EECS2210: Electronic Circuits & Devices

Lab #4

BJT AC Characteristics

Lab 4 prelab

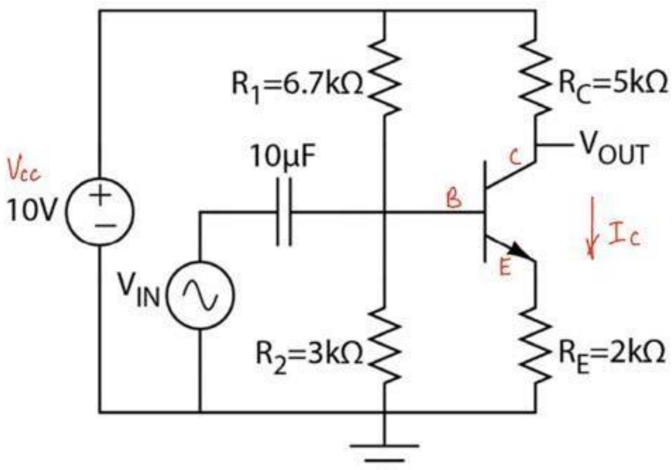


Figure 1

1.] $V_{cc} = 10V$ $\quad R_E = 2k\Omega$

$R_1 = 6.7k\Omega \quad \beta = 200$

$R_2 = 3k\Omega \quad V_{BE} = 0.7V$

$R_C = 5k\Omega$

$$V_B = V_{cc} \times \frac{R_2}{R_1 + R_2} = 10V \times \frac{3k\Omega}{6.7k\Omega + 3k\Omega} = 3.09V$$

$$V_E = V_B - V_{BE} = 3.09V - 0.7V = 2.39V$$

$$I_E = \frac{V_E}{R_E} = \frac{2.39V}{2k\Omega} \approx 1.2mA$$

$$I_E \approx I_c = 1.2mA$$

$$V_{CE} = V_{cc} - I_c R_c - I_E R_E$$

$$= 10V - (1.195mA \times 5k\Omega) - (1.195mA \times 2k\Omega)$$

$$= 10V - 5.975V - 2.39V$$

$$\approx 1.635V$$

$$I_B = \frac{I_C}{\beta} = \frac{1.2mA}{200} = 0.006mA$$

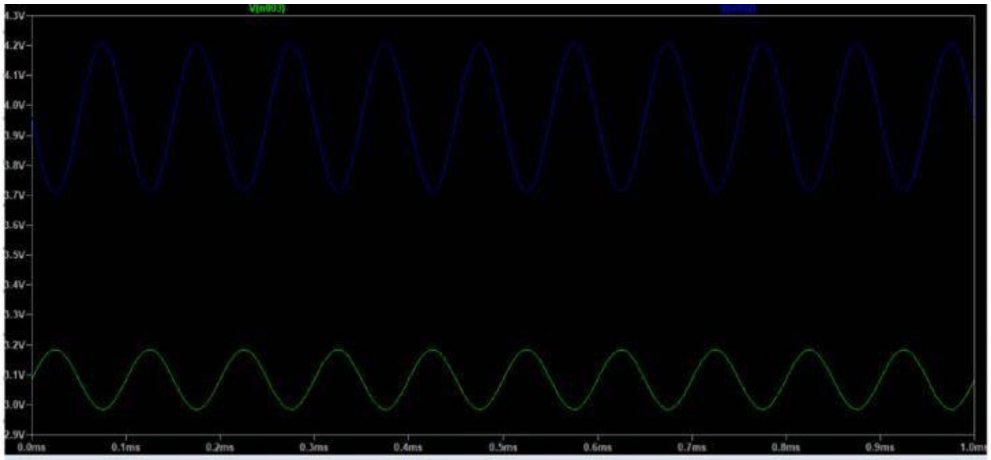
Q2] $$g_m = \frac{I_c}{V_T} = \frac{1.195mA}{25mV} = 47.8 mA/V$$

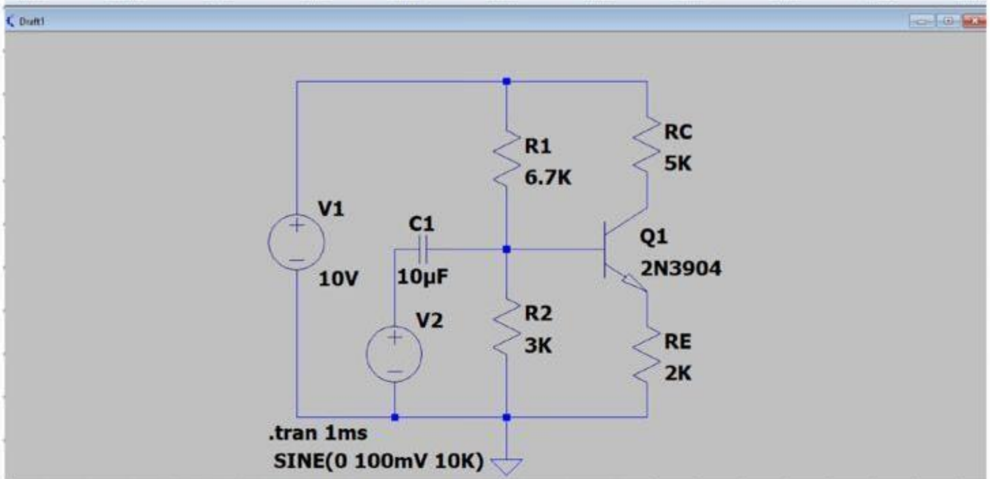
$$r_\pi = \frac{\beta}{g_m} = \frac{200}{47.8mA/V} \approx 4.2k\Omega$$

$$A_v = \frac{-g_m R_c}{g_m R_E + 1} \approx \frac{R_c}{R_E} \approx 2.5$$

, When apply 100mV to input, $V_{out} = 250mV$ ∴ the gain is 2.5.

Q3]





--- Operating Point ---

V(n003):	3.08449	voltage
V(n001):	10	voltage
V(n002):	3.95902	voltage
V(n005):	2.4244	voltage
V(n004):	0	voltage
Ic(Q1):	0.0012082	device_current
Ib(Q1):	4.00434e-06	device_current
Ie(Q1):	-0.0012122	device_current
I(C1):	-3.08449e-17	device_current
I(R2):	0.00102816	device_current
I(Rc):	0.0012082	device_current
I(Re):	0.0012122	device_current
I(R1):	0.00103217	device_current
I(V1):	-0.00224036	device_current
I(V2):	3.08449e-17	device_current

Q4] To increase the gain, we know the formula for gain is $A_V = \frac{R_C}{R_E}$
in this case we can increase R_C and decrease R_E, but it needs to be within the limit.

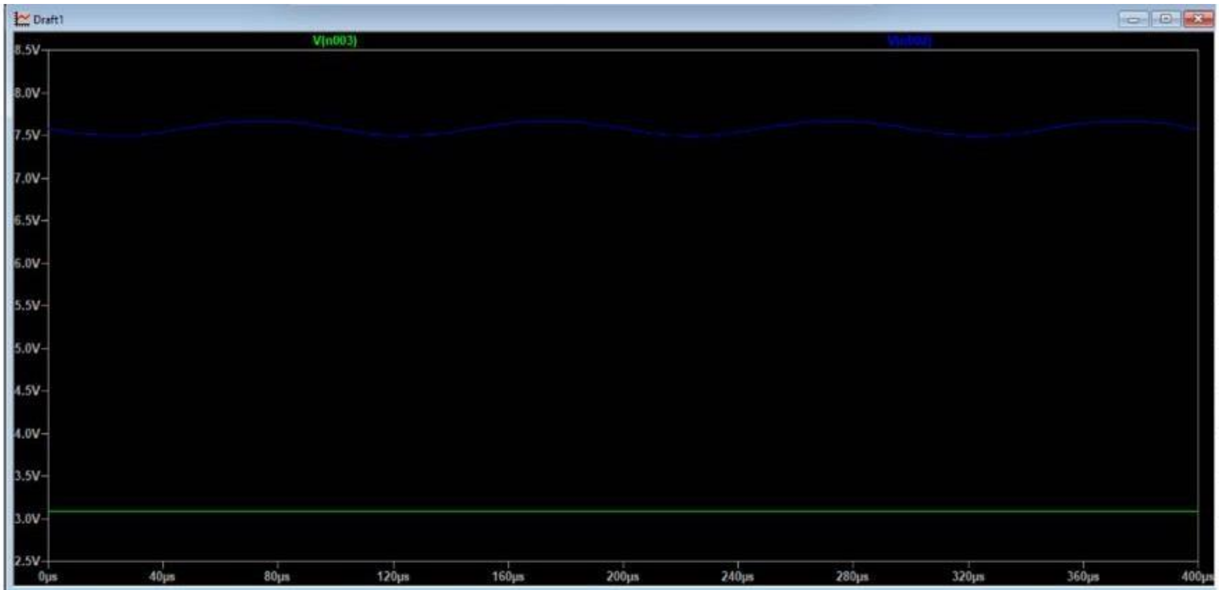
Q5] power consumption $= [I_1 \times V_{CC}] + [I_C \times V_{CC}]$

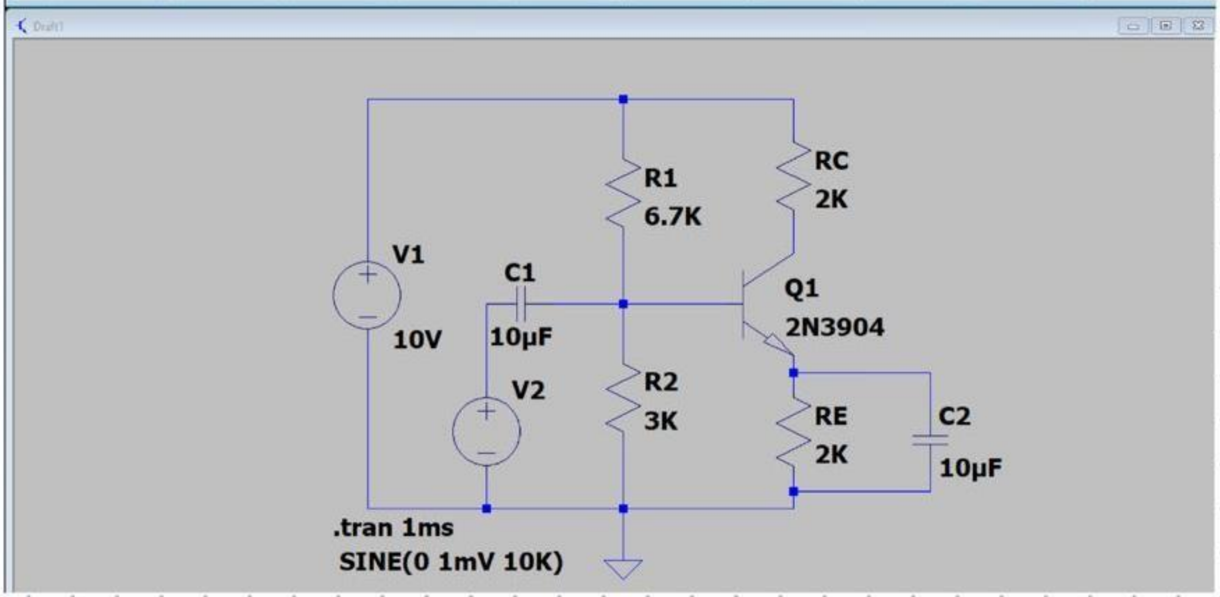
The max power consumption is 30mW, $I_1 \times V_{CC} \approx 10mW$

$I_C \times V_{CC} = 20mW$, $I_C = \frac{20 \times 10^{-3}}{10} = 2mA$

$g_m = \frac{I_C}{V_T} = \frac{2\,mA}{26\,mV} = 76.92\,mA/mV$

Q6-Q7





--- Operating Point ---

V(n003):	3.08477	voltage
V(n001):	10	voltage
V(n002):	7.58215	voltage
V(n004):	2.42559	voltage
V(n005):	0	voltage
Ic(Q1):	0.00120893	device_current
Ib(Q1):	3.86745e-06	device_current
Ie(Q1):	-0.00121279	device_current
I(C1):	-3.08477e-17	device_current
I(C2):	2.42559e-17	device_current
I(R2):	0.00102826	device_current
I(Rc):	0.00120893	device_current
I(Re):	0.00121279	device_current
I(R1):	0.00103212	device_current
I(V1):	-0.00224105	device_current
I(V2):	3.08477e-17	device_current

$(-g_m R_c) = A_v$

$160 = (-76.92\,mS\, R_c)$

$R_c \cong 2k$ and I choose to stick with $R_E = 2k$

but I end up getting 90 as the gain not 160,

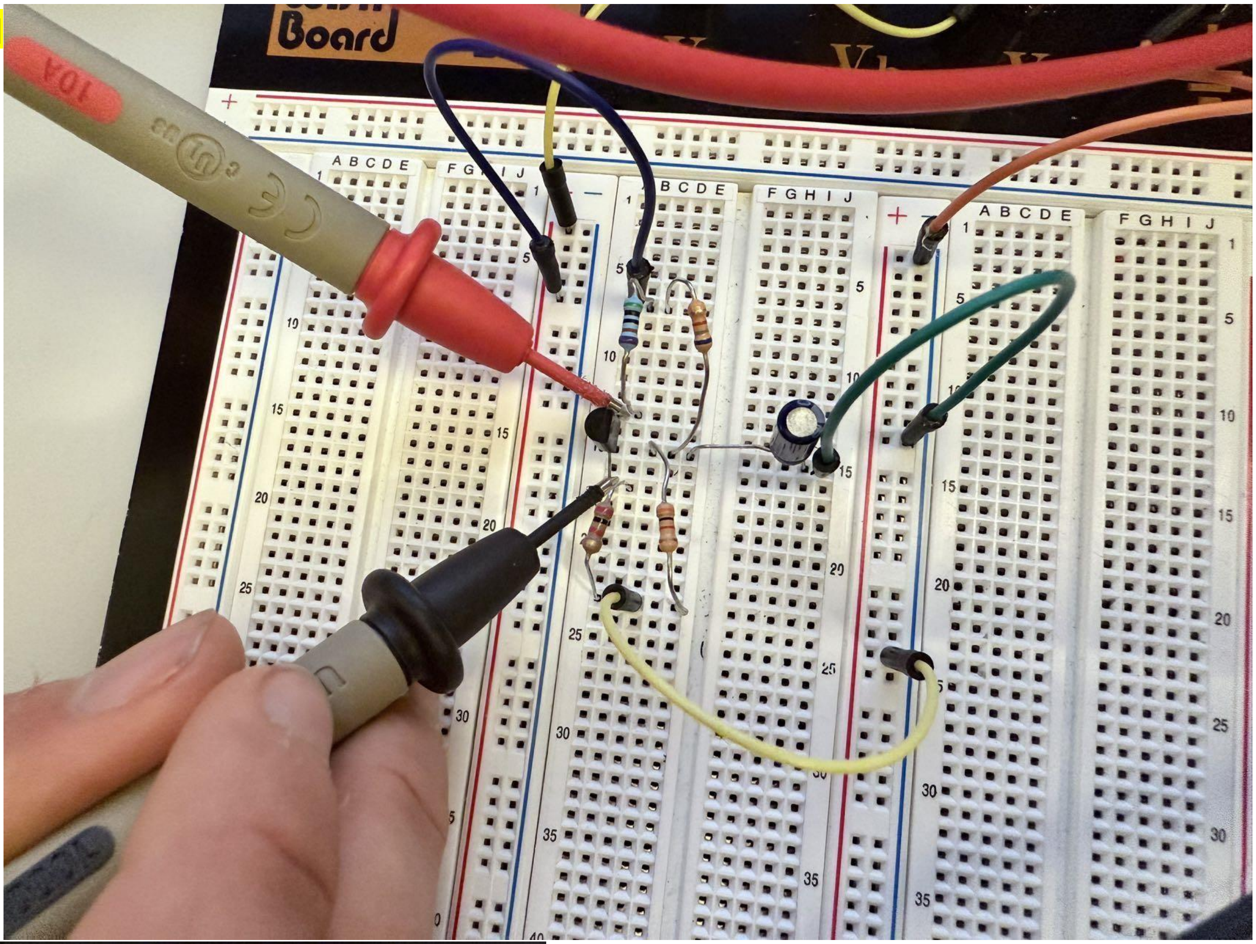
so, I increased the R_E by a bit. up to $2.3k\Omega$ and finally I got 160 as my gain.

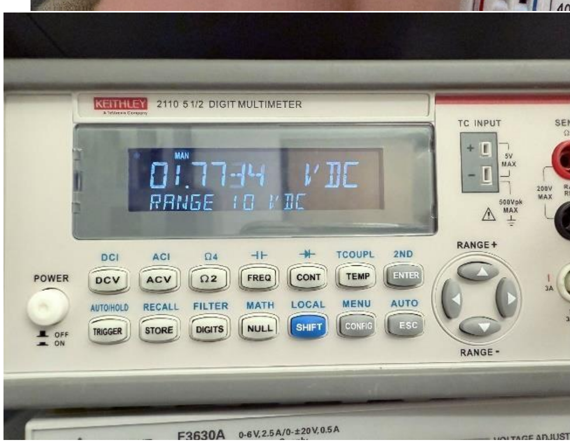
$6.5V - 4.9V = 1.6V$

$\frac{1.6V}{0.01} = 160 = $ gain

Lab Experiments

1]





2-3] The transistor is in the active/linear region if Vce>Vbe. If we assume that Vbe is 0.7V. Vce=1.77V > Vbe=0.7V therefore, the transistor is operating in the active region.

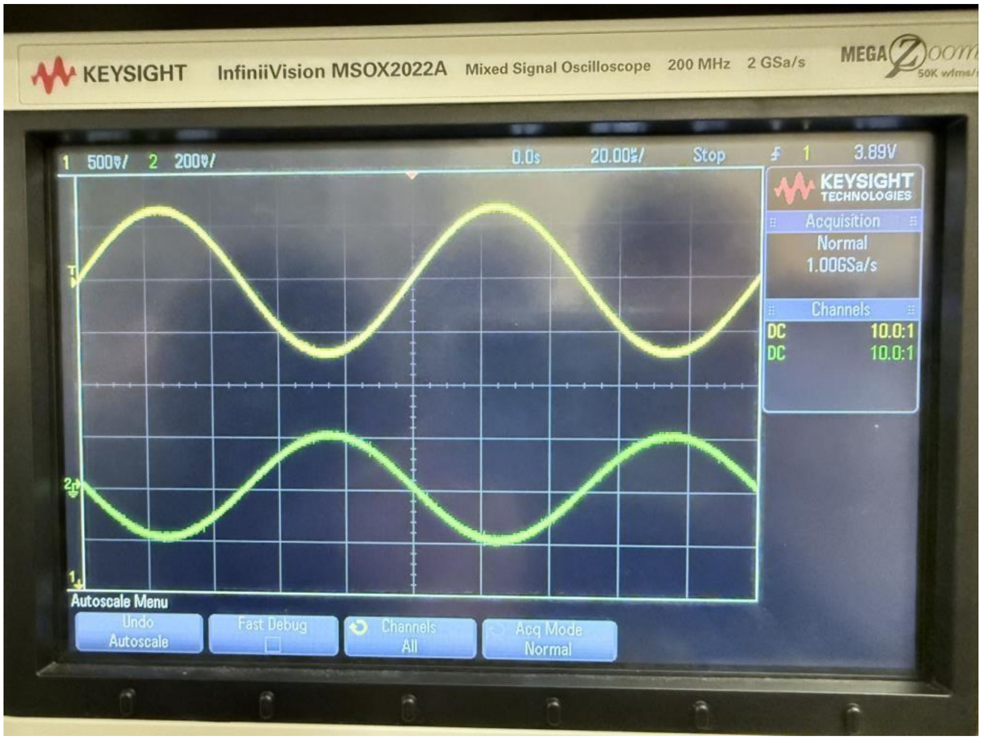
$$\beta = \frac{Ic}{Ib} = \frac{1.206mA}{0.005mA} = 241.2$$

$Ic \quad 1.206mA \qquad mA$

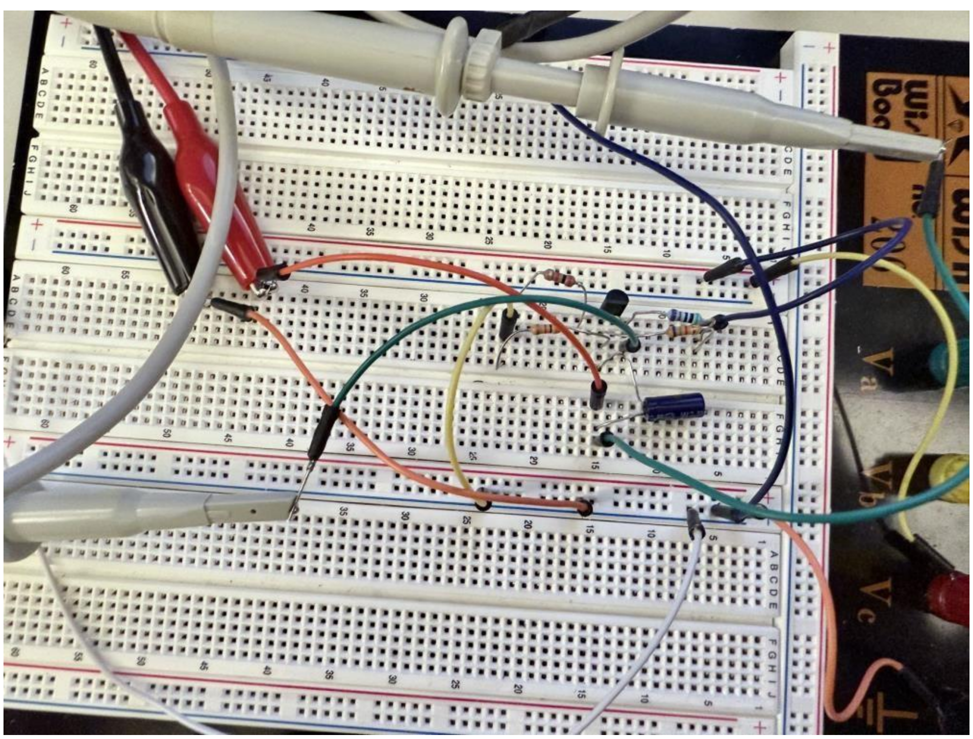
$$gm = \frac{}{VT} = \frac{}{25mV} = 48.24\frac{}{V}$$

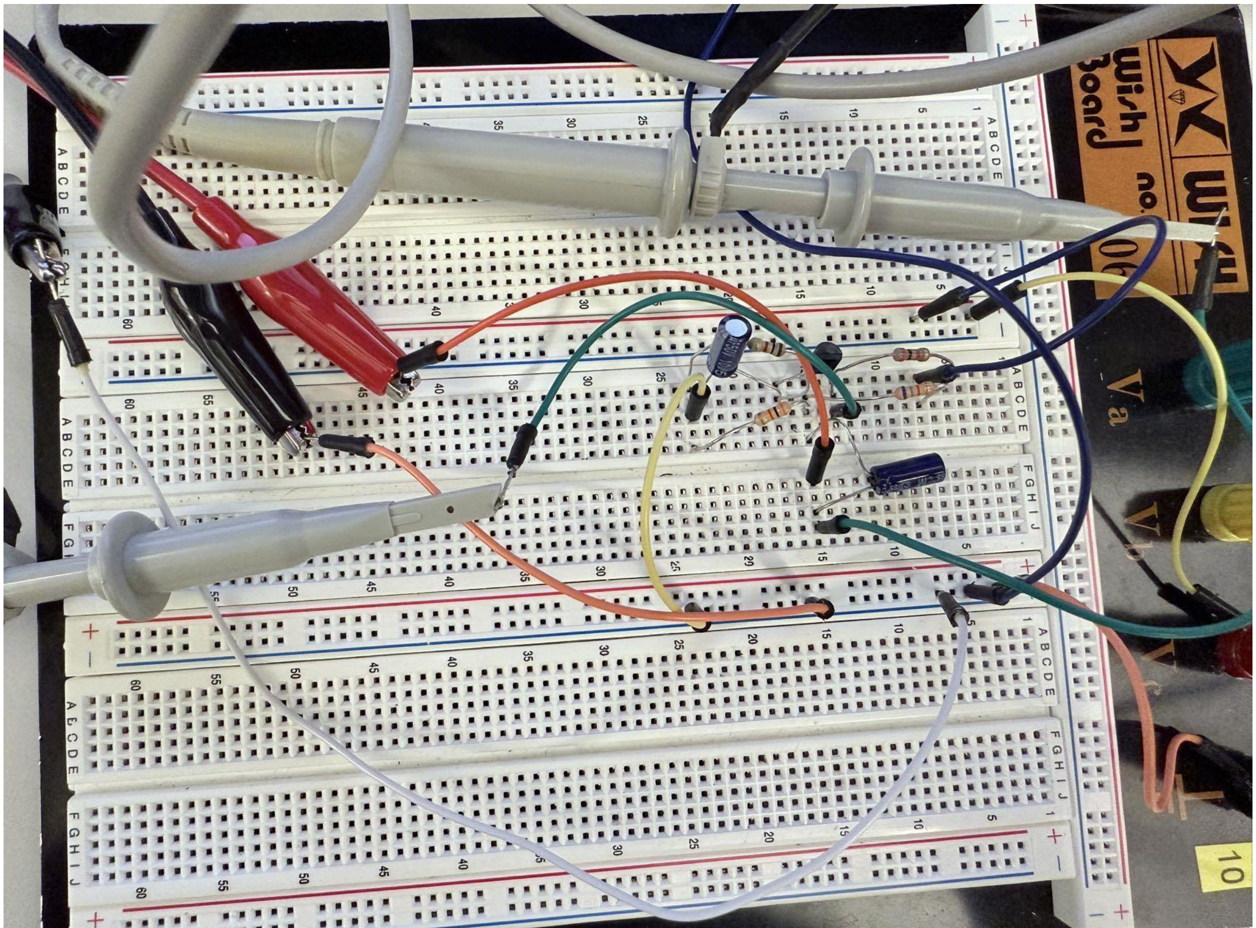
$$r_{\pi} = \frac{\beta}{gm} = \frac{241.2}{48.24} = 5k\ ohms = r_{in}$$

4]



500-200 so the amplitude is 250-100





5]7] Our circuit, with the bypass capacitor and biasing resistors, It can improve the stability of higher AC gain and better signal isolation compared.