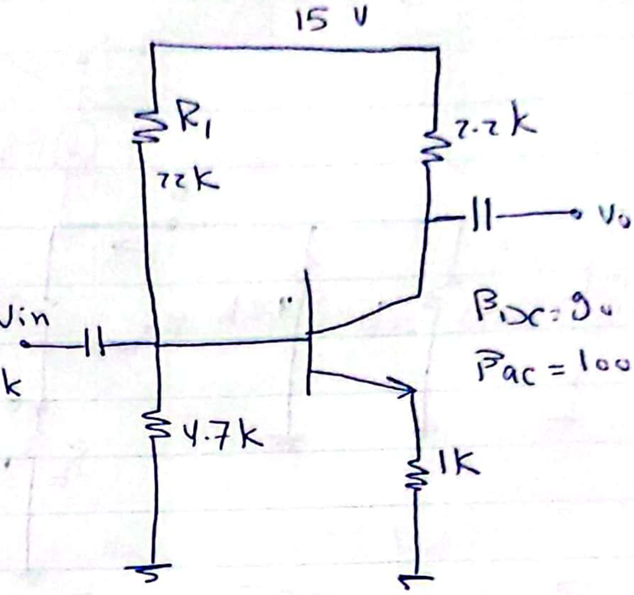
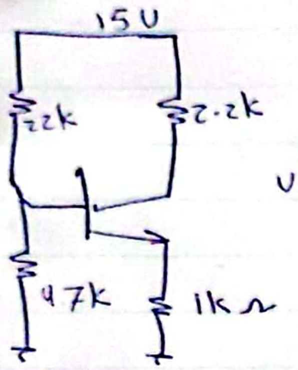
Sheet 1
Electronic circuits

(1)

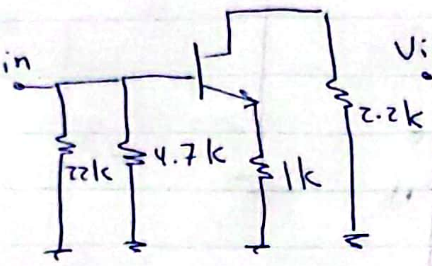


$\beta_{DC} = 90$
$\beta_{ac} = 100$

a



Dc equivalent



Ac equivalent

b

$$V_B = 15 \times \frac{4.7k}{4.7k + 22k} = 2.64\ V$$

$$V_E = 2.64 - 0.7 = 1.94\ V$$

$$I_E = \frac{1.94}{1k} = 1.94\ mA$$

$$I_C \simeq I_E = 1.94\ mA$$

$$V_C = 15 - 1.94mA[2.2k] = 11.6\ V$$

c

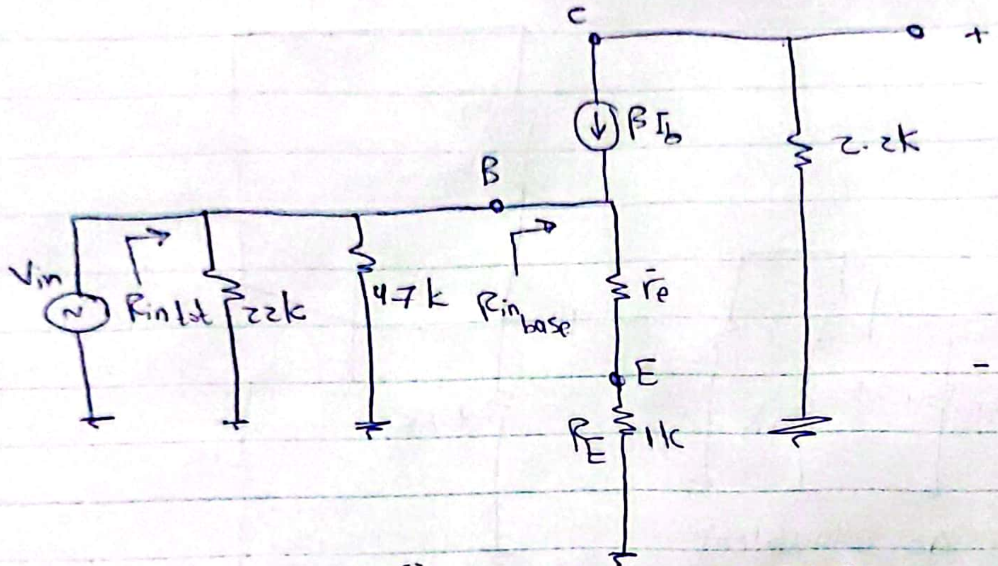
$$P_{diss} = V_{CC}\, I_{CC} \longrightarrow I_{R_1} + I_C = \frac{V_B}{4.7k} + 1.94mA$$

$$= 2.5mA$$

$$= 15 \times 2.5mA = 37.5\ mW$$

d $R_{in\,base}$ - $R_{in\,tot}$ - A_v

using r-Parameter model



$$R_{in\,base} = \beta_{ac}[\bar{r}_e + R_E] = 100\left[\frac{12.9}{1000}k\Omega + 1k\right] = 101\,k\Omega$$

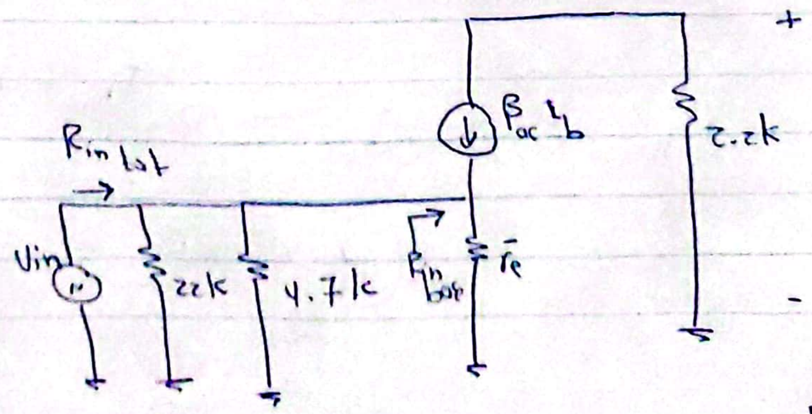
$$\frac{25mV}{I_E} = \frac{25mV}{1.94mA} = 12.9\ \Omega$$

$$R_{in\,tot} = R_{in\,base} \,//\, R_1 \,//\, R_2 = 101k \,//\, 22k \,//\, 4.7k$$

$$= 3.73\,k\Omega$$

$$A_v = -\frac{R_c}{\bar{r}_e + R_E} = \frac{-2.2k}{\frac{12.9}{1000} + 1k} = -2.17$$

e

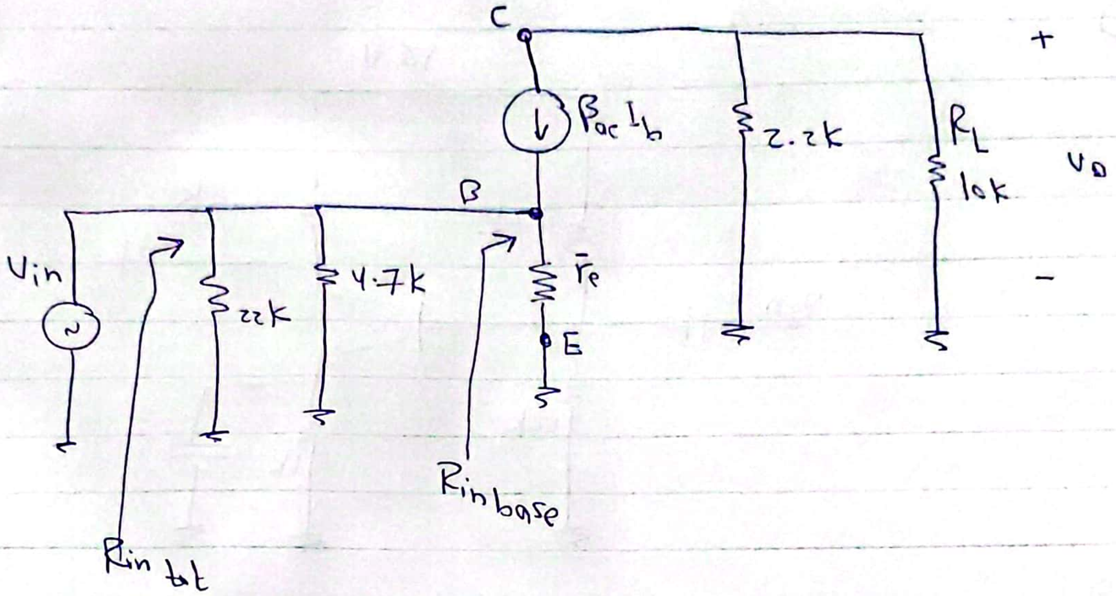


$$R_{in\,base} = \beta_{ac}\,\bar{r}_e$$
$$= 100(12.9\,\Omega)$$
$$= 1.29\,k\Omega$$

$$R_{in\,tot} = 1.29 \,//\, 22 \,//\, 4.7$$
$$= 968\ \Omega$$

$$A_v = \frac{-R_c}{\bar{r}_e} = \frac{-2.2k}{\frac{12.9}{1000}} = -171$$

f

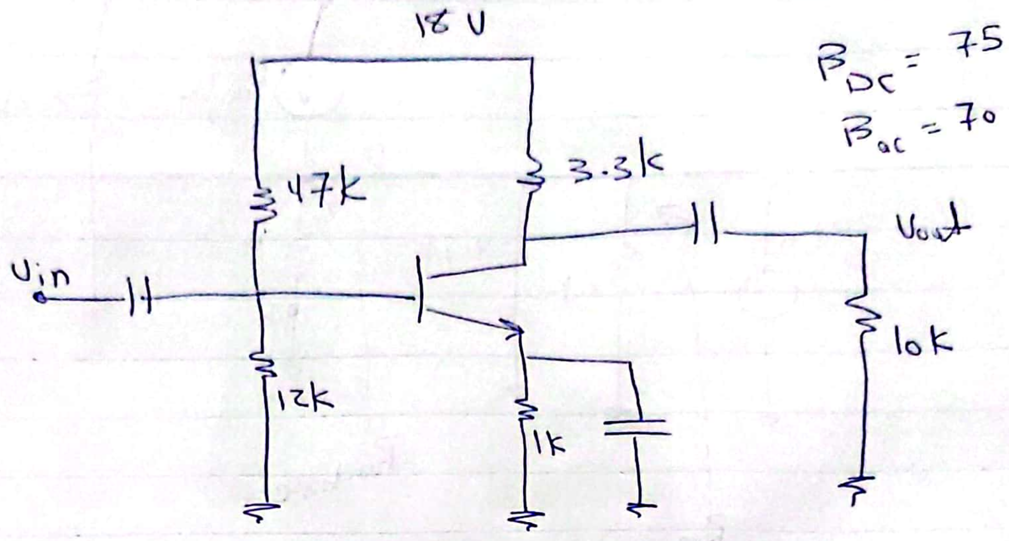


$$R_{in\,base} = \beta_{ac}\,\bar{r}_e = 100\,(12.9\,\Omega) = 1.29\,k\Omega$$

$$R_{in\,tot} = 1.29k \parallel 22k \parallel 4.7k = 968\,\Omega$$

$$A_V = -\frac{R_c \parallel R_L}{\bar{r}_e} = \frac{-2.2k \parallel 10k}{\frac{1.29}{1000}} = -140$$

(2)



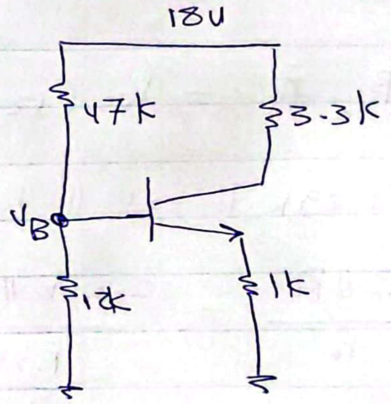
$\beta_{DC} = 75$

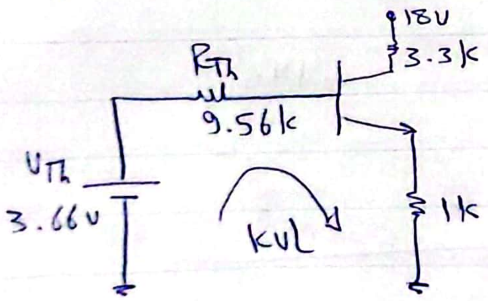
$\beta_{ac} = 70$

a

$V_{Th} = 18 * \dfrac{12k}{12k + 47k} = 3.66V$

$R_{Th} = 47k \,||\, 12k = 9.56k\Omega$





$V_{Th} - \dfrac{I_E}{\beta_{DC}} R_{Th} - 0.7 - I_E R_E = 0$

$I_E = \dfrac{V_{Th} - 0.7}{\dfrac{R_{th}}{\beta_{DC}} + R_E} = \dfrac{3.66 - 0.7}{\dfrac{9.56k}{75} + 1k} = 2.63 \, mA$

$V_E = 2.63 \, mA * 1k = 2.63 \, V$

$V_B = 2.63 + 0.7 = 3.76 \, V$

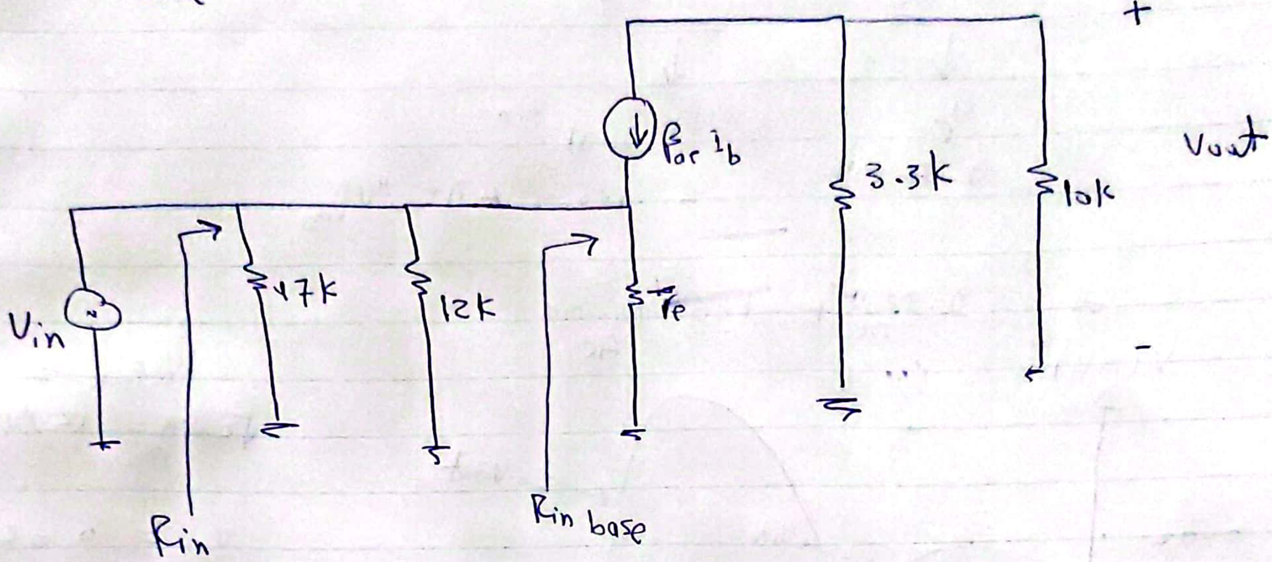
$I_C \cong I_E \cong = 2.63 \, mA$

$V_C = 18 - (2.63 \, mA)(3.3k) = 9.32 \, V$

$V_{CE} = 9.32 - 2.63 = 6.69 \, V$

b

$R_{in\,base}$ R_{in} A_V A_i A_p



$$r_e = \frac{25\,mV}{I_E} = \frac{25\,mV}{2.63\,mA} = 9.5\,\Omega$$

$$R_{in\,base} = \beta_{ac}\, r_e$$

$$= 70 * 9.5 = 665\,\Omega$$

$$R_{in} = 47k \parallel 12k \parallel \frac{665}{1000}k = 622\,\Omega$$

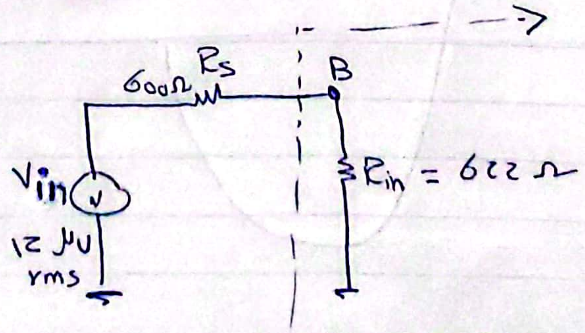
$$A_V = \frac{-R_C \parallel R_L}{r_e} = \frac{-3.3k \parallel 10k}{\frac{9.5}{1000}} = -261$$

$$A_i = \beta_{ac} = 70$$

$$A_P = A_V A_i = (261)(70) = 18270$$

circuit in Figure 3

c



$$V_B = 12\,\mu V * \frac{622}{622+600}$$

$12\,\mu V *$ 0.5

attenuation factor

$\boxed{\theta = 180°}$

$$A_{V\,overall} = \frac{V_{out}}{V_B} \cdot \frac{V_B}{V_S} = (261)(0.5) \;\; \boxed{130.5} \;\#$$

$\boxed{5}$

$$V_{out_{rms}} = \underline{\underline{V_{out_{DC}}}} + \underline{\underline{V_{out_{AC}}}}$$

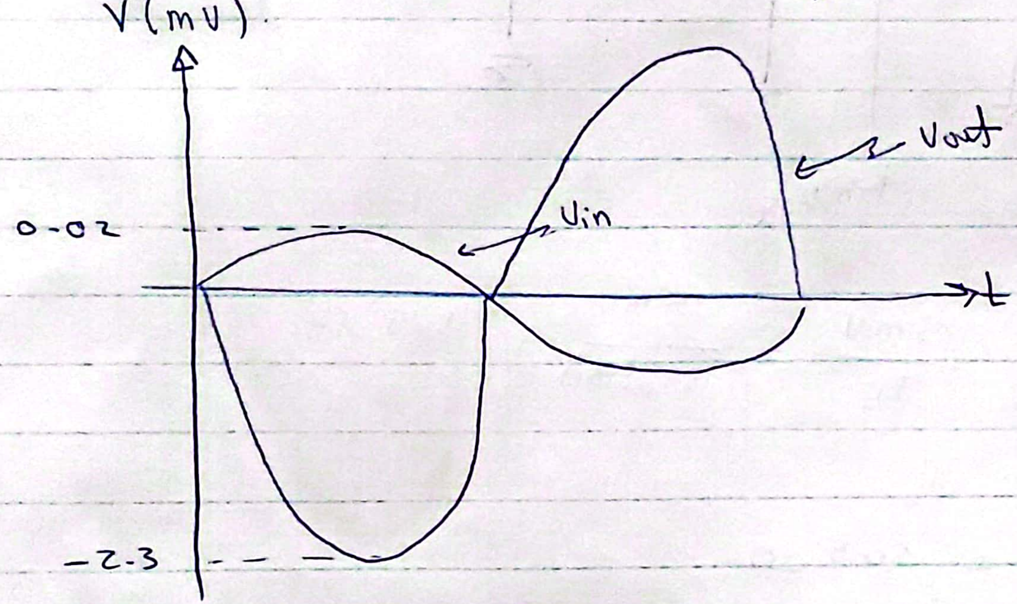
$$\downarrow \qquad \qquad \downarrow$$

$$V_C \qquad \qquad Av_{overall} \; v_{in}$$

9.32 volt

$$= -130.5 * (12 \mu v)_{rms}$$

$$= 9.32 \text{ volt}_{DC} + 1.6 \text{ rms mV}_{AC}$$



V_{in} Peak $=$

$\sqrt{2} V_{in_{rms}} = 12 \mu v \sqrt{2}$

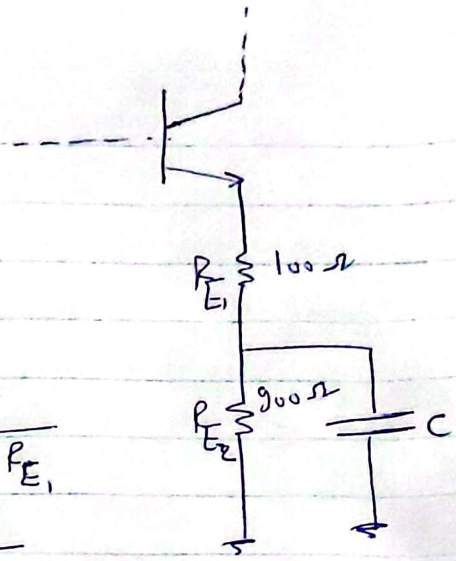
$V_{in_{Peak}} = 0.02$ mV

V_{out} Peak $=$

$\sqrt{2} V_{out_{rms}} = 1.6 \sqrt{2}$

$V_{out_{Peak}} = 2.3$ mV

d



$\bar{r}_e = 9.5\ \Omega$

$R_{E_1} \geq 10\ \bar{r}_e \longrightarrow A_V = \dfrac{-R_c}{\bar{r}_e + R_{E_1}}$

$\simeq \dfrac{-R_c}{R_{E_1}}$ if $R_{E_1} \geq 10\ \bar{r}_e$

set $R_{E_1} = 100\ \Omega$

The gain is reduced For Temperature stability

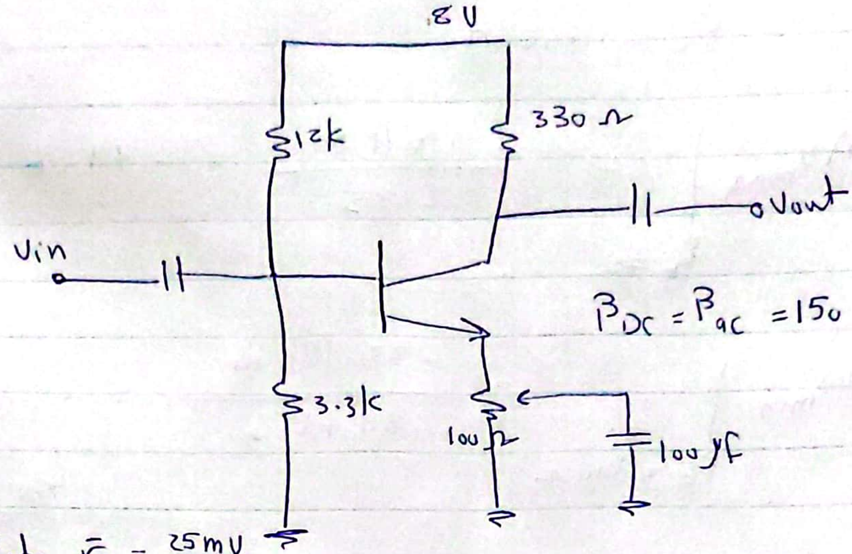
$$A_V = \frac{-3.3 \parallel 10k}{\frac{9.5 + 100}{1000}} = -23$$

③

a

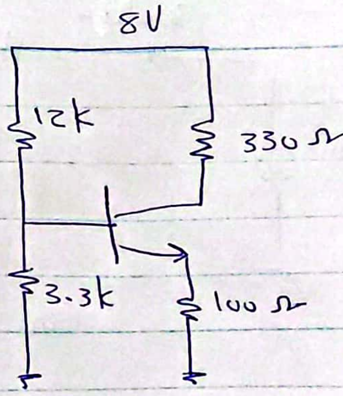
$A_{V_{min}}$ & $A_{V_{max}}$

??

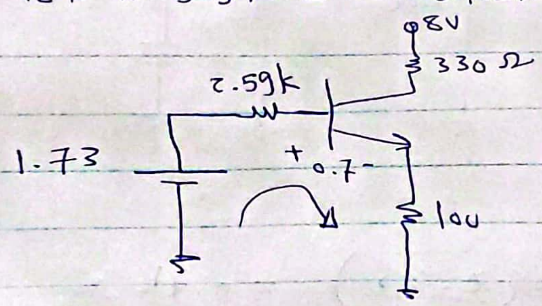


DC analysis to compute $r_e' = \frac{25mV}{I_E}$

$V_{Th} = 8 * \frac{3.3k}{3.3k + 12k} = 1.73\ V$



$R_{Th} = 12k \parallel 3.3k = 2.59k\Omega$

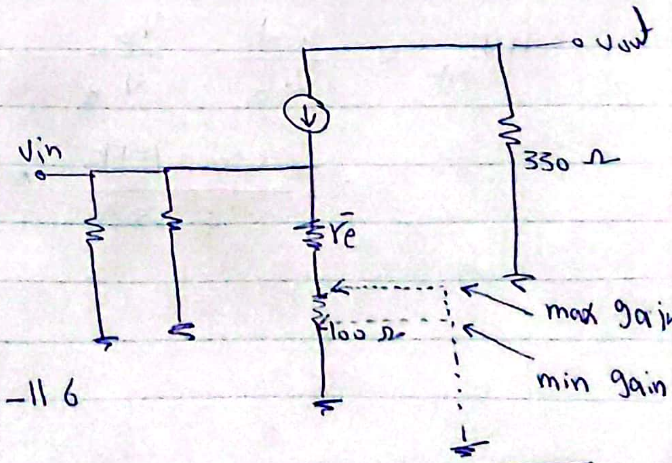


$1.73 - \frac{I_E}{\beta} 2.59k - 0.7 - \frac{100}{1000} k\Omega\ I_E = 0$

$I_E = \frac{1.73 - 0.7}{\frac{2.59k}{150} + 0.1} = 8.78\ mA$

$r_e' = \frac{25\ mV}{8.78m\ A} = 2.85\ \Omega$

To comput Gain → draw r model



maximum gain at $R_E = 0\ \Omega$

$A_{V_{max}} = \frac{-R_C}{r_e'} = \frac{-330\ \Omega}{2.85\Omega} = -116$

minimum gain at $R_E = 100\ \Omega$

$A_{V_{min}} = \frac{-R_C}{r_e' + R_E} = \frac{-330}{2.85 + 100} = -3.21$

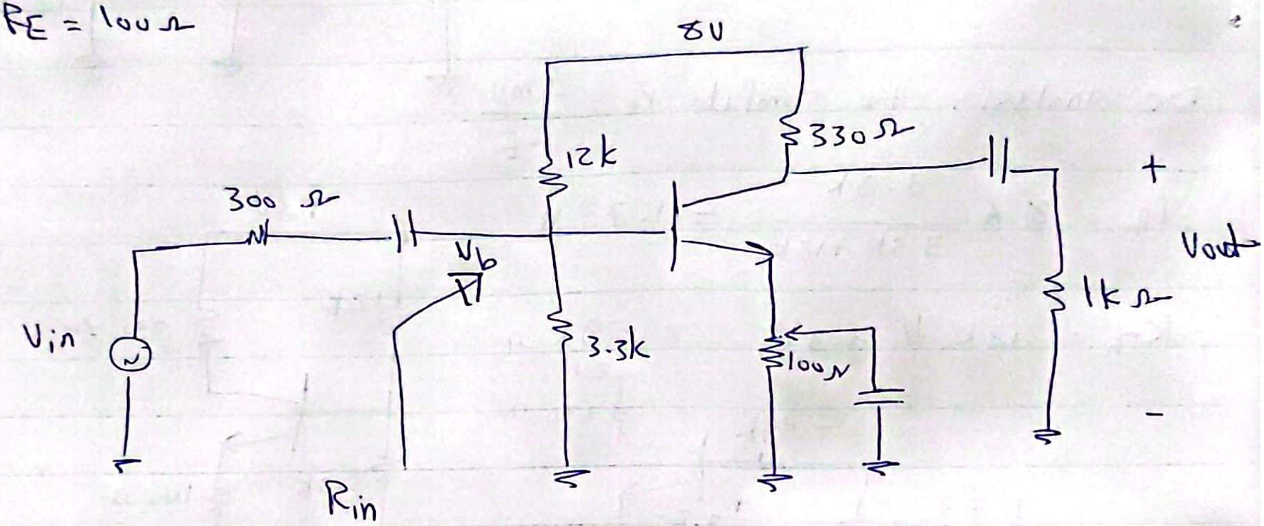
8

b $R_L = 600\,\Omega$

$$Av_{max}\Big|_{R_E=0} = \frac{-330 \parallel 600}{2.85} = -74.7$$

$$Av_{min}\Big|_{R_E=100\,\Omega} = \frac{-330 \parallel 600}{2.85+100} = -2.07$$

c



$$R_{in} = 12k \parallel 3.3k \parallel 150\left(\frac{2.85}{1000}\right) = 0.4k\,\Omega$$

$$\frac{V_b}{V_{in}} = \frac{R_{in}}{R_{in}+R_s} = \frac{0.4k}{0.4k+0.3} = 0.57$$

$$Av_{tot} = \frac{V_{out}}{V_b} \cdot \frac{V_b}{V_{in}}$$

$$= \frac{-330\,\Omega \parallel 1k}{2.85\,\Omega} * 0.57 = -49$$