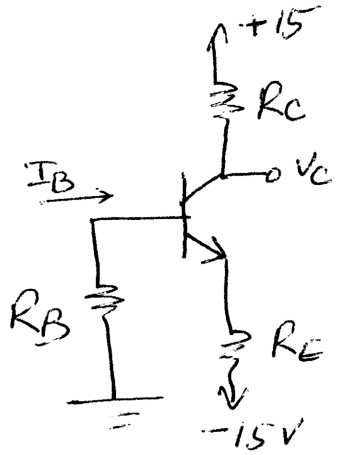
Assigment #6

EE 341

4.37



when $\beta=100$ $I_E = 1\,mA$ & $V_C = 5V$

$$\alpha = \frac{\beta}{1+\beta} = 0.99$$

$$\therefore I_C = \alpha I_E = .99\,mA$$

$$\therefore R_C = \frac{15-5}{.99} = 10.1\,k\Omega$$

KVL: $I_B R_B + 0.7 + I_E R_E = 15$

or $$\frac{I_E}{1+\beta} R_B + R_E I_E = 14.3$$

$$\therefore I_E = \frac{14.3}{R_E + \frac{R_B}{1+\beta}}$$

So if β goes up, I_E increases

$$1.1 = \frac{14.3}{R_E + \frac{R_B}{151}} \quad \text{— (1)}$$

$$0.9 = \frac{14.3}{R_E + \frac{R_B}{51}} \quad \text{— (2)}$$

After Solving for R_B & R_E

$R_B = 221.7\,k\Omega$

$R_E = 11.53\,k\Omega$

4.47

$$g_m = 80\,mA/V = \frac{I_c}{V_T} = \frac{I_c}{.025}$$

$\therefore$ Nominal value of $I_c = 2\,mA$

Now we know $g_m r_\pi = \beta$

$$r_\pi = \frac{\beta}{g_m}$$

Now if $I_c = 1.25 \times 2\,mA = 2.5\,mA$

$$g_m = \frac{2.5}{.025} = 100\,mA/V$$

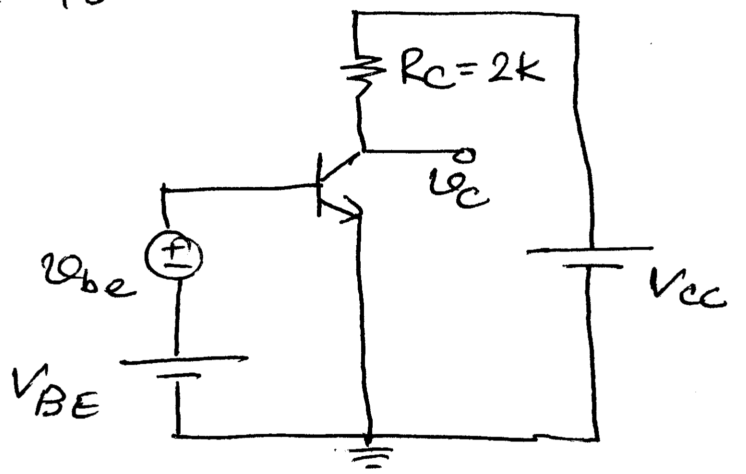
if $I_c = 0.75 \times 2\,mA = 1.5\,mA$

$$g_m = \frac{1.5}{.025} = 60\,mA/V$$

$$\therefore r_\pi(max) = \frac{200}{60\,mA/V} = 3.34\,k\Omega$$

$$r_\pi(min) = \frac{50}{100\,mA/V} = 0.5\,k\Omega$$

4.48



DC analysis:

$V_C = 2V \quad V_{CC} = 10V$

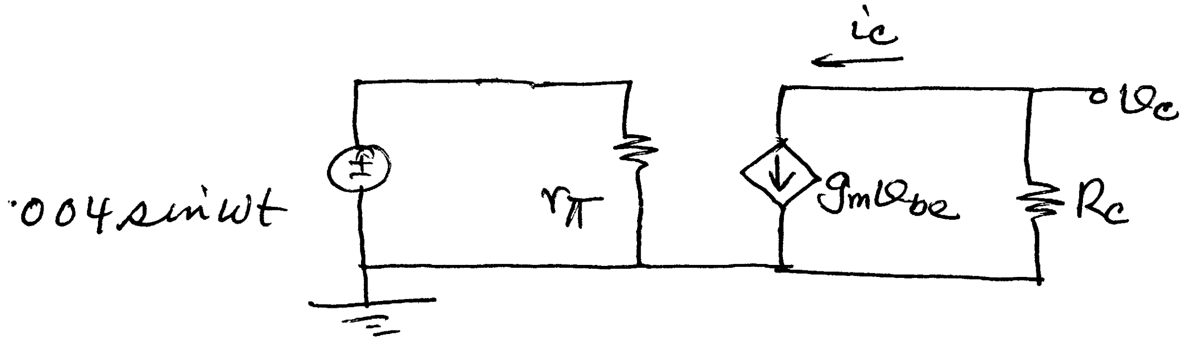
$I_C = \dfrac{V_{CC} - V_C}{R_C} = 4\,mA$

$g_m = \dfrac{4\,mA}{.025V} = 160\,mA/V$

$r_\pi = \dfrac{\beta}{g_m} = \dfrac{100}{160\,mA/V} = 0.625\,k\Omega$

$I_B = \dfrac{4m}{100} = 40\mu A$

Small signal equivalent ckt



$v_c = -i_c R_C = -g_m v_{be} R_C$

$= -160 \frac{mA}{V} \cdot 2k\Omega * .004 \sin \omega t$

$= -1.28 \sin \omega t$

$i_c(t) = g_m v_{be} = 160 \frac{mA}{V} * .004 \sin \omega t$

$= 0.64 \sin \omega t \quad mA$

$i_B(t) = \dfrac{i_c(t)}{\beta} = .0064 \sin \omega t \ mA = 6.4 \sin \omega t \ \mu A$

$\therefore v_C(t) = 2 - 1.28 \sin \omega t \quad V$

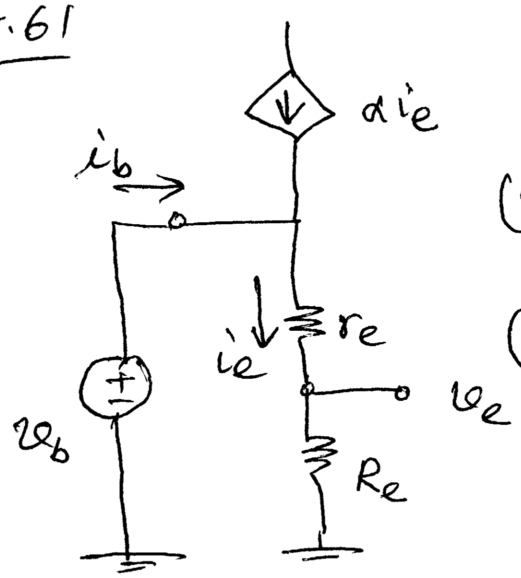
$i_C(t) = 4 + 0.64 \sin \omega t \quad mA$

$i_B(t) = 40 + 6.4 \sin \omega t \ \mu A$

$A_V = -g_m R_C$

$= -320 \ V/V$

4.61



By voltage divider rule

(a) $v_e = v_b \dfrac{R_e}{r_e + R_e}$; $\dfrac{v_e}{v_b} = \dfrac{1k}{1.025k} = .976$

(b) $R_{in} \equiv \dfrac{v_b}{i_b}$ --- (1)

But $i_b = \dfrac{i_e}{(\beta+1)}$ --- (A)

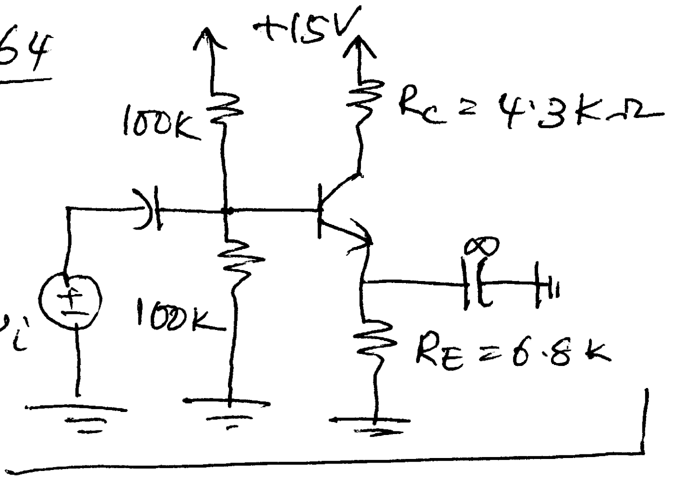
& $v_b = i_e (r_e + R_e)$

$r_e = \dfrac{.025}{1mA} = .025k\Omega$ $\therefore i_e = \dfrac{v_b}{r_e + R_e}$ --- (B)

using (A) & (B) in Equation (1)

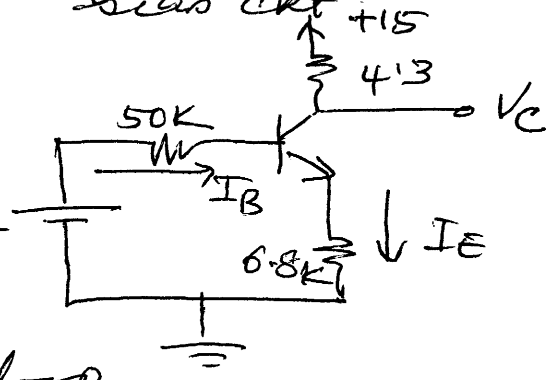
$R_{in} = (1+\beta)(r_e + R_e) = (101)(1.025k) = 102.5k$

4.64



DC analysis

Thevenize the Base bias ckt



KVL around the B-E loop.

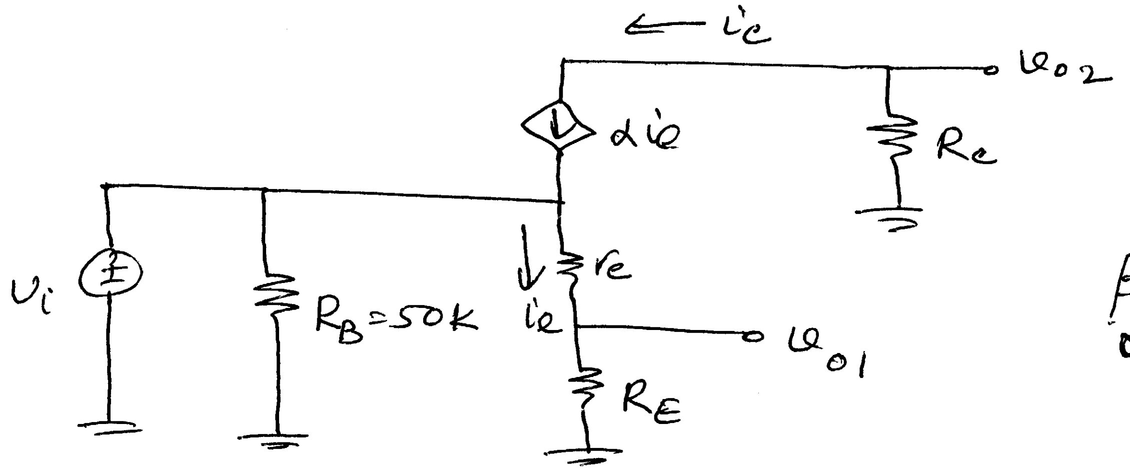
$7.5 = 50 I_B + 0.7 + 6.8 I_E$ $\left[I_B = \dfrac{I_E}{1+\beta} \to 0 \text{ if } \beta \to \infty \right]$

$= 0.7 + 6.8 I_E$

$\therefore I_E = \dfrac{6.8}{6.8} = 1mA$ $I_C = \alpha I_E = 1mA$ since $\alpha \to 1$

$$r_e = \frac{V_T}{I_E} = \frac{.025\,V}{1\,mA} = 25\,\Omega \text{ or } .025\,k\Omega$$

Small signal analysis



$\beta \to \infty$

$\alpha \to 1$

$$i_e = \frac{v_i}{r_e + R_E} \quad \therefore v_{o1} = i_e R_E = \frac{v_i R_E}{R_E + r_e}$$

$$\therefore \frac{v_{o1}}{v_i} = \frac{R_E}{R_E + r_e} = \frac{6.8}{6.8 + .025} = 0.996\,\frac{V}{V}$$

$$v_{o2} = -i_c R_c = -\alpha i_e R_c = -\frac{\alpha R_c v_i}{R_E + r_e}$$

$$\therefore \frac{v_{o2}}{v_i} = \frac{-\alpha R_c}{R_E + r_e} = \frac{-4.3}{6.8 + .025} = -0.63\,\frac{V}{V}$$