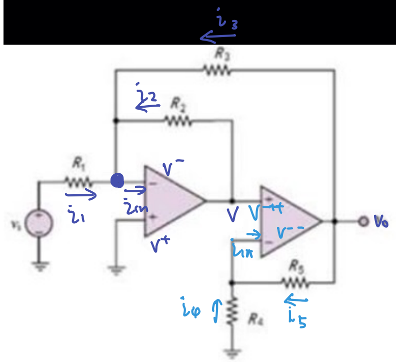
[redacted]



$i_1 + i_2 + i_3 = i_{IN} = 0$

$\frac{V_s - V^-}{R_1} + \frac{V - V^-}{R_2} + \frac{V_o - V^-}{R_3} = 0$

$V^+ = V^- = 0$

$\frac{V_s}{R_1} + \frac{V}{R_2} + \frac{V_o}{R_3} = 0 \;\Big|\; \frac{V_s}{10} + \frac{V}{10} + \frac{V_o}{10} = 0 \;\Big\|\; V = -V_o - V_s$

Given $R_1=10\Omega$, $R_2=10\ \Omega$, $R_3=10\ \Omega$, $R_4=10\ \Omega$ and $R_5= 30\ \Omega$.

- ○ Av= -2.25(V/V)
- ○ Av= 0.80(V/V)
- ● Av= -0.80(V/V) //
- ○ Av= 2.25(V/V)

[redacted]

$\frac{V}{10} + \frac{V}{30} = \frac{V_o}{30}$

$\frac{V_o}{V_i} = -\frac{10\times10\,(10+30)}{10(10\times10+10(10+30))}$

$= -\frac{4}{5}$

$= -0.8$

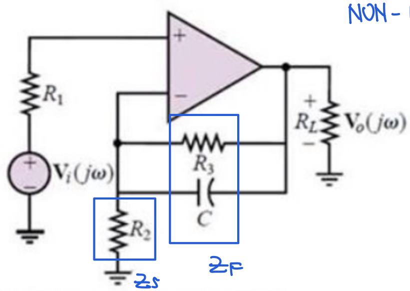
Input Values

R1	10
R2	10
R3	10
R4	10
R5	30
Vout	-1
Vin	1.25
Av	-0.8

[redacted]

The circuit shown in the figure is an active filter with. Determine the cutoff frequency (ω_0) and pass-band gain (A_V) of the filter.

NON-INVERTING



$$A_v \Rightarrow 20\log\left(1+\frac{50}{5}\right)$$

$$= 20.827\ \text{dB}$$

$$\omega_0 = \frac{1}{R_3 \cdot C}$$

$$= \frac{1}{(50000)(100\times10^{-7})} \approx 200\ \text{rad/s}$$

Given R_1=2kΩ,R_2=5kΩ,R_3=50kΩ,C=100nF.

- ( ) ω_0 = 2000 rad/sec; A_V = 8.22 dB.
- (•) ω_0 = 200 rad/sec; Av = 20.83 dB.
- ( ) ω_0 = 2000 rad/sec; Av = 20.83 dB.
- ( ) ω_0 = 200 rad/sec; Av = 8.22 dB.

[redacted]

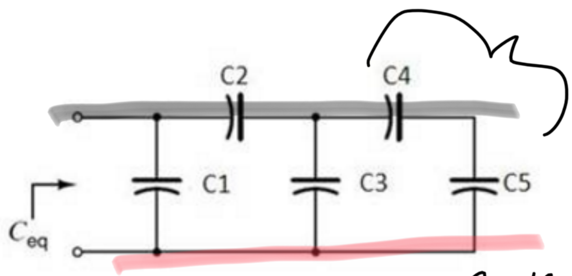
Input

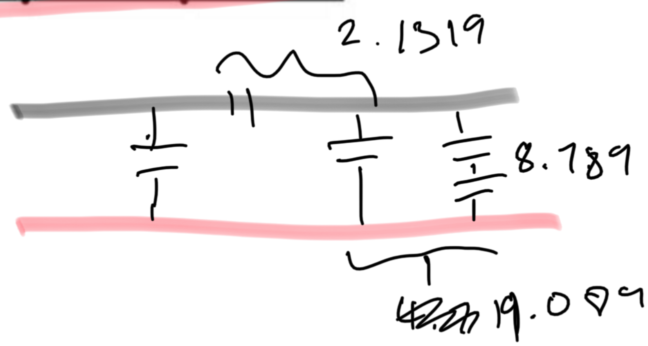
R1	2			
R2	5			
R3	50		SI unit (R3, kilo)	5.00E+04
C	100.00		SI Unit C, Nano	0
Wo	200.00	rad/s		
Vout/vin	11			
Gain (DB)	20.827854			

Question 3

Referring to the following circuit

$$\left(\frac{1}{C4} + \frac{1}{C5}\right)^{-1}$$





and knowing that

C1 = 1.5 [uF]
C2 = 2.4 [uF]
C3 = 10.3 [uF]
C4 = 20.3 [uF]
C5 = 15.5 [uF]

determine the value of the equivalent capacitor Ceq (NOTE: uF stands for micro-Farad).

Allowing for some numerical approximation, which among the following values most closely matches the correct answer?

- (●) Ceq = 3.632 [uF]
- ( ) Ceq = 22.7274 [uF]
- ( ) Ceq = 10.8959 [uF]
- ( ) Ceq = 50 [uF]

Series: $\left(\frac{1}{C4} + \frac{1}{C5}\right)^{-1}$

$= \left(\frac{1}{20.3} + \frac{1}{15.5}\right)^{-1}$

$= 8.789$

$\left(\frac{1}{19.0891} + \frac{1}{2.4}\right)^{-1} = 2.1319$

Parallel: $8.789 + 10.3$

$= 19.0891$

$2.1319 + 1.5$

$= 3.6319$

	C1	1.5
	C2	2.4
	C3	10.3
	C4	20.3
	C5	15.5
Answer:	Ceq	3.631957

capacitor open

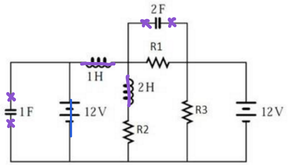
inductor short

Question 5

Referring to the following circuit

$W_L = \frac{1}{2} L i_L^2$

$W_C = \frac{1}{2} C V_C^2$



and knowing that

R1 = 13.8 [Ohms]
R2 = 27.6 [Ohms]
R3 = 13.8 [Ohms]

determine the total energy E stored in the circuit at steady state.

Allowing for some numerical approximation, which among the following values most closely matches the correct answer?

[Hint: there is no need to solve any complex system of equations, just a few simple calculations. Look carefully at the circuit!!!]

- E = 331.2 J
- (selected) E = 72.2836 J
- E = 0 J
- E = 243.36 J

After Steady State

R1	13.8
R2	27.6
R3	13.8
Voltage	12

Mesh Current 1		Mesh Current 2		Mesh Current 3	
i1	27.6	i1	-27.6	i1	0
i2	-27.6	i2	55.2	i2	-13.8
i3	0	i3	-13.8	i3	13.8
Voltage	12	Volatge	0	Volatge	-12

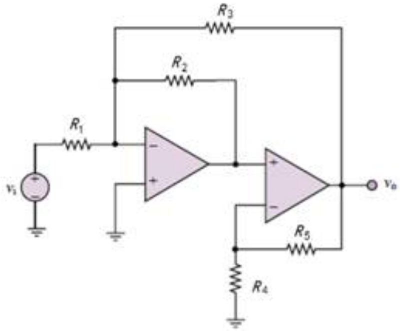
After Solving Simultaneous Equation

i1	6.0000
i2	0.0000
i3	-12.0000

$$A = \begin{bmatrix} 27.6 & -27.6 & 0 \\ -27.6 & 55.2 & -13.8 \\ 0 & -13.8 & 13.8 \end{bmatrix} \quad X = \begin{bmatrix} i1 \\ i2 \\ i3 \end{bmatrix} \quad B = \begin{bmatrix} 12 \\ 0 \\ -12 \end{bmatrix}$$

Energy

1F	1.0000	72
2F	2.0000	0
1H	1.0000	18
2H	2.0000	36
Asnwer: Total Energy		126



$\frac{V_o}{V_i} =$

Given R_1=30Ω, R_2=10 Ω, R_3=10 Ω, R_4=10 Ω and R_5= 10 Ω.

Selected Answer: Av= -0.22 (V/V)

Answers:

Av= -1.78 (V/V)

Av= 0.22 (V/V)

Av= -0.22 (V/V)

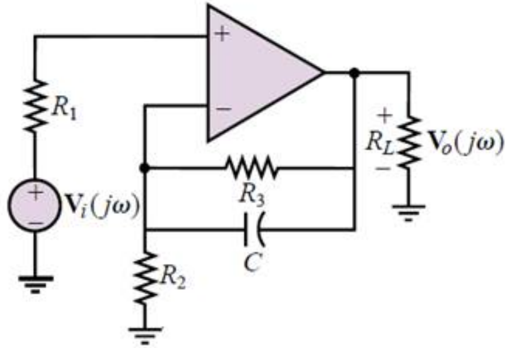
Av= 1.78 (V/V)

25 out of 25 points

Question 4

25 out of 25 points

The circuit shown in the figure is an active filter with. Determine the cutoff frequency (ω_0) and pass-band gain (A_V) of the filter.



Given R_1=2kΩ,R_2=5kΩ,R_3=40kΩ,C=100nF.

Selected Answer: ω_0 = 250 rad/sec; A_V = 19.08 dB.

Answers:

ω_0 = 250 rad/sec; A_V = 19.08 dB.

ω_0 = 2000 rad/sec; A_V = 19.08 dB.

ω_0 = 2000 rad/sec; A_V = 8.22 dB.

ω_0 = 250 rad/sec; A_V = 8.22 dB.

Wednesday, November 13, 2019 11:08:46 AM SGT

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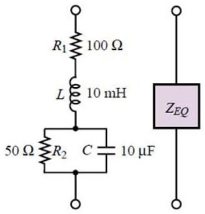
Moving to the next question prevents changes to this answer.

Question 4

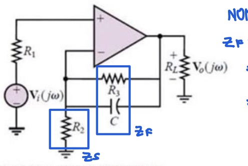
Which of the following impedances best approximates the equivalent impedance of the following circuit, at frequency $\omega=10^4$ rad/sec?



- a. $Z_{EQ} = 100 + 100\,e^{j\pi}\Omega$
- b. $Z_{EQ} = 100 + j90\Omega$
- c. $Z_{EQ} = j100\ \Omega$
- d. $Z_{EQ} = 100\,e^{j\pi/2}\Omega$

[redacted]

The circuit shown in the figure is an active filter with. Determine the cutoff frequency (ω_0) and pass-band gain (A_V) of the filter.



Given R_1=2kΩ,R_2=5kΩ,R_3=50kΩ,C=100nF.

- ○ ω_0 = 2000 rad/sec; A_V = 8.22 dB.
- ● ω_0 = 200 rad/sec; A_V = 20.83 dB.
- ○ ω_0 = 2000 rad/sec; A_V = 20.83 dB.
- ○ ω_0 = 200 rad/sec; A_V = 8.22 dB.

NON INVERTING

$$Z_F = R//C$$

$$= \left(\frac{1}{R_3} + jwC\right)^{-1}$$

$$= \left(\frac{1 + R_3 jwC}{R_3}\right)^{-1}$$

$$= \frac{R_3}{1 + jwCR_3}$$

low pass

$w \to 0 \Rightarrow 1$

$w \to \infty \Rightarrow 0$

$$Z_s = R_2$$

$$A_V = \frac{V_o}{V_i} = 1 + \frac{Z_F}{Z_s} = \frac{R_3}{R_2}\left(\underbrace{\frac{1}{1 + R_3 jwC}}\right)$$

[redacted]

$$A_V(j\omega) = 1 + \frac{R_3}{R_2}(1) \quad \text{where } w \to 0$$

$$= 1 + \frac{50}{5}$$

$$= 11$$

$$\text{gain} = 20\log_{10} 11 = 20.83 \text{dB}$$

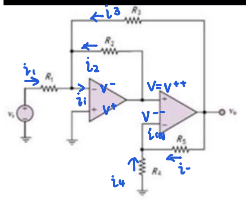
$$W_o = \frac{1}{R_3 C} = \frac{1}{50000 \times 100 \times 10^{-9}}$$

$$= 200 \text{rad/s}$$

Zf :

167

[redacted]



Given R_1=10Ω, R_2=10 Ω, R_3=10 Ω, R_4=10 Ω and R_5= 30 Ω.

- ○ Av= -2.25(V/V)
- ○ Av= 0.80(V/V)
- ◉ Av= -0.80(V/V)
- ○ Av= 2.25(V/V)

[redacted]

$i_{IN} = i_1 + i_2 + i_3 = 0$

$$\frac{V_i - V^-}{R_1} + \frac{V - V^-}{R_2} + \frac{V_0 - V^-}{R_3} = 0$$

$V^- = V^+ = 0$

$$\frac{V_i}{R_1} + \frac{V}{R_2} + \frac{V_0}{R_3} = 0$$

$i_{IN} = i_4 + i_5 = 0$

$$-\frac{V^{--}}{R_4} + \frac{V_0 - V^{--}}{R_5} = 0$$

$V^{++} = V^{--} = V$

$$\frac{-V}{R_4} + \frac{V_0}{R_5} - \frac{V}{R_5} = 0$$

$$\frac{V}{R_4} + \frac{V}{R_5} = \frac{V_0}{R_5}$$

$$\frac{VR_5 + VR_4}{R_4R_5} = \frac{V_0}{R_5}$$

$$V = \frac{R_4R_5V_0}{R_5(R_5+R_4)}$$

$$= V_0\left(\frac{R_4}{R_4+R_5}\right)$$

$$\frac{V_i}{R_1} + \frac{V_0}{R_2}\left(\frac{R_4}{R_4+R_5}\right) + \frac{V_0}{R_3} = 0$$

$$\frac{V_i}{10} + \frac{V_0}{10}\left(\frac{10}{10+30}\right) + \frac{V_0}{10} = 0$$

$V_i + 1.25V_0 = 0$

$V_i = -1.25V_0$

$$\frac{V_0}{V_i} = (-1.25)^{-1} = -0.$$

Question 5

White colou

if Vin = 5∠20° and Vout = 10∠45° , in phasor format (amplitude ∠ angle), which of the following phasors best represent the ratio Vout / Vin ?

- ○ 0.5∠-15°
- ○ 5∠-15°
- ● 2∠15°
- ○ 15∠65°

$\frac{10}{5} \angle 45-20$

$= 2 \angle 15$

Click **Submit** to complete this assessment.

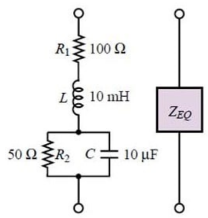
$4.69 + 1.7j$

$7.07 + 7.07j$

Moving to the next question prevents changes to this answer.

Question 4

Which of the following impedances best approximates the equivalent impedance of the following circuit, at frequency $\omega = 10^4$ rad/sec?



- a. $Z_{EQ} = 100 + 100\, e^{j\pi}\,\Omega$
- b. $Z_{EQ} = 100 + j90\Omega$
- c. $Z_{EQ} = j100\ \Omega$
- d. $Z_{EQ} = 100\, e^{j\pi/2}\,\Omega$

$$Z_{RC} = \left(\frac{1}{R} + j\omega C\right)^{-1}$$

$$= \left[\frac{1}{50} + j\,(10^4 \times 10 \times 10^{-6})\right]^{-1}$$

$$= (0.02 + 0.1j)^{-1}$$

$$= \frac{1}{0.02 + 0.1j} \times \frac{(0.02 - 0.1j)}{0.02 - 0.1j}$$

$$= \frac{0.02 - 0.1j}{0.02^2 + 0.1^2}$$

$$= \frac{0.02}{0.0104} - \frac{0.1}{0.0104} j$$

$$Z_{eq} = \frac{0.02}{0.0104} + 100 - \frac{0.1}{0.0104} j + j\,(10^4)(10 \times 10^{-3})$$

$$= 101.9 + 90.38j$$

$$100 + j\omega L + \left(\frac{1}{50} + \frac{1}{j\omega C}\right)^{-1}$$

$$100 + j\,10^4(10 \times 10^{-3}) + \left(\frac{1}{50} + \frac{1}{10^4(10 \times 10^{-3})\,j}\right)^{-1}$$

$$100 + 100j + \left(\frac{1}{50} + \frac{1}{100j}\right)^{-1}$$

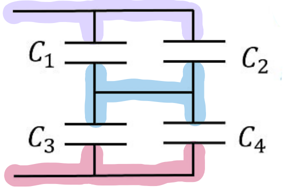
$$100 + 100j + \left(\frac{100j + 50}{5000j}\right)^{-1}$$

$$100 + 100j + \frac{5000j}{100j + 50}$$

⚠ Moving to the next question prevents changes to this answer.

Question 3

Capacitors in series/parallel.



With reference to the figure, determine the equivalent capacitance when C1 = 4 mF, C2 = 16 mF, C3 = 9 mF, C4 = 21 mF.

- ✓ Ceq = 12 mF
- Ceq = 46 mF
- Ceq = 84 mF
- Ceq = 29 mF

$C_1 // C_2 + C_3 // C_4$

$C_1 // C_2 = 4 + 16 = 20\,mF$

$C_3 // C_4 = 9 + 21 = 30\,mF$

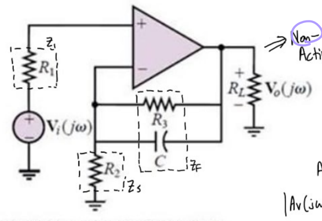
$C_T = \left(\frac{1}{20} + \frac{1}{30}\right)^{-1}$

$= 12\,mF$

$C_1 // C_2 = 13 + 7$
$= 20$

$C_3 // C_4 = 11 + 19$
$= 30$

The circuit shown in the figure is an active filter with. Determine the cutoff frequency (ω_0) and pass-band gain (A_V) of the filter.



?? +ve terminal

→ Non-inverting
Active Filter 因为有 capacitor

$$Z_F = \frac{R_3\left(\frac{1}{j\omega C}\right)}{R_3 + \frac{1}{j\omega C}} = \frac{R_3}{R_3 j\omega C + 1}$$

$$Z_s = R_2$$

$$A_V = \frac{V_o}{V_i} = 1 + \frac{Z_F}{Z_F} = 1 + \frac{R_3}{R_2}\underbrace{\left(\frac{1}{R_3 j\omega C + 1}\right)}_{\text{Gain}}$$

$$\text{Gain} = \frac{1}{\sqrt{\left(\frac{\omega}{\omega_0}\right)^2 + 1}} \begin{array}{l} = 1,\ \omega \to 0 \\ = 0,\ \omega \to \infty \end{array} \Big\} \text{Low pass}$$

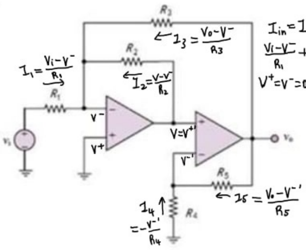
$$|A_V(j\omega)| = 1 + \frac{R_3}{R_2}(1) \quad \text{where } \omega \to 0$$
$$= 11$$

$$\omega_0 = \frac{1}{R_3 C} = \frac{1}{50000 \times 100 \times 10^{-9}}$$
$$= 200 \text{ rad/s}$$

Given R_1=2kΩ,R_2=5kΩ,R_3=50kΩ,C=100nF.

- ○ ω_0 = 2000 rad/sec; A_V = 8.22 dB.
- ● ω_0 = 200 rad/sec; A_V = 20.83 dB.
- ○ ω_0 = 2000 rad/sec; A_V = 20.83 dB.
- ○ ω_0 = 200 rad/sec; A_V = 8.22 dB.

$$\text{Gain} = 20\log_{10}(11) = 20.83 \text{ dB}$$



$I_{in} = I_1 + I_2 + I_3 = 0$

$\frac{V_i - V^-}{R_1} + \frac{V - V^-}{R_2} + \frac{V_0 - V^-}{R_3} = 0$

$V^+ = V^- = 0,\ \frac{V_i}{R_1} + \frac{V}{R_2} + \frac{V_0}{R_3} = 0$

$V = -R_2\left(\frac{V_1}{R_1} + \frac{V_0}{R_3}\right)$

$I_{in} = I_4 + I_5 = 0$

$-\frac{V^{-'}}{R_4} + \frac{V_0 - V^{-'}}{R_5} = 0$

$V^{+'} = V^{-'} = V,\ -\frac{V}{R_4} + \frac{V_0}{R_5} - \frac{V}{R_5} = 0$

$V\left(\frac{1}{R_4} + \frac{1}{R_5}\right) = \frac{V_0}{R_5}$

$V = V_0\left(\frac{R_4 R_5}{R_4 + R_5}\right) \cdot R_5 = V_0\left(\frac{R_4}{R_4 + R_5}\right)$

$\therefore -R_2\left(\frac{V_1}{R_1} + \frac{V_0}{R_3}\right) = V_0\left(\frac{R_4}{R_4 + R_5}\right)$

$-\frac{R_2}{R_1}V_1 - \frac{R_2}{R_3}V_0 = V_0\left(\frac{R_4}{R_4 + R_5}\right)$

$-V_1 - V_0 = 0.25 V_0$

$-V_1 = 1.25 V_0$

$A_V = \frac{V_0}{V_1} = \frac{-1}{1.25} = -0.8$

Given $R_1 = 10\Omega$, $R_2 = 10\ \Omega$, $R_3 = 10\ \Omega$, $R_4 = 10\ \Omega$ and $R_5 = 30\ \Omega$.

- ○ Av= -2.25(V/V)
- ○ Av= 0.80(V/V)
- ● Av= -0.80(V/V)
- ○ Av= 2.25(V/V)

-0.6

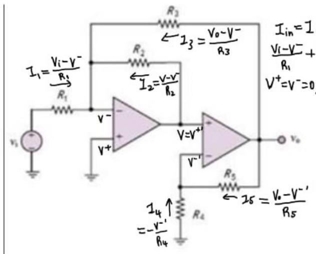
$R_1 = 10$
$R_2 = 10$
$R_3 = 10$
$R_4 = 20$
$R_5 = 10$

$-\frac{R_2}{R_1}V_1 - \frac{R_2}{R_3}V_0 = V_0\left(\frac{R_4}{R_4 + R_5}\right)$

$-\frac{10}{10}V_1 - \frac{10}{10}V_0 = V_0\left(\frac{20}{20 + 10}\right)$

$-V_1 - V_0 = \frac{2}{3}V_0$

$-V_1 = \frac{5}{3}V_0$



$I_{in} = I_1 + I_2 + I_3 = 0$

$\frac{V_1 - V^-}{R_1} + \frac{V - V^-}{R_2} + \frac{V_0 - V^-}{R_3} = 0$

$V^+ = V^- = 0, \; \frac{V_1}{R_1} + \frac{V}{R_2} + \frac{V_0}{R_3} = 0$

$V = -R_2\left(\frac{V_1}{R_1} + \frac{V_0}{R_3}\right)$

$I_{in} = I_4 + I_5 = 0$

$\frac{-V^{-'}}{R_4} + \frac{V_0 - V^{-'}}{R_5} = 0$

$V^{+'} = V^{-'} = V, \; -\frac{V}{R_4} + \frac{V_0}{R_5} - \frac{V}{R_5} = 0$

$V\left(\frac{1}{R_4} + \frac{1}{R_5}\right) = \frac{V_0}{R_5}$

$V = V_0\left(\frac{R_4 R_5}{R_4 + R_5}\right) \cdot R_5 = V_0\left(\frac{R_4}{R_4 + R_5}\right)$

$\therefore -R_2\left(\frac{V_1}{R_1} + \frac{V_0}{R_3}\right) = V_0\left(\frac{R_4}{R_4 + R_5}\right)$

$-\frac{R_2}{R_1}V_1 - \frac{R_2}{R_3}V_0 = V_0\left(\frac{R_4}{R_4 + R_5}\right)$

$-V_1 - V_0 = 0.25V_0$

$-V_1 = 1.25\,V_0$

$A_V = \frac{V_0}{V_1} = \frac{-1}{1.25} = -0.8$

Given $R_1 = 10\Omega$, $R_2 = 10\ \Omega$, $R_3 = 10\ \Omega$, $R_4 = 10\ \Omega$ and $R_5 = 30\ \Omega$.

- ○ Av= -2.25(V/V)
- ○ Av= 0.80(V/V)
- ● Av= -0.80(V/V)
- ○ Av= 2.25(V/V)

-0.6

$R_1 = 10$
$R_2 = 10$
$R_3 = 10$
$R_4 = 20$
$R_5 = 10$

$$-\frac{R_2}{R_1}V_1 - \frac{R_2}{R_3}V_0 = V_0\left(\frac{R_4}{R_4 + R_5}\right)$$

$$-\frac{10}{10}V_1 - \frac{10}{10}V_0 = V_0\left(\frac{20}{20 + 10}\right)$$

$$-V_1 - V_0 = \frac{2}{3}V_0$$

$$-V_1 = \frac{5}{3}V_0$$