Name: Ezaz Ahmed
ID : C223009 Section: 2AM

Assignment

Ex: 25.1 - A differential amplifier has an open-circuit voltage gain 100. The input signals are 3.25 V and 3.15V. Output voltage ?

Solution:

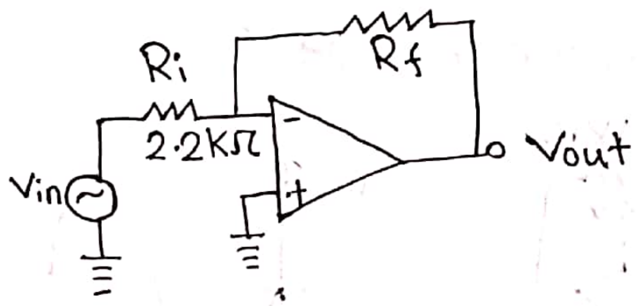
Output voltage, $V_o = A(V_1 - V_2)$

$= 100(3.25 - 3.15)$ [Given in the ques]

$\therefore V_o = 10V.$

Ans:

Ex: 25.25 - Given the OP-amp configuration. Determine the value of R_f required to produce a closed-loop voltage gain of -100.



Solution:

$A_{CL} = -\frac{R_f}{R_i}$ or, $R_f = -A_{CL} \cdot R_i$

$= -(-100).(2.2)$

$\therefore R_f = 220 K\Omega$

Ans:

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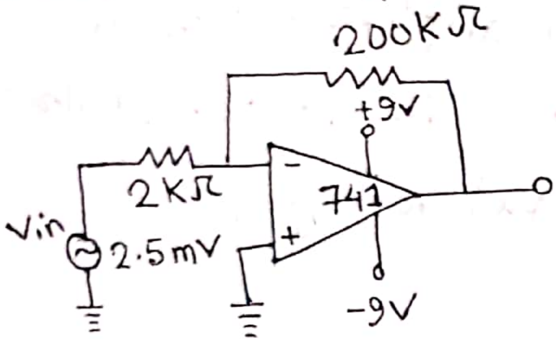
Ex: 25.26-

Output voltage ?



Solution:

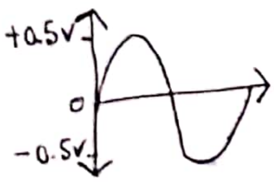
$$A_{CL} = -\frac{R_f}{R_i} = -\frac{200K\Omega}{2K\Omega} = -100$$

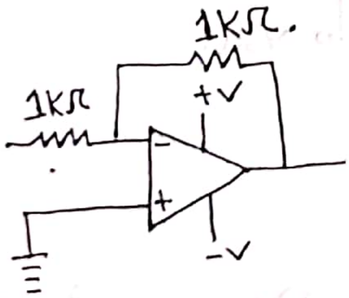
$$V_{out} = A_{CL} \times V_{in} = (-100) \times (2.5\,mV) = -250\,mV$$

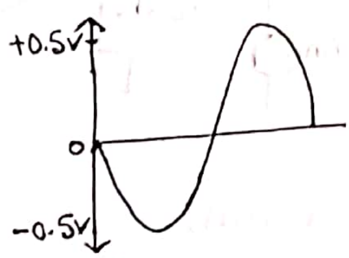
$$\therefore V_{out} = -0.25\,V$$

Ans:

Example: 25.2~~7~~- output voltage ?







Solution: $A_{CL} = -\frac{R_f}{R_i} = -\frac{1K\Omega}{1K\Omega} = -1$

As A_{CL} is -1 the output will have the same amplitude but with 180° phase inversion.

Ans:

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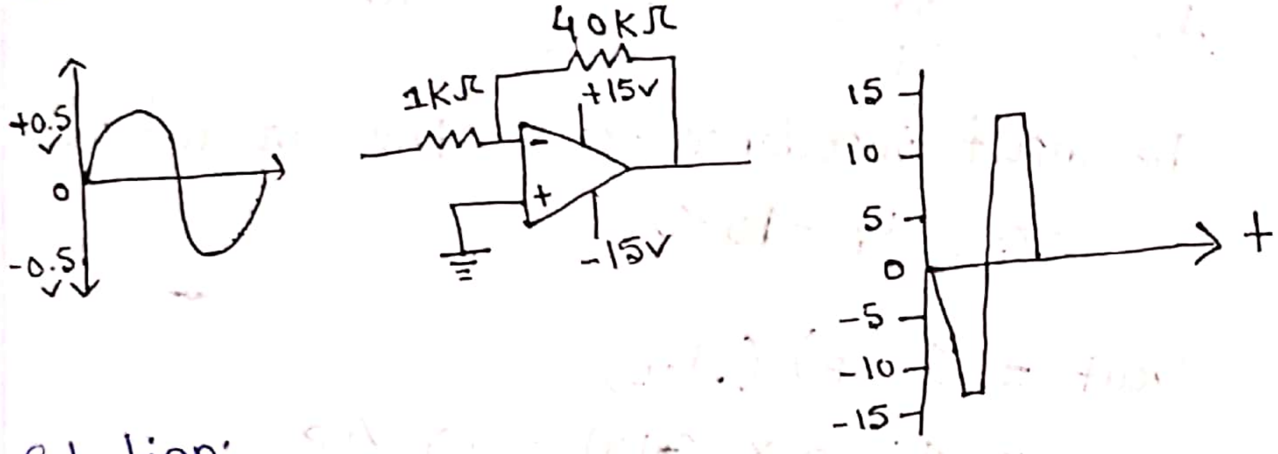
Ex: 28: Output voltage?

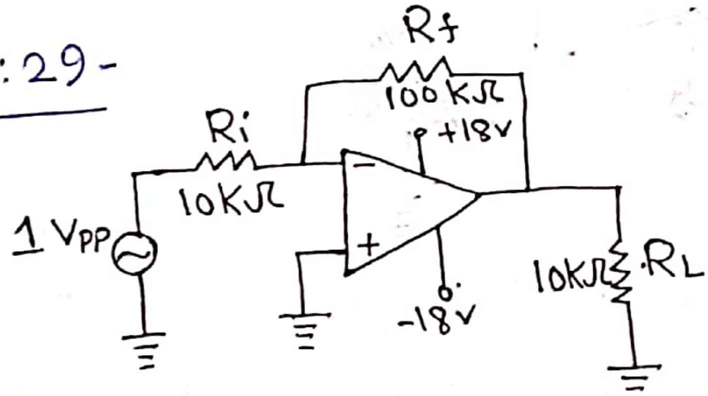


Solution:

$$A_{CL} = -\frac{R_f}{R_i} = -\frac{40K\Omega}{1K\Omega} = -40$$

Since supply voltages are ±15 V the saturation occurs at ±13 V. Since the output voltage far exceeds the saturation level, the OP-amp will be driven to deep saturation and it will behave as a non-linear amplifier. This means the output will not have the same shape as input but will clip at the saturation voltage. Note that 180° phase inversion does occur.

Ex: 29-



Find:

(i) closed-loop voltage gain (ii) input impedence of the circuit (iii) maximum operating frequency. Slew rate 0.5 V/μs

Solution:

(i) $A_{CL} = -\frac{R_f}{R_i} = -\frac{100K\Omega}{10K\Omega} = -10$

(ii) The input impedance Z_i of the circuit is:

$$Z_i \simeq R_i = 10\,K\Omega$$

(iii) $V_{out} = (1\,V_{PP})\,(A_{CL})$

$$= 1\,V_{PP} \times (-10) = 10\,V_{PP}$$

Peak output voltage is,

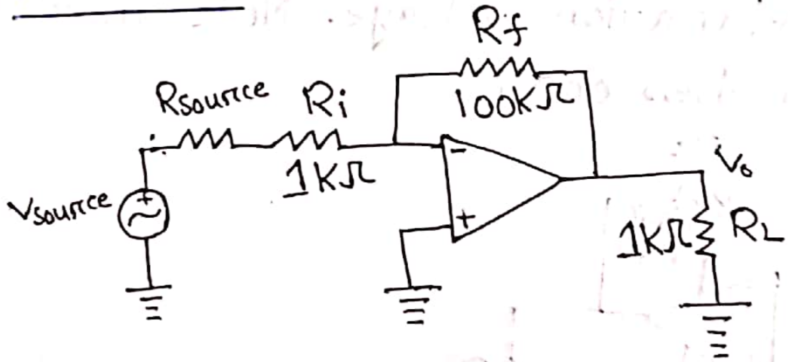
$$V_{PK} = 10/2 = 5V$$

$$\therefore f_{max} = \frac{\text{Slew rate}}{2\pi V_{PK}} = \frac{0.5V/\mu s}{2\pi \times 5}$$

$$= \frac{500\,KHz}{2\pi \times 5} = 15.9\,KHz$$

Ans:

Ex: 25.31-



Inverting OP-amp. Find the closed loop gain if (i) $R_{source} = 0\Omega$ (ii) $R_{source} = 1\Omega$

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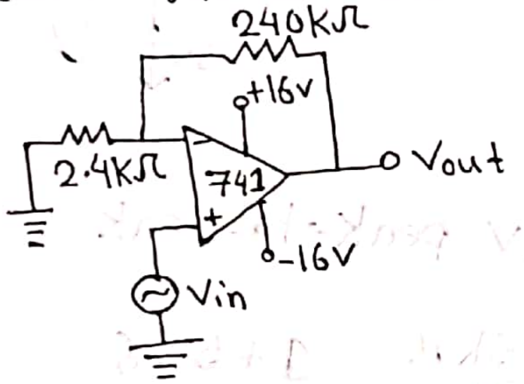
Solution:

(i) When $R_{source} = 0\Omega$; $A_{CL} = -\frac{R_f}{R_i} = -\frac{100k\Omega}{1k\Omega} = -100$

(ii) When $R_{source} = 1k\Omega$; $A_{CL} = -\frac{R_f}{R_{source} + R_i} = -\frac{100k\Omega}{1k\Omega + 1k\Omega} = -50$

Example: 25.32 -

output voltage from non-inverting amplifier circuit for an input of $120\ \mu V$



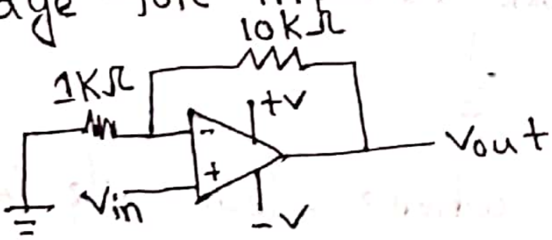
Solution:

$A_{CL} = 1 + \frac{R_f}{R_i} = 1 + \frac{240k\Omega}{2.4k\Omega} = 1 + 100 = 101$

$V_{out} = A_{CL} \times V_{in} = (101) \times (120\ \mu V) = 12.12\ mV$

Ex: 25.33 -

non-inverting amplifier circuit find output voltage for input voltage of (i) 1V (ii) -1V



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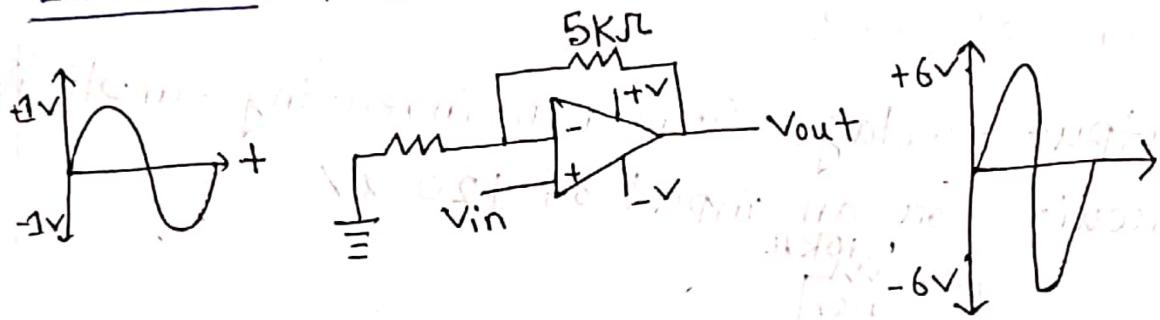
Solution:

(i) For $V_{in} = 1V$; $V_{out} = A_{CL} \times V_{in} = 11 \times 1V = 11V$

(ii) For $V_{in} = -1V$; $V_{out} = A_{CL} \times V_{in} = 11 \times (-1V) = -11V$

Ex-25.34: Peak-to-peak output voltage ?



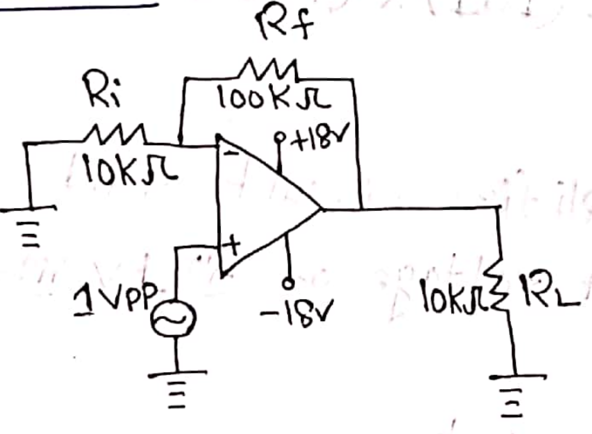
Solution:

The input signal is 2V peak-to-peak

$$A_{CL} = 1 + \frac{R_f}{R_i} = 1 + \frac{5K\Omega}{1K\Omega} = 1 + 5 = 6$$

Peak-to-peak output voltage $= 6 \times 2 = 12V$

Ex-25.35:



(i) $A_{CL} = ?$ (ii) f_{max} where slew rate is $0.5\ V/\mu s$

Solution:

(i) $A_{CL} = 1 + \frac{R_f}{R_i} = 1 + \frac{100K\Omega}{10K\Omega} = 1+10 = \underline{11}$

(ii) $V_{out} = A_{CL} \times V_{in}$

$= 11 \times (1\,V_{PP}) = 11\,V_{PP}$

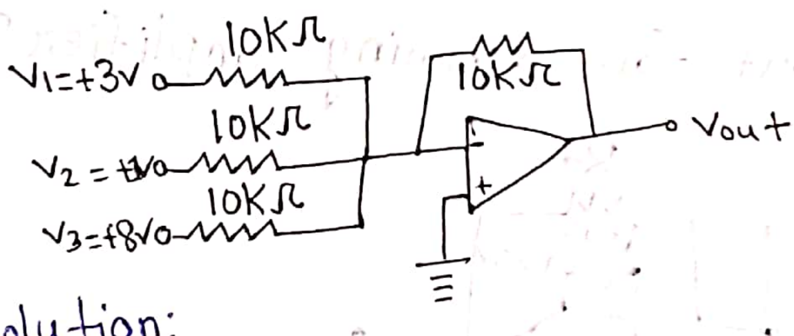
$V_{PK} = 11/2 = 5.5V$

$f_{max} = \frac{0.5V/\mu s}{2\pi \times 5.5} = 14.47\ KHz$ $[\because 0.5V/\mu s = 500\ KHz]$

$\therefore f_{max} = 14.47\ KHz$

Ex
25.44:

output voltage for summing amplifier?



Solution:

$V_{out} = -(V_1+V_2+V_3) = -(3+1+8) = -12\,V$

Ans:

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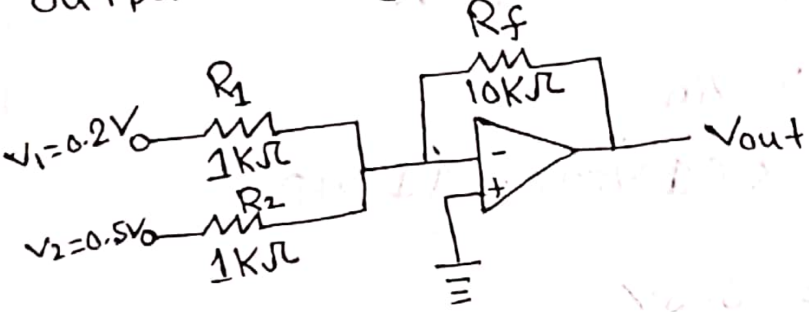
Ex: 25.45- output voltage for summing amplifier?



Solution:

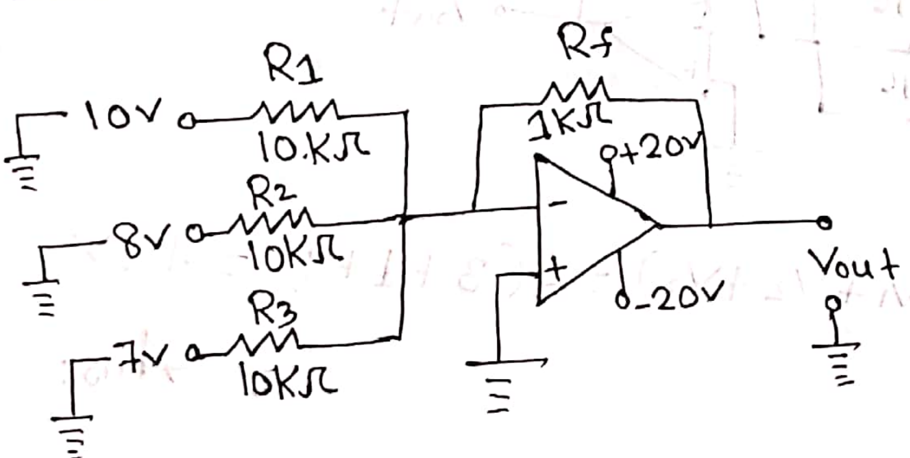
$R_f = 10K\Omega$, $R_1 = R_2 = R = 1K\Omega$

gain of the amplifier $= -\frac{R_f}{R} = \frac{-10K\Omega}{1K\Omega} = -10$

Now, $V_{out} = -\frac{R_f}{R}(V_1+V_2) = -\frac{10K\Omega}{1K\Omega}(0.2+0.5)$

$= -7V$

Ex: 25.46- Vout for summing amplifier?



Solution:

gain of amplifier $= -\frac{R_f}{R} = \frac{-1K\Omega}{10K\Omega} = -\frac{1}{10}$

$$V_{out} = -\frac{R_f}{R}(V_1 + V_2 + V_3)$$

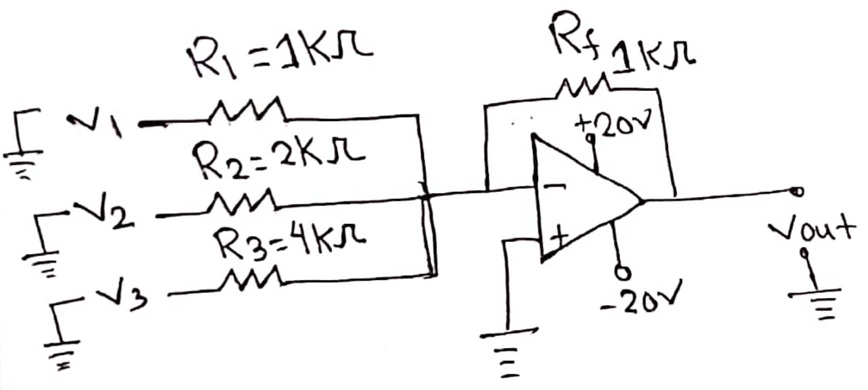
$$\therefore V_{out} = -\frac{1k\Omega}{10k\Omega}(10+8+7) = -2.5V$$

<u>Ans:</u>

Ex: 25.48:

Vout for each combinations -

V_1	V_2	V_3
+10	0	+10
0	+10	+10
+10	+10	+10



Solution:

$$V_{out} = -\left(\frac{1K\Omega}{1K\Omega}V_1 + \frac{1K\Omega}{2K\Omega}V_2 + \frac{1K\Omega}{4K\Omega}V_3\right)$$

$$V_{out} = -(V_1 + 0.5V_2 + 0.25V_3)$$

for first set, $V_{out} = -(10 + 0.5\times0 + 0.25\times10)$
$= -12.5V$

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for second set, Vout $= -(0 + 0.5\times10 + 0.25\times10)$

$= -7.5V$

for third set, Vout $= -(10 + 0.5\times10 + 0.25\times10)$

$= -17.5\,V$

<u>Ans:</u>

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