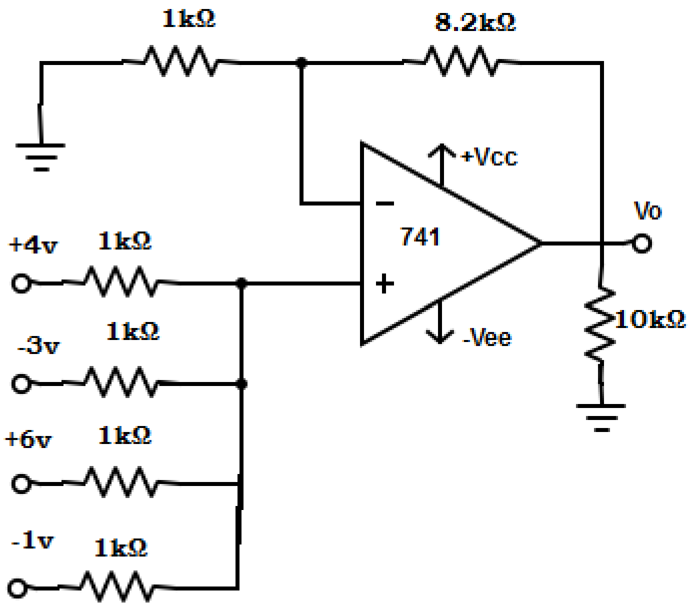
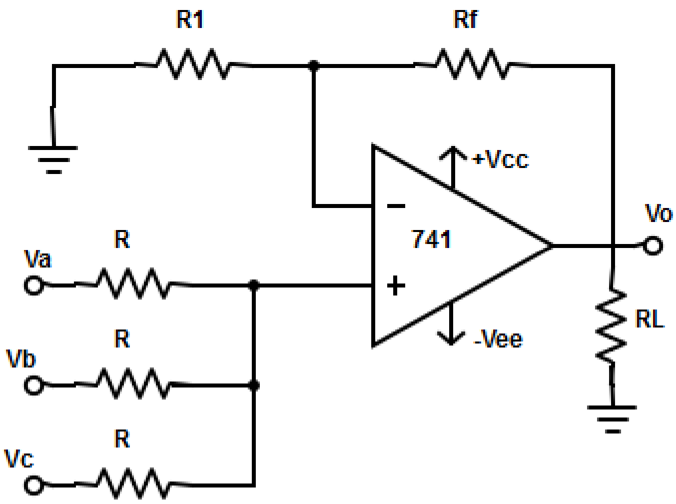
1.Find the value of V_1 in the circuit shown below?



Using the superposition theorem the voltage V_1 at non-inverting terminal is $V_1 = V_a/4 + V_b/4 + V_c/4 + V_d/4 = [V_a + V_b + V_c + V_d]/4 = [4+(-3v)+6v+(-1v)]/4 = 1.5v$.

2. In the circuit shown, supply voltage = ±15v, V_a= +3v , V_b= -4v , V_c= +5v, R= R_1= 1kΩ and R_F= 2kΩ. 741 op-amp has A= 2×10^5 and R_1= 10kΩ. Determine the output voltage internal resistance of the circuit?

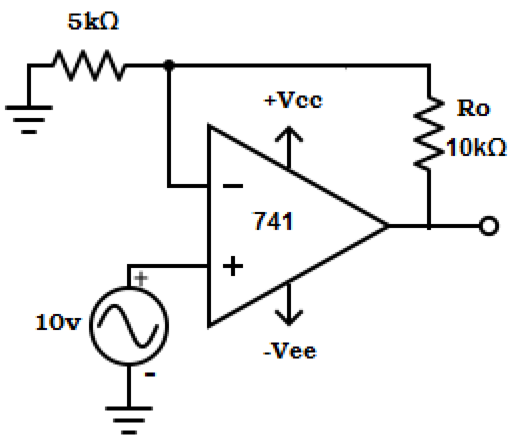


The output voltage $V_o = [1 + (R_F/R_1)] \times [(V_a+V_b+V_c/3)] = [1+(2k\Omega/1k\Omega)] \times[(3-4+5)/3] = 2.67 \cong 3v$.
Internal resistance of circuit, $R_{iF} = R_i\,[A\times R_1/(R_1+R_F)] = 100\Omega\times[(200000\times1k\Omega)/(1k\Omega+2k\Omega)]$
=> R_{iF}= 6.67 MΩ.

3. Consider the entire resistors in the bridge circuit are equal. The resistance and change in resistance are given as 3kΩ and 30kΩ. Calculate the output voltage of differential instrumentation amplifier?

The output voltage of the circuit is $V_o = -(R_F/R_1)\times(\triangle R/R)\times V_{dc}$
$= (5.5k\Omega/100\Omega)\times(30k\Omega/3k\Omega)\times 3 = 1.65v$

4. Given voltage to current converter with floating load. Determine the output current?

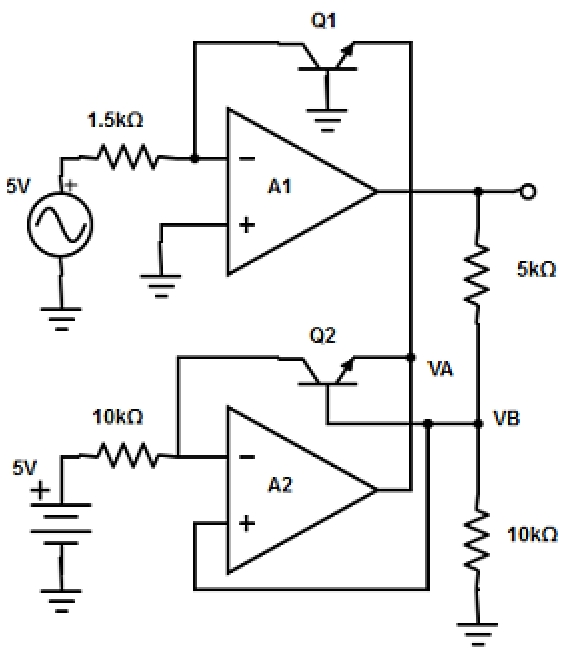


Output current, $I_o = V_{in} / R_1 = 10/5k\Omega = 2mA$.

5. Find the gain of the voltage to current converter with grounded load?

In voltage to current converter with grounded load all resistor must be equal in value.
∴ Gain $= V_o/V_{in} = [1+(R_F/R_1)] = 1+R/R = 1+1=2$.

6. Calculate the base voltage of Q_2 transistor in the log-amp using two op-amps?

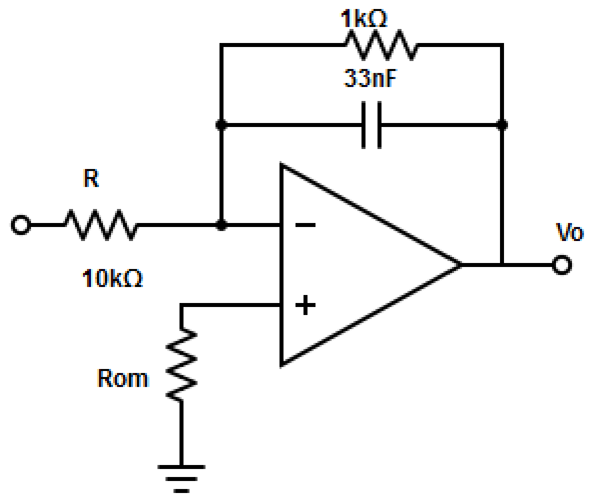


The base voltage of Q_2 transistor, $V_B = [R_{TC} / (R_2 + R_{TC})] \times (V_i) = [10k\Omega/(5k\Omega+10k\Omega)] \times 5v = 3.33v$.

7. Calculate the phase difference between two input signals applied to a multiplier, if the input signals are $V_x = 2\sin\omega t$ and $V_y = 4\sin(\omega t+\theta)$. (Take $V_{ref} = 12v$).

$V_o = [V_{mx} \times V_{my} / (2 \times V_{ref})] \times \cos\theta$
=> $(V_o \times 2 \times V_{ref}) / (V_{mx} \times V_{my}) = \cos\theta$
=> $\cos\theta = (10 \times 2 \times 12)/(2 \times 4) = 30$.
=> $\theta = \cos^{-1}30 = 1.019$.

8. Determine the lower frequency limit of integration for the circuit given below.



The lower frequency limit of integration, $f = 1/(2\pi R_F C_F) = 1/(2\pi \times 1k\Omega \times 33nF) = 4.82kHz$.

9. A sine wave of $1v_{peak}$ at 1000Hz is applied to a differentiator with the following specification: $R_F = 1k\Omega$ and $C_1 = 0.33\mu F$, find the output waveform?

Given, $V_{in} = V_p \times \sin\omega t = \sin(2\pi \times 1000)t$
The output of differentiator $V_o = -R_F \times C_1 \times (dV_{in}/dt) = (1k\Omega) \times (0.33\mu F) \times d[\sin 2\pi \times 1000t]/dt$
$= -3.3 \times 10^{-4} \times 2\pi \times 1000 \times [\cos 2\pi(1000)t] = -2.07 \times [\cos 2\pi(1000)t]$.

10. Calculate the frequency of oscillation for RC phase shift oscillator having the value of R and C as 35Ω and 3.7μF respectively.

The frequency of oscillation of RC phase shift oscillator is,
$f_o = 1/(2\pi RC\sqrt{6}) = 1/(2 \times 3.14 \times \sqrt{6} \times 3.7\mu F \times 35\Omega)$
=> $f_o = 1/ 1.9921 \times 10^{-3} = 502Hz$.

11. Calculate the value of capacitance in wein bridge oscillator, such that $f_o = 1755Hz$ and $R = 3.3k\Omega$.

The frequency of oscillation is given as $f_o = 0.159/RC$
=> $C = 0.159/R \times f_o = 0.159/3.3k\Omega \times 1755Hz$
=> $C = 0.027\mu F = 0.03\mu F$.

12. . What will be the frequency of output waveform of a square wave generator if $R_2 = 1.16\ R_1$?

When $R_2 = 1.16\ R_1$, then $f_o = 1/2RC \times \ln[\ (2R_1 + R_2) / R_2] = 1/2RC \times \ln\ [(2R_1 + 1.161R_1\ )/(1.161R_1)] = 1/(\ 2RC \times \ln 2.700) = 1/2RC$.

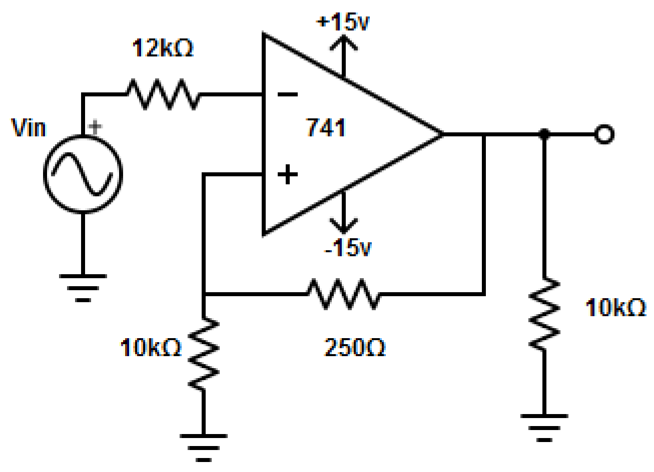
13. A square wave oscillator has f_o =1khz. Assume the resistor value to be 10kΩ and find the capacitor value?

Let's take $R_2 = 1.16\ R_2$, therefore the output frequency $f_o = 1/2RC$
=> $C = 1/2Rf_o = 1/\ (2\times 10k\Omega \times 1khz) = 0.05\mu F$.

14. Find the capacitor value for a the output frequency, f_o = 2kHz & $V_O(pp)$ = 7v, in a triangular wave generator. The op-amp is 1458/741 and supply voltage = ±15v. (Take internal resistor=10kΩ)

Given, V_{sat} =15v
∴ $V_O(pp) = (2R_2/R_3) \times V_{sat}$
=> $R_2 = (V_O(pp) \times R_3) / (V_{sat}\times 2) = [7/(2\times 15)]\times R_3 = 0.233R_3$
∵ Internal resistor, $R_2 = R_1 = 10k\Omega$
=> $R_3 = 0.233\times 10k\Omega = 2.33k\Omega$.
So, the output frequency $f_O = R_3 / (\ 4\times R_1\ \times C_1\times\ R_2)$
=> $2khz = 2.33khz/\ (4\times 10k\Omega\ \times 10k\Omega\times C_1)$
=> $C_1 = 2.33k\Omega\ /\ (8\times 10^{-11}) = 2.9\ \times 10^{-9} \cong 3nF$.

14. Determine the upper and lower threshold voltage



Upper threshold voltage, $V_{UT} = [R_1/(R_1+ R_2)]\times (+V_{sat}) = [10k\Omega/(10k\Omega\ +250\Omega)]\times(+15v)$= +14.63v.
Lower threshold voltage $V_{LT} = [R_1/(R_1+ R_2)]\times(\ -V_{sat}) = [10k\Omega\ /(10k\Omega+250\Omega)]\times(-15v)$= -14.63v.

15. Calculate the hysteresis voltage for the schmitt trigger from the given specification: R_2 =56kΩ , R_1 = 100Ω ,V_{ref} = 0v & V_{sat} = ±14v

Upper threshold voltage, V_{UT} =[R_1/(R_1+R_2)]×(+V_{sat}) = [100kΩ/(56kΩ +100 Ω)]×(+14v)= +25mv.
Lower threshold voltage V_{LT} = [R_1/(R_1+ R_2)]×(-V_{sat}) = [100kΩ /(56kΩ+100Ω)]×(-14v)= -25 mv.
∴ Hysteresis voltage = V_{UT}-V_{LT} = 25-(-25) = 50mv.

16. A monostable multivibrator has R = 120kΩ and the time delay T = 1000ms, calculate the value of C?

Time delay for a monostable multivibrator, T = 1.1RC
=> C = T/(1.1R) = 1000ms/(1.1×120kΩ) = 7.57μF.

17. Astable multivibrator operating at 150Hz has a discharge time of 2.5m. Find the duty cycle of the circuit.

Given f=150Hz.Therefore,T=1/f =1/150 =6.67ms.
∴ Duty cycle, D%=(t_{Low}/T) x 100% = (2.5ms/6.67ms)x100% = 37.5%.

18. Calculate the value of external timing capacitor, if no modulating input signal is applied to VCO. Consider f_o=25 kHz and R_T=5 kΩ.

When modulating input signal is not applied to VCO, the output frequency becomes f_o=1/(4×R_T×C_T)
=> C_T =1/(4×R_T×f_o) =1/(4×5kΩ×25kHz) = 2×10^{-9} =2nF.

19. Calculate the voltage to frequency conversion factor, where f_o=155Hz and V_{cc}=10V.

The voltage to frequency conversion factor, K_v = △f_o/△V_{cc}= 8×f_o/V_{cc} = (8×155)/10=124.

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