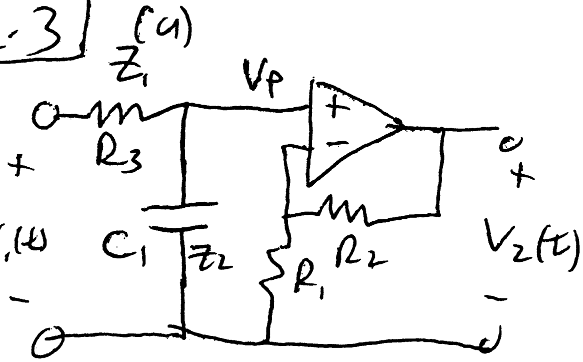
EECS 245 Homework 10 solution

Problems 11-37 & 11-40 are in the Homework 9 solution

$\boxed{12.3}$ (a)



From Op-Amps, $V_2(t) = V_P\left(\frac{R_1+R_2}{R_1}\right)$
(standard non-inverting Op-Amp amplifier)

$$V_P = V_1(t)\left[\frac{Z_2}{Z_1+Z_2}\right] \therefore$$

$$V_2(s) = \left(\frac{R_1+R_2}{R_1}\right)\left(\frac{\frac{1}{C_1 s}}{R_3+\frac{1}{C_1 s}}\right)V_1(s)$$

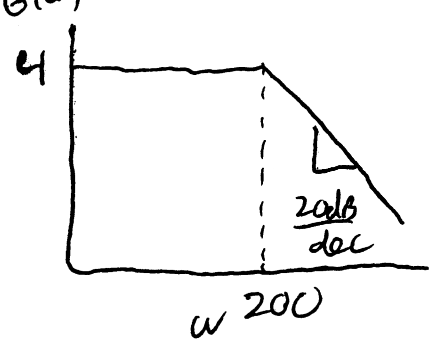
$$V_2(s) = \left(\frac{10+30}{10}\right)\left(\frac{1}{.005s+1}\right)V_1(s) \qquad \frac{V_2(s)}{V_1(s)} = \boxed{T_V(s) = \frac{800}{s+200}}$$

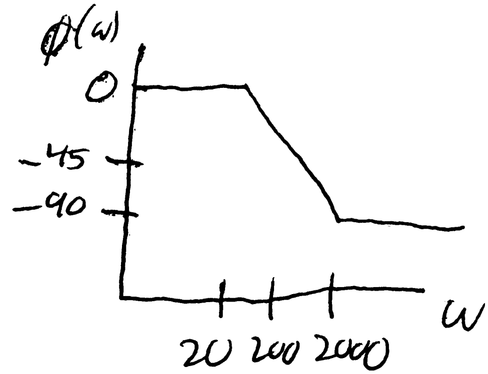
(b) • DC gain $= T_V(0) = \frac{800}{200} = \boxed{4}$

• ∞ frequency gain $= T_V(\infty) = \frac{800}{\infty} = \boxed{0}$

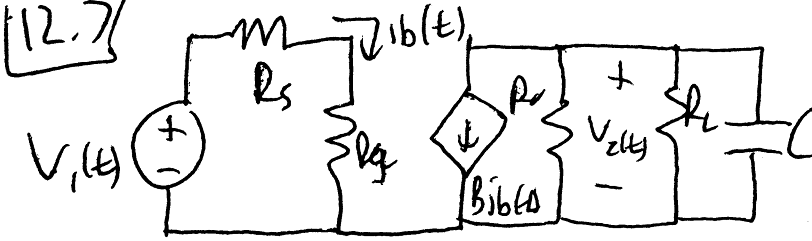
cutoff frequency & type of filter: circuit is of type shown in eqn 12-4; $\boxed{\text{low-pass filter w/ } \omega_C = 200}$

(c) $G(\omega)$





12.7



$$I_B(s) = \frac{V_1(s)}{R_s + R_g}$$

$$V_2(s) = (-\beta I_B(s))(R_o // R_L // C_L)$$

$$V_2(s) = \left(\frac{R_o R_L}{R_L + R_o + C_L s R_o R_L}\right)\left(-\beta \frac{V_1(s)}{R_s + R_g}\right)$$

$$\boxed{T_V(s) = \left(\frac{-\beta R_o R_L}{R_s + R_g}\right)\left(\frac{1}{s(R_o \cdot R_L \cdot C_L) + R_o + R_L}\right)}$$

$$\boxed{|T_V(0)| = \frac{\beta}{R_s + R_g}\left(\frac{R_o R_L}{R_o + R_L}\right)} = 0.665$$

$$T_V(s) = \frac{-9980}{s(2.5 \times 10^{-4}) + 15{,}000}$$

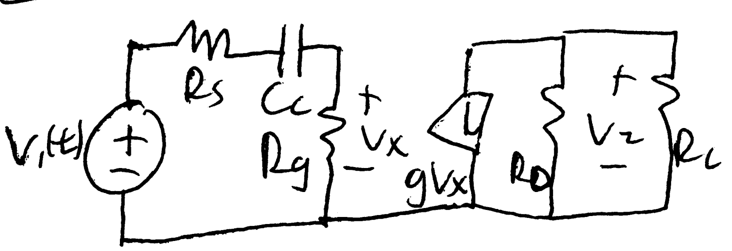
$$\boxed{|T_V(j\omega = \infty)| = 0}$$

Pass-band gain: $\boxed{K = T_V(0) = 0.665}$

$$\omega_c = \frac{R_o + R_L}{R_o \cdot R_L \cdot C_L} \qquad \boxed{\omega_c = 6 \times 10^7}$$

Circuit is low-pass

12.8



$$V_x(s) = \frac{V_1(s) R_g}{R_g + R_s + \frac{1}{C_c s}} = \frac{V_1(s) R_g C_c s}{C_c s (R_g + R_s) + 1}$$

$$V_2(s) = \left(\frac{R_D R_L}{R_D + R_L}\right)(-g \cdot V_x(s)) \therefore$$

$$\boxed{T_V(s) = \frac{-g R_D R_L}{R_D + R_L}\left[\frac{R_g C_c s}{(R_g + R_s) C_c s + 1}\right]} = \frac{-.8\overline{3}s}{.025s + 1}$$

$$\boxed{|T_V(0)| = 0} \qquad \boxed{|T_V(\infty)| = \left[\frac{g R_D R_L}{R_D + R_L}\right]\left[\frac{R_g C_c}{(R_g + R_s) C_c}\right]} = 33.?$$

$$\boxed{K = T_V(\infty) = 33.2} \qquad \omega_c = \frac{1}{(R_g + R_s) C_c} \qquad \boxed{\omega_c = 39.992}$$

Circuit is high pass

Take all terms in

$$\frac{R_g C_c s}{(R_g + R_s) C_c s + 1}$$ & divide by s →

$$R_g C_c / (R_g + R_s) C_c + 1/s \qquad 1/\infty = 0$$