جواب سوالات Homwork 8

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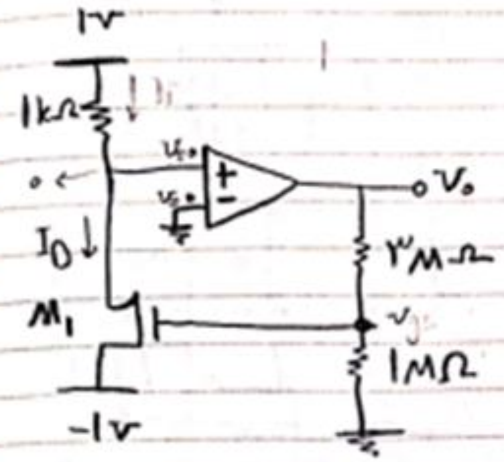

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$$I_D = \frac{1-0}{1k} = 1m$$

اگر فرض کنیم در اشباع است

از فرمول I_D برای

حالت اشباع داریم:

$$I_D = \frac{k}{۲}\left(V_{gs} - |V_t|\right)^۲$$

$$1m = \frac{۲m}{۲}\left(V_{gs} - ۲\right)^۲$$

$1 = (V_{gs} - ۲)^۲ \qquad 1 = V_{gs} - ۲ \qquad V_{gs} = ۳$

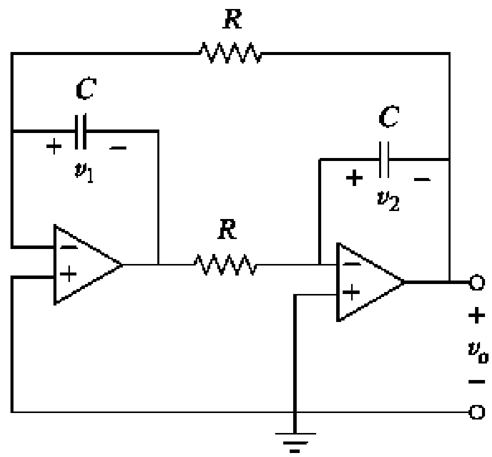
$-1 = V_{gs} - ۲ \qquad V_{gs} = +1$

$V_{gs} > |V_t| \longrightarrow ۳ > ۲$ ✓

$V_{DS} > V_{gs} - V_t \longrightarrow 1 \geq ۳ - ۲$ ✓

$V_{gs} = ۳ \qquad V_g - V_S = ۳ \qquad V_g = ۲$

$kcl: \quad \frac{V_o - ۲}{۳M} + \frac{0 - ۲}{1M} = 0 \qquad V_o - ۲ - ۶ = 0 \qquad V_o = ۸V$



At the input of the first op amp,

$$(v_o - 0)/R = Cd(v_1 - 0)/dt \qquad (1)$$

At the input of the second op amp,

$$(-v_1 - 0)/R = Cdv_2/dt \qquad (2)$$

Let us now examine our constraints. Since the input terminals are essentially at ground, then we have the following,

$$v_o = -v_2 \text{ or } v_2 = -v_o \qquad (3)$$

Combining (1), (2), and (3), eliminating v_1 and v_2 we get,

$$\frac{d^2v_o}{dt^2} - \left(\frac{1}{R^2C^2}\right)v_o = \frac{d^2v_o}{dt^2} - 100v_o = 0$$

Which leads to $s^2 - 100 = 0$

Clearly this produces roots of –10 and +10.

And, we obtain,

$$v_o(t) = (Ae^{+10t} + Be^{-10t})V$$

$$\text{At } t = 0,\ v_o(0+) = -v_2(0+) = 0 = A + B,\ \text{thus } B = -A$$

This leads to $v_o(t) = (Ae^{+10t} - Ae^{-10t})V$. Now we can use $v_1(0+) = 2V$.

$$\text{From (2)},\ v_1 = -RCdv_2/dt = 0.1dv_o/dt = 0.1(10Ae^{+10t} + 10Ae^{-10t})$$

$$v_1(0+) = 2 = 0.1(20A) = 2A \text{ or } A = 1$$

$$\text{Thus},\ v_o(t) = \underline{\mathbf{(e^{+10t} - e^{-10t})V}}$$

It should be noted that this circuit is unstable (clearly one of the poles lies in the right-half-plane).

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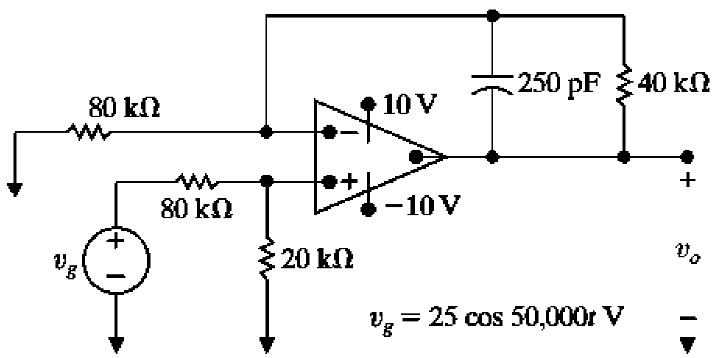


[a] $\mathbf{V}_g = 25\underline{/0^\circ}$ V

$$\mathbf{V}_{\text{p}} = \frac{20}{100}\mathbf{V}_g = 5\underline{/0^\circ}; \qquad \mathbf{V}_{\text{n}} = \mathbf{V}_{\text{p}} = 5\underline{/0^\circ}\text{ V}$$

$$\frac{5}{80{,}000} + \frac{5 - \mathbf{V}_o}{Z_{\text{p}}} = 0$$

$$Z_{\text{p}} = -j80{,}000 \| 40{,}000 = 32{,}000 - j16{,}000\,\Omega$$

$$\mathbf{V}_o = \frac{5Z_{\text{p}}}{80{,}000} + 5 = 7 - j = 7.07\underline{/-8.13^\circ}$$

$$v_o = 7.07\cos(50{,}000t - 8.13^\circ)\text{ V}$$

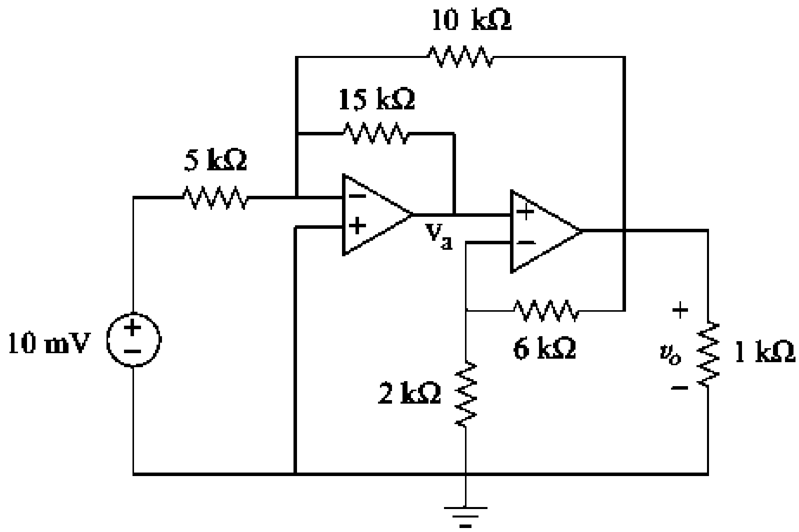
[b] $\mathbf{V}_{\text{p}} = 0.2V_m\underline{/0^\circ}; \qquad \mathbf{V}_{\text{n}} = \mathbf{V}_{\text{p}} = 0.2V_m\underline{/0^\circ}$

$$\frac{0.2V_m}{80{,}000} + \frac{0.2V_m - \mathbf{V}_o}{32{,}000 - j16{,}000} = 0$$

$$\therefore \quad \mathbf{V}_o = 0.2V_m + \frac{32{,}000 - j16{,}000}{80{,}000}V_m(0.2) = V_m(0.28 - j0.04)$$

$$\therefore \quad |V_m(0.28 - j0.04)| \le 10$$

$$\therefore \quad V_m \le 35.36\text{ V}$$



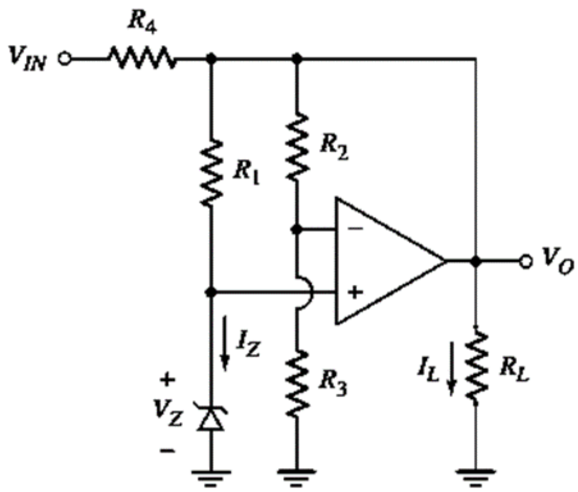
In this case, the first stage is a summer

$$v_a = -\frac{15}{5}(10) - \frac{15}{10}v_o = -30 - 1.5v_o$$

For the second stage,

$$v_o = \left(1 + \frac{6}{2}\right)v_a = 4v_a = 4(-30 - 1.5v_o)$$

$$7v_o = -120 \longrightarrow v_o = -\frac{120}{7} = \underline{\mathbf{-17.143mV}}$$



$$R_1 = \frac{V_O - V_Z}{I_Z} = \frac{12 - 5.6}{2} = 3.2\,\mathrm{k}\Omega$$

$$\frac{V_O}{V_Z} = \left(1 + \frac{R_2}{R_3}\right) = \frac{12}{5.6} \Rightarrow \frac{R_2}{R_3} = 1.143$$

Let $I_R = 2\,\mathrm{mA}, \ \Rightarrow R_2 + R_3 = \frac{V_O}{I_R} = \frac{12}{2} = 6\,\mathrm{k}\Omega$

Then $1.143R_3 + R_3 = 6$, $\Rightarrow R_3 = 2.8\,\mathrm{k}\Omega$ and $R_2 = 3.2\,\mathrm{k}\Omega$

Let $I_{R4} = 4\,\mathrm{mA}, \ R_4 = \frac{V_{IN} - V_O}{I_{R4}} = \frac{15 - 12}{4} = 0.75\,\mathrm{k}\Omega$