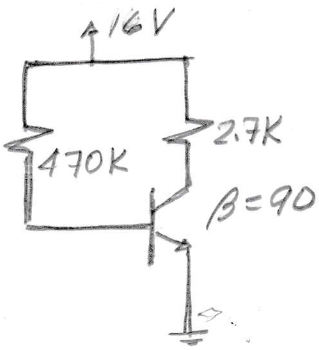
TRANSISTORES
PROBLEMAS RESUELTOS.

PROBLEMA Nº1 PARA EL CIRCUITO INDICADO DETERMINE EL PUNTO DE OPERACIÓN Y LOS VOLTAJES EN TERMINALES: V_C, V_B e V_E.



a) MALLA DE ENTRADA

$$V_{CC} = I_B R_B + V_{BE}$$

$$I_{BQ} = \frac{V_{CC}-V_{BE}}{R_B} = \frac{16-0.7}{470 \times 10^3} = 32.5\ \mu A$$

$$I_{CCQ} = \beta I_B = 90 \times 32.5 \times 10^{-6} = 2.92\ mA$$

b) EN LA MALLA DE SALIDA

$$V_{CC} = I_C R_C + V_{CEQ}$$

$$V_{CEQ} = V_{CC} - I_C R_C = 16 - (2.92 \times 10^{-3})(2.7 \times 10^3)$$

$$= 16 - 7.88 = 8.12 V$$

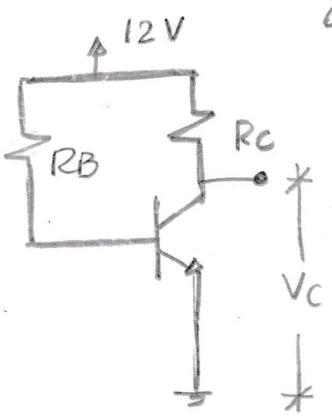
c) VOLTAJES EN TERMINALES

$$V_C = V_{CEQ} = 8.12 V$$

$$V_B = 0.7 V$$

$$V_E = 0$$

PROBLEMA Nº2 DADO QUE $I_B = 40 \mu A$ Y $\beta = 80$ Y $V_C = 6V$ DETERMINE R_C Y R_B. CUANTO VALE V_{CE}



a) CALCULO DE R_C

$$R_C = \frac{V_{CC} - V_C}{I_C}$$

$$I_C = \beta I_B = 80 \times 40 \times 10^{-6} = 3.2\ mA$$

$$R_C = \frac{12-6}{3.2} \times 10^3 = 1.87\ K\Omega$$

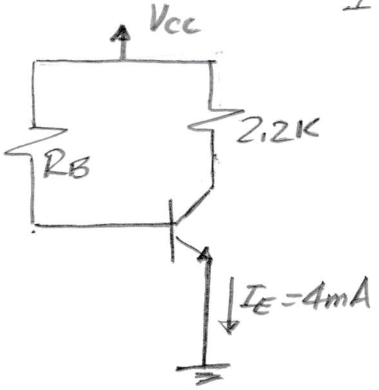
b) CALCULO DE R_B

$$R_B = \frac{V_{CC} - V_B}{I_B} = \frac{12-0.7}{40 \times 10^{-6}} = 282.5\ K\Omega$$

c) $V_{CE} = V_C = 6V.$

PROBLEMA Nº3 DETERMINE: V_{CC} β y R_B. $V_{CE} = 7.2\,v$

$I_E = 4\,mA$, $I_B = 20\,\mu A$



a) CALCULO DE V_{CC}

$V_{CC} = I_C R_C + V_{CE}$ (MALLA DE SALIDA)

$I_C = I_E = 4\,mA$

$V_{CC} = (4\times10^{-3})(2.2\times10^{3}) + 7.2$

$V_{CC} = 16\ Volt$

b) CALCULO DE β

$I_C = \beta I_B \Rightarrow \beta = \frac{I_C}{I_B} = \frac{4\,mA}{20\,\mu A} = 200$

c) CALCULO DE R_B

$R_B = \frac{V_{CC} - V_{BE}}{I_B} = \frac{16 - 0,7}{20\times10^{-6}}$

$R_B = 765K$

Si CONSIDERAMOS:

$I_E = I_C + I_B$

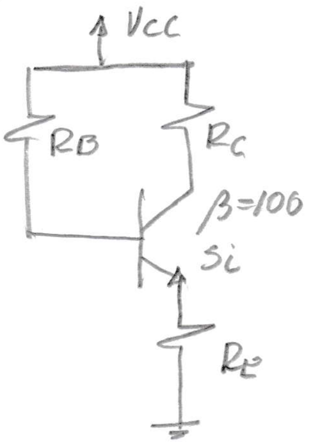
$I_C = I_E - I_B = 3,98\,mA$

$V_{CC} = 15,95\,V$

$\beta = \frac{3,98\times10^{-3}}{20\times10^{-6}} = 199$

$R_B = \frac{15,95 - 0.7}{20\times10^{-6}} = 763K$

PROBLEMA Nº 4 PARA UN AMPLIFICADOR EN EMISOR COMÚN CON POLARIZACION DE CORRIENTE DE BASE CONSTANTE, DETERMINE EL VALOR DE RB PARA QUE ICQ SEA LA MITAD DE LA CORRIENTE DE SATURACIÓN. LOS PARAMETROS DEL AMPLIFICADOR Y EL TRANSISTOR SON: $V_{CC} = 20V$; $R_C = 3.3K$; $R_E = 1,2K$; $\beta = 100$; Si. DIBUJE EL CIRCUITO COMPLETO.



$I_{SAT} = \frac{V_{CC}}{R_C + R_E} = \frac{20}{3.3\times10^{3} + 1,2\times10^{3}}$

$= \frac{20}{4.5\times10^{3}} = 4.44\,mA$

$I_{CQ} = \frac{I_{SAT}}{2}$

$= 2.22\,mA$

$I_C = \beta I_B \Rightarrow I_B = \frac{I_C}{\beta}$

$I_B = \frac{2.22 \times 10^{-3}}{100} = 22.22 \times 10^{-6}$

$= 22.22 \mu A$

$V_{CC} = I_B R_B + V_{BE} + (\beta+1) I_B R_E$

DE DONDE:

$R_B = \frac{V_{CC} - V_{BE} - (\beta+1) I_B R_E}{I_B}$

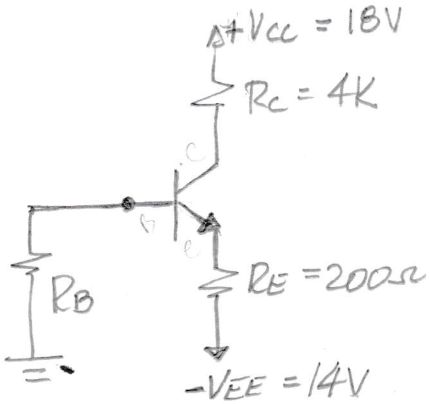
$= \frac{20 - 0.7 - (101)(22.22 \times 10^{6})(1.2 \times 10^{3})}{22.22 \times 10^{-3}}$

$= \frac{19.3 - 2.69}{22.22 \times 10^{-6}}$

$= \frac{16.61}{22.22 \times 10^{-6}}$

$\boxed{R_B = 747.38 K\Omega}$

PROBLEMA N° 5 PARA EL CIRCUITO INDICADO DETERMINE R_B PARA $I_{CQ} = 2mA$. CUAL ES EL PUNTO DE OPERACIÓN DEL CIRCUITO. $\beta = 50$, Si, $I_{CBO} = 0$.



a) EN LA MALLA DE ENTRADA TENEMOS.

$R_B = \frac{V_B}{I_B}$

HACIENDO MALLA TENEMOS

$V_B = V_{BE} + (\beta+1) I_B R_E - V_{EE}$

$I_B = \frac{I_C}{\beta} = \frac{2 \times 10^{-3}}{50} = 40 \times 10^{-6}$

$I_B = 40 \mu A$

$V_B = 0.7 + (51)(40 \times 10^{-6})(.2 \times 10^{3}) - 14$

$= -12.89$

$R_B = \frac{12.89}{40 \times 10^{-6}} = 322.5 \times 10^{3}$

$$V_C = V_{CC} - I_C R_C$$
$$= 18 - 8 =$$
$$\boxed{V_C = 10V}$$
$$V_E = I_E R_E - 14$$
$$= -13.6$$

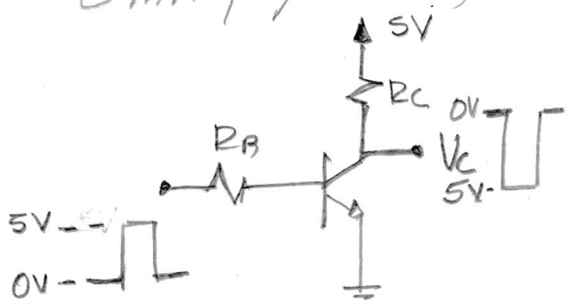
$$\boxed{R_B = 322.2K}$$

b) PUNTO DE OPERACIÓN

$$-V_{CC} + I_C R_C + V_{CE} + I_E R_E - V_{EE}$$
$$V_{CC} + V_{EE} = I_C(R_C + R_E) + V_{CE}$$
$$V_{CE} = V_{CC} + V_{EE} - I_C(R_C + R_E)$$
$$= 18 + 14 - (2\times10^{-3})(4\times10^{3} + .2\times10^{3})$$
$$= 32 - 8.4$$
$$= 23.6$$

$$\boxed{V_{CEQ} = 23.6,\ I_C = 2mA,\ I_{BQ} = 40\mu A}$$

PROBLEMA Nº6 DISEÑE EL INVERSOR INDICADO PARA UNA $I_B = 1.2 I_{Bmax}$; SI LA CORRIENTE DE SATURACIÓN ES 8mA Y $\beta = 100$; Si.



$$I_{CSAT} = 8\times10^{-3}$$
$$I_{Bmax} = \frac{I_{SAT}}{\beta} = \frac{8\times10^{-3}}{100}$$
$$I_{Bmax} = 80\times10^{-6}$$
$$= 80\mu A$$
$$I_B = 1.2\times80\times10^{-6}$$
$$= 96\times10^{-6}$$
$$I_B = 96\mu A$$

OPERACIÓN

1) CUANDO LA SEÑAL DE ENTRADA ESTA EN 0V EL TRANSISTOR ESTA EN CORTE Y $V_C = 0$. CUANDO LA SEÑAL DE ENTRADA ES 5V EL TRANSISTOR SE SATURA, (I_{CSAT}), EL VOLTAJE $V_C = 0V$.

EN SATURACIÓN:

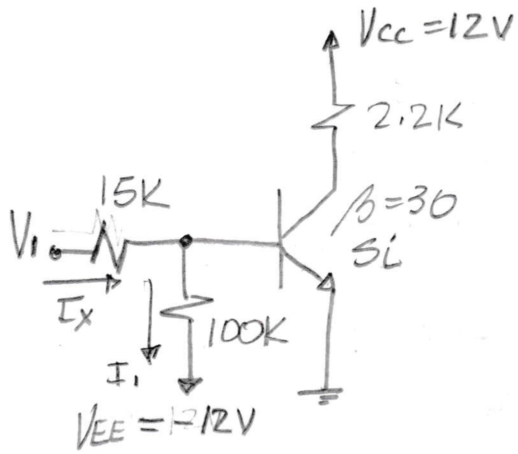
$$R_B = \frac{V_i - V_{BE}}{I_B}$$
$$= \frac{5 - 0.7}{96\times10^{-6}}$$

$$\boxed{R_B = 44.8K}$$

$$I_C = \beta I_B = 100\times96\mu A = 9.6mA$$

$$R_C = \frac{V_{CC}}{I_C} = \frac{5V}{9.6\times10^{-3}} = 520\,\Omega$$

PROBLEMA Nº 7 DETERMINE V_1 PARA QUE $V_{CEQ} = 6V$



$$I_C = \frac{V_{CC} - V_{CE}}{R_C}$$

$$= \frac{12 - 6}{2.2 \times 10^3}$$

$$I_C = 2.72 \times 10^{-3} \qquad \boxed{I_C = 2.72\,mA}$$

$$I_B = \frac{I_C}{\beta} = \frac{2.72 \times 10^{-3}}{30}$$

$$= 90.9 \times 10^{-6} \qquad \boxed{I_B = 90{,}9\,\mu A}$$

$$I_1 = \frac{V_{BE} - (-V_{EE})}{R_B}$$

$$= \frac{0.7 + 12}{100 \times 10^3}$$

$$I_1 = 127 \times 10^{-6} \qquad \boxed{I_1 = 127\,\mu A}$$

$$I_X = I_1 + I_B$$

$$= 127 \times 10^{-6} + 90{,}9 \times 10^{-6}$$

$$= 217.9 \times 10^{-6} \qquad \boxed{I_X = 217.9\,\mu A}$$

$$I_X = \frac{V_1 - V_{BE}}{R}$$

$$V_1 = I_X R + V_{BE}$$

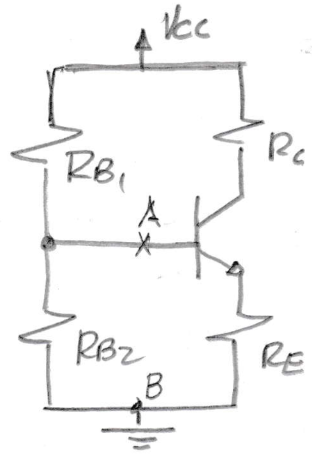
$$= (217.9 \times 10^{-6})(15 \times 10^3) + 0.7$$

$$= 3.96V \qquad \boxed{V_1 = 3.96V}$$

PROBLEMA Nº 8 PARA EL AMPLIFICADOR EN EMISOR COMÚN, CON POLARIZACIÓN POR DIVISOR DE TENSIÓN Y CUYOS PARÁMETROS DEL TRANSISTOR SON: $\beta = 175$; $I_{CBO} = 2\mu A$; Si, DETERMINE: a) LINEA DE CARGA, b) CORRIENTE DE BASE I_B, c) CORRIENTE DE COLECTOR, d) VOLTAJE COLECTOR EMISOR e) DEFINA EL PUNTO DE OPERACIÓN, f) V_C, V_B, V_E g) LA MAXIMA OSCILACIÓN DE V_{ce} ó i_c permitida. h) gra-

FIQUE SU RESPUESTA. $R_{B1} = 560K$, $R_{B2} = 330K$, $R_C = 1.2K$

$R_E = 610\,\Omega$ $V_{CC} = 20V$ $\beta = 175$



a) LINEA DE CARGA

$$V_{CC} = I_C(R_C + R_E) + V_{CE}$$

$$Si\ I_C = 0 \quad V_{CE} = V_{CC} = 20V$$

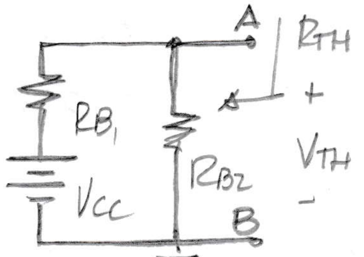
$$Si\ V_{CE} = 0 \quad I_C = \frac{V_{CC}}{R_C + R_E}$$

$$= \frac{20}{(1.2 + .61)\times 10^3}$$

$$= 11.04\ mA.$$

B) CORRIENTE DE BASE

DETERMINAMOS EL EQUIVALENTE THEVENIN EN LA MALLA DE ENTRADA



$$V_{TH} = \frac{V_{CC} R_{B2}}{R_{B1} + R_{B2}} = \frac{20(330\times 10^3)}{(560+330)\times 10^3}$$

$$= \frac{6.6\times 10^6}{890\times 10^3}$$

$$V_{TH} = 7.41\ Volt.$$

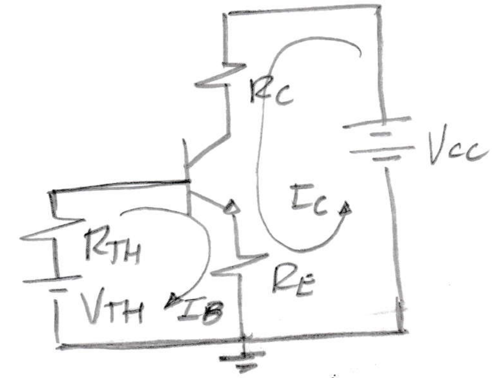
$$R_{TH} = R_{B1} // R_{B2}$$

$$R_{TH} = \frac{R_{B1} R_{B2}}{R_{B1} + R_{B2}} = \frac{(560\times 330)10^6}{(560+330)\times 10^3}$$

$$= \frac{184.8\times 10^6}{890\times 10^3}$$

$$R_{TH} = 207.64K.$$

CIRCUITO



$$V_{TH} = R_{TH} I_B + V_{BE} + (\beta+1) I_B R_E$$

$$V_{TH} = I_B [R_{TH} + (\beta+1) R_E] + V_{BE}$$

$$I_B = \frac{V_{TH} - V_{BE}}{R_{TH} + (\beta+1) R_E}$$

$$I_B = \frac{7.41 - 0.7}{207.64\times 10^3 + 176(.610\times 10^3)}$$

$$= \frac{6.71}{315\times 10^3} = 21.3\times 10^{-6}$$

$$I_B = 21.3\ \mu A.$$

c) CORRIENTE DE COLECTOR

$$I_C = \beta I_B + (\beta+1) I_{CBO}$$

$$= 175(21.3\times 10^{-6}) + 176(2\times 10^{-6})$$

$$= 4.07\ mA.$$

VALOR GRAFICO: 4 mA.

d) CALCULAR V_{CE}

$V_{CC} = I_C(R_C + R_E) + V_{CE}$

$V_{CE} = V_{CC} - I_C(R_C + R_E)$

$= 20 - 4.07\times10^{-3}(1.81\times10^{3})$

$= 20 - 7.36$

$V_{CE} = 12.64\,V.$

E) PUNTO DE OPERACION

$I_{BQ} = 21.3\,\mu A;\ I_{CQ} = 4.01\,mA$

$V_{CEQ} = 12.64\,V$

F) V_C, V_E Y V_B

$V_E = I_C R_E$

$= (4.01\times10^{3})(.610\times10^{3})$

$= 2.45\,V$

$V_B = V_E + V_{BE}$

$= 2.45 + 0.7$

$= 3.15\,V$

$V_C = V_E + V_{CE}$

$= 2.45 + 12.64$

$= 15.09\,V$

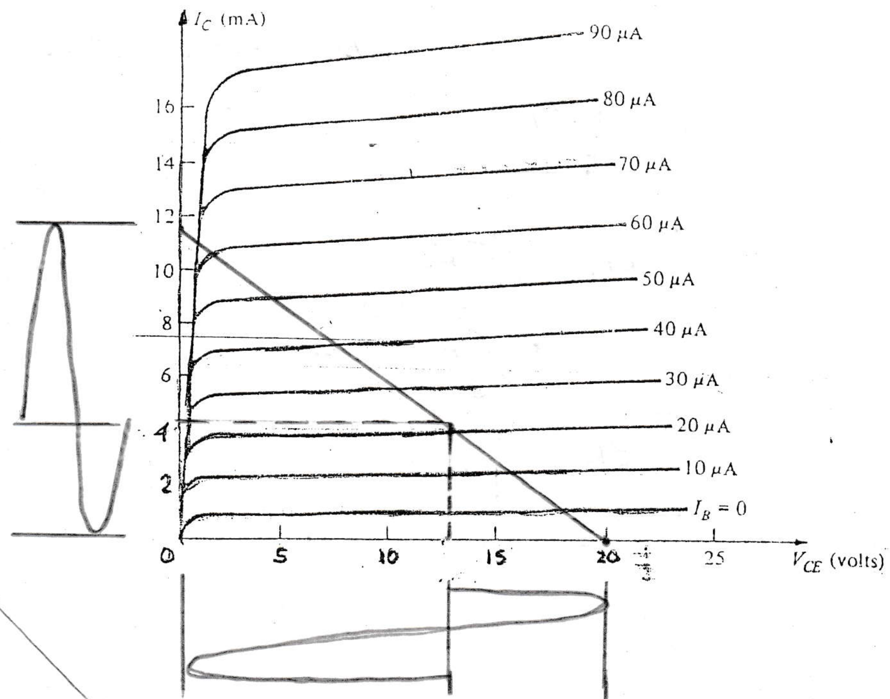
G) MAXIMAS OSCILACIONES DE i Y v

S/P $V_{pico} = V_{CC} - V_{CEQ}$

$= 20 - 12.64$

$= 7.36$

S/N $V_{pico} = 12.64\,V$



S/P $I_{pico} = I_{SAT} - I_{CQ}$

$= 11.4 - 4.01\,mA$

$= 7.39\,mA$

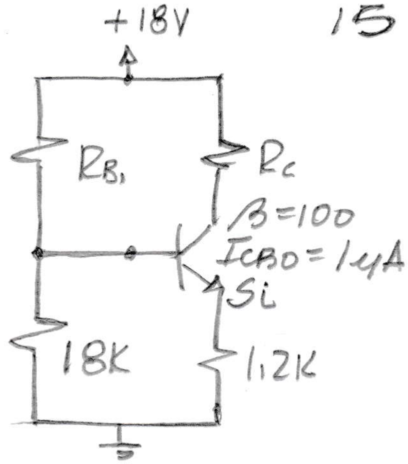
S/N $I_{pico} = I_{CQ}$

$= 4.01$

$V_{p\,max} = 7.36$

$I_{p\,max} = 4.01$

PROBLEMA N°9 DETERMINE RB₁ Y RC PARA UN PUNTO DE OPERACIÓN DE $I_{CQ} = 1{,}5\,mA$ Y $V_{CEQ} = 15$ Volt.



$$V_{R_C} = I_C R_C$$

$$V_{CC} = I_C R_C + V_{CE} + I_C R_E$$

$$R_C = \frac{V_{CC} - V_{CE} - I_C R_E}{I_C}$$

$$R_C = \frac{18 - 15 - (1{,}5\times10^{-3})(1{,}2\times10^{3})}{1{,}5\times10^{-3}}$$

$$R_C = \frac{1{,}2}{1{,}5\times10^{-3}}$$

$$R_C = 800\,\Omega$$

PARA R_{B_1} TENEMOS:

$$V_B = V_{BE} + I_C R_E$$

$$= 0.7 + (1{,}5\times10^{-3})(1.2\times10^{3})$$

$$= 2.5\,V$$

$$I_{R_2} = \frac{V_B}{R_{B_2}} = \frac{2.5V}{18K}$$

$$= 138.9\,\mu A$$

$$I_C = \beta I_B + (\beta+1) I_{CBO}$$

$$I_B = \frac{I_C - (\beta+1) I_{CBO}}{\beta}$$

$$= \frac{1.5\times10^{-3} - (101)(1\times10^{-6})}{\beta}$$

$$= 13.99\,\mu A$$

$$I_{R_1} = I_B + I_{R_2}$$

$$= (13.99 + 138{,}9)10^{-6}$$

$$= 152.89\,\mu A$$

$$V_{R_2} = V_{CC} - V_B$$

$$= 18 - 2.5$$

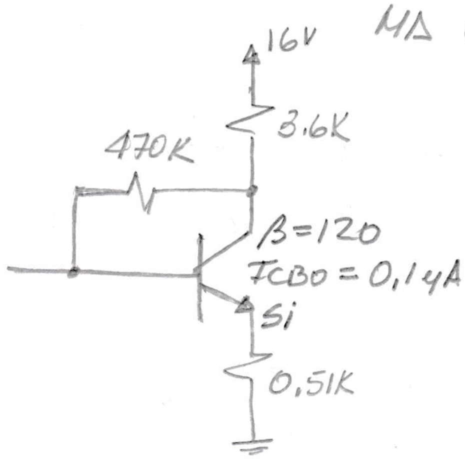
$$V_{R_1} = 15.5\ Volt$$

$$R_{B_1} = \frac{V_{R_1}}{I_{R_1}}$$

$$= \frac{15.5}{152.89\times10^{-6}}$$

$$\boxed{R_{B_1} = 101.38\,K\Omega}$$

PROBLEMA Nº10 CUAL ES LA AMPLITUD DE CORRIENTE MAXIMA QUE PUEDE SUMINISTRARSE A LA CARGA.



MALLA DE ENTRADA

$V_{CC} = I_C' R_C + I_B R_F + V_{BE} + I_C' R_E$

$I_C' = I_C + I_B$

$I_C = \beta I_B$

$I_C' = \beta I_B + I_B$

$I_C' = (\beta+1) I_B$

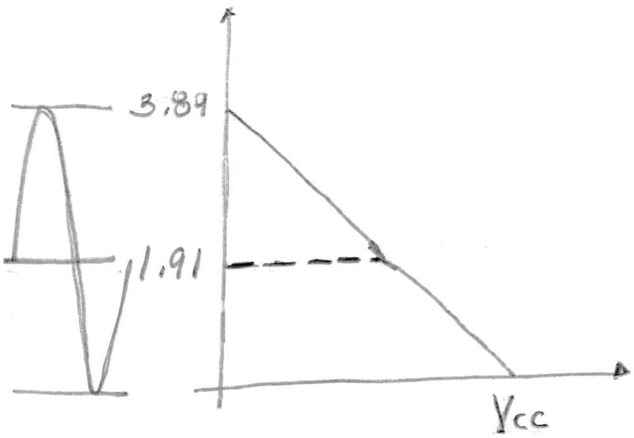
REEMPLAZANDO TENEMOS:

$V_{CC} = (\beta+1)(R_C + R_E) I_B + I_B R_F + V_{BE}$

$$I_B = \frac{V_{CC} - V_{BE}}{(\beta+1)(R_C+R_E) + R_F}$$

$$= \frac{16 - 0.7}{(121)(4.11\times10^3) + 470\times10^3}$$

$I_B = 15.81 \mu A$



$I_C = \beta I_B + (\beta+1) I_{CBO}$

$= (120)(15.81\times10^{-6}) + (121)(0.1\times10^{-6})$

$= 1.91\, mA$

RECTA DE CARGA

$V_{CC} = I_{C\,max}' R_C + V_{CE} + I_{C\,max}' R_E$

Si $V_{CE} = 0$ $\quad I_{C\,max}' = \dfrac{V_{CC}}{R_C + R_E}$

$$= \frac{16}{4.11\times10^3}$$

$= 3.89\, mA$

S/P $I_{C\,pico} = I_{C\,max}' - I_C$

$= 3.89 - 1.91\, mA$

$= 1.98\, mA$

S/N $I_{C\,pico} = I_C$

$= 1.91\, mA$

M.O.C.

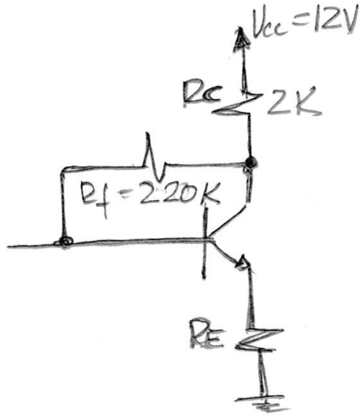
$I_{C\,pico} = 1.91\, mA$

$I_C' = (\beta+1) I_B + (\beta+1) I_{CBO}$

$= 121 (I_B + I_{CBO})$

$= 1.92\, mA.$

PROBLEMA N°11 DETERMINE EL VALOR DE R_E QUE POLARIZA EL TRANSISTOR EN $V_{CEQ} = 5V$.
$\beta = 80$, Si, $I_{CBO} = 0$



MALLA DE ENTRADA

$$V_{CC} = I_C' R_C + I_B R_f + V_{BE} + I_C' R_E$$
$$= (\beta+1) I_B (R_C + R_E) + I_B R_F + V_{BE}$$

$$I_B = \frac{V_{CC} - V_{BE}}{(\beta+1)(R_C+R_E) + R_F} \qquad (1)$$

MALLA DE SALIDA

$$V_{CC} = I_C' R_C + V_{CE} + I_C' R_E$$
$$V_{CC} = I_C'(R_C + R_E) + V_{CE}$$
$$I_C' = (\beta+1) I_B$$
$$V_{CC} = (\beta+1)(R_C+R_E) + V_{CE}$$

$$I_B = \frac{V_{CC} - V_{CE}}{(\beta+1)(R_C+R_E)} \qquad (2)$$

IGUALANDO (1) Y (2)

$$\frac{V_{CC} - V_{BE}}{(\beta+1)(R_C+R_E) + R_F} = \frac{V_{CC} - V_{CE}}{(\beta+1)(R_C+R_E)}$$

$$\frac{V_{CC} - V_{CE}}{V_{CC} - V_{BE}} = \frac{(\beta+1)R_C + (\beta+1)R_E}{(\beta+1)R_C + (\beta+1)R_E + R_F}$$

DIVIDIENDO EL TERMINO DE LA DERECHA POR EL FACTOR $(\beta+1)R_C$ QUEDA:

$$\frac{V_{CC} - V_{CE}}{V_{CC} - V_{BE}} = \frac{1 + \frac{R_E}{R_C}}{1 + \frac{R_E}{R_C} + \frac{R_F}{(\beta+1)R_C}}$$

$$\frac{12-5}{12-0.7} = \frac{1 + (0.5\times10^{-3})R_E}{1 + (0.5\times10^{-3})R_E + 1.36}$$

$$0.62 = \frac{1 + (0.5\times10^{-3})R_E}{2.36 + (0.5\times10^{-3})R_E}$$

$$0.62\left[2.36 + (0.5\times10^{-3})R_E\right] = 1 + 0.5\times10^{-3} R_E$$

$$1.46 + .310\times10^{-3} R_E = 1 + 0.5\times10^{-3} R_E$$

$$(0.310 - 0.5)\times10^{-3} R_E = 0.46$$

$$(0.19\times10^{-3}) R_E = 0.46$$

$$R_E = \frac{0.46}{0.19\times10^{-3}}$$

$$\boxed{R = 2.42K\Omega}$$

DETERMINAMOS V_{CEQ}

$$I_B = \frac{V_{CC} - V_{BE}}{(\beta+1)(R_C+R_E) + R_F}$$
$$= \frac{12 - 0.7}{81 \times 4.4\times10^3 + 200\times10^3}$$
$$= 19.6\,\mu A$$

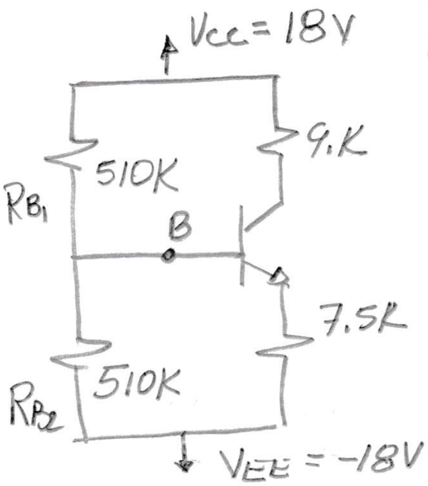
$$I_C' = (\beta+1) I_B$$
$$= 81 (19.6\times10^{-6})$$
$$= 1.59\ mA$$

$$V_{CEQ} = V_{CC} - I_C'(R_C + R_E)$$
$$= 12 - 1.59\times10^{-3}(4.4\times10^3)$$

$$\boxed{V_{CEQ} = 5.004}$$ PEDIDO POR EL PROBLEMA.

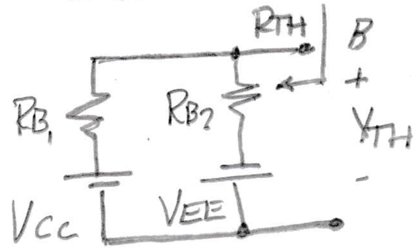
PROBLEMA Nº 12 DETERMINE EL PUNTO DE OPERACIÓN Y LOS VALORES DE V_C Y V_E DEL AMPLIFICADOR INDICADO. $\beta = 130$; $I_{CBO} = 1\mu A$

Si



1) MALLA DE ENTRADA.

EQUIVALENTE THEVENIN:



$R_{TH} = R_1 // R_2 = \frac{R_1}{2}$

$R_{TH} = 255K\Omega$

$-V_{CC} + I_1 R_{B1} + I_1 R_{B2} - V_{EE} = 0$

$$I_1 = \frac{V_{CC} + V_{EE}}{R_{B1} + R_{B2}} = \frac{\cancel{2} V_{EE}}{\cancel{2} R_{B1}} \text{ ó } \frac{2V_{CC}}{2R_{B2}}$$

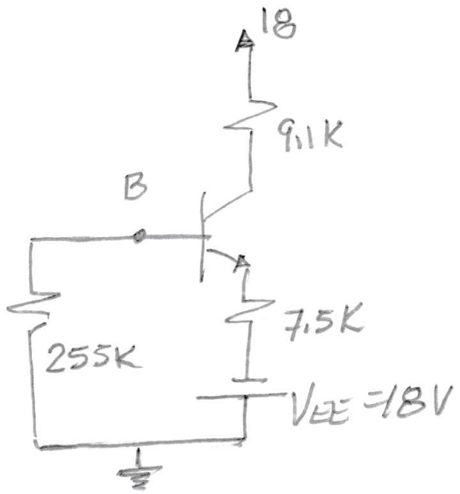
$$I_1 = \frac{V_{EE}}{R_{B1}} = \frac{18V}{510K}$$

$$I_1 = 35.3 \mu A$$

$$V_{TH} = V_{R2} - V_{EE}$$

$$= (35.3 \cdot 10^{-6})(510 \times 10^3) - 18$$

$$= 0$$



CALCULO DE I_B

$$I_B R_{TH} + V_{BE} + (\beta+1) R_E I_B - V_{EE} = 0$$

$$I_B = \frac{V_{EE} - V_{BE}}{R_{TH} + (\beta+1) R_E}$$

$$= \frac{18 - 0.7}{255 \times 10^3 + (131)(7.5 \times 10^3)}$$

$$I_B = 13.97 \mu A \cong 14 \mu A$$

CALCULO DE I_C

$$I_C = \beta I_B + (\beta + 1) I_{CBO}$$

$$= 130 \times 13.97 \times 10^{-6} + 131 \times 1 \times 10^{-6}$$

$$= 1.94 mA$$

b) CON ESTOS DATOS CALCULAMOS V_C Y V_E

- DETERMINAMOS V_{CE}

MALLA DE SALIDA

$$-V_{CC} + I_C R_C + V_{CE} + I_C R_E - V_{EE} = 0$$

$$V_{CE} = V_{CC} + V_{EE} - I_C (R_C + R_E)$$

$$= 36 - 1.94(9.1 + 7.5)$$

$$= 36 - 32.2$$

$$V_{CE} = 3.79$$

DE DONDE

$$V_C = V_{CE} + I_C R_E - V_{EE}$$

$$= 3.79 + 1.9 \times 7.5 - V_{EE}$$

$$V_C = 0.34$$

$$V_C = V_{CC} - I_C R_C$$

$$= 18 - 1.94 \times 9.1$$

$$= 0.346$$

OTRA ECUACIÓN DE LA MALLA DE SALIDA

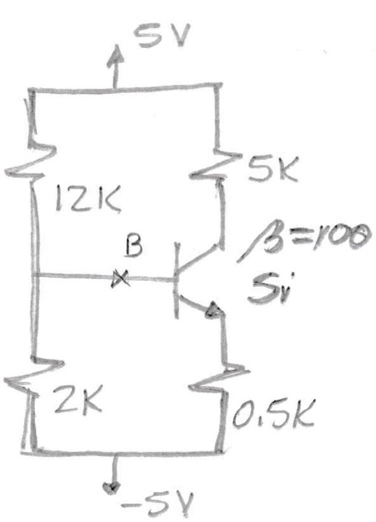
Y POR LO TANTO

$$V_E = I_C R_E - V_{EE}$$

$$= 1.94 \times 7.5 - 18$$

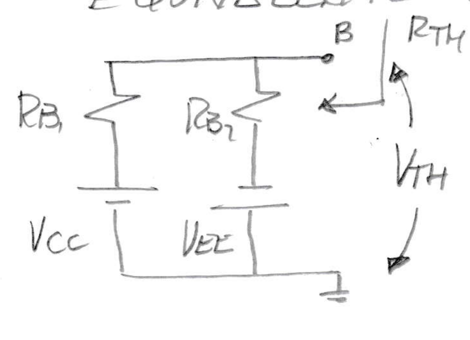
$$= -3.45$$

PROBLEMA N° 13 DETERMINE EL PUNTO DE OPERACIÓN, GRAFIQUE LA LINEA DE CARGA Y DETERMINE LA MAXIMA OSCILACIÓN DE VOLTAJE.



A) MALLA DE ENTRADA

EQUIVALENTE THEVENIN



$$R_{TH} = \frac{R_{B1} R_{B2}}{R_{B1} + R_{B2}}$$

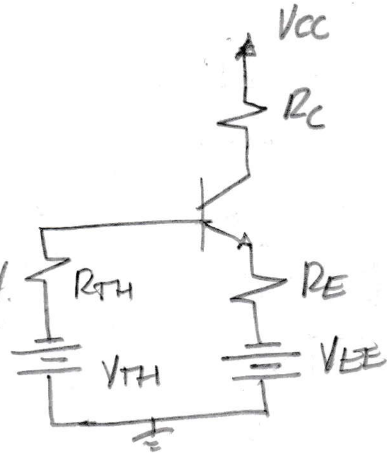
$$= \frac{(12 \times 2) \times 10^6}{(12 + 2) \times 10^3}$$

$$= 1.71\ K$$

$$V_{TH} = \frac{10 \times 2 \times 10^3}{12 \times 10^3 + 2 \times 10^3} - 5$$

$$= -3.57$$

CTO EQUIVALENTE THEVENIN



CALCULO DE I_B

$$V_{TH} + I_B R_{TH} + V_{BE} + (\beta+1) R_E I_B - V_{EE} = 0$$

$$I_B = \frac{V_{EE} - V_{TH} - V_{BE}}{R_{TH} + (\beta+1) R_E}$$

$$= \frac{5 - 3.57 - 0.7}{1.71 \times 10^3 + (101)(0.5 \times 10^3)}$$

$$= 13.98\ \mu A$$

CALCULO DE I_C

$$I_C = \beta I_B$$

$$= 100 \times 13.98\ \mu A$$

$$= 1.39\ mA.$$

B) DE LA MALLA DE SALIDA.

$$V_{CE} = V_{CC} + V_{EE} - I_C(R_C + R_E)$$

$$V_{CE} = 10 - 1.39(5.5)$$

$$= 2.35\ V$$

C) PUNTO DE OPERACIÓN

$$I_{BQ} = 13.98\ \mu A;\ I_{CQ} = 1.39\ mA$$

$$V_{CEQ} = 2.35\ V$$

D) LINEA DE CARGA

$$-V_{CC} + I_C R_C + V_{CE} + I_C R_E - V_{EE}$$

$$V_{CC} + V_{EE} = I_C(R_C + R_E) + V_{CE}$$

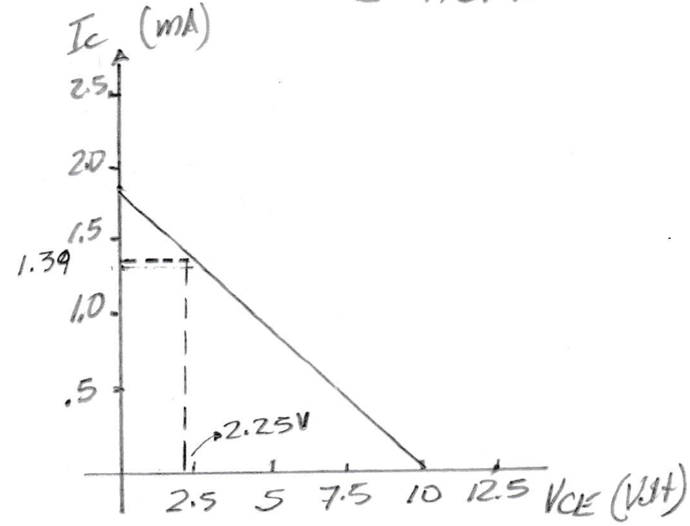
Si $I_C = 0$ $\quad V_{CE} = 2V_{CC}$ ó $2V_{EE}$

$$= 10\ Volt.$$

Si $V_{CE} = 0$ $\quad I_C = \frac{2V_{CC}}{R_C + R_E}$

$$= \frac{10}{5.5 \times 10^3}$$

$$= 1.81\ mA$$



MAXIMA OSCILACIÓN DE VOLTAJE PERMITIDA:

$$V_{p\,max} = 2.35\ Volt$$

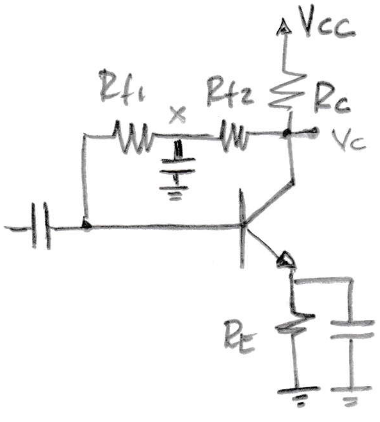
ó

saturación

$$V_{p\,max} = 2.25 - 0.2$$

$$= 2.05\ Volt$$

PROBLEMA 14 DETERMINE V_C Y V_X



$V_{CC} = 30V$
$R_C = 6.2K$
$R_E = 1.5K$
$R_{f1} = 470K$
$R_{f2} = 220K$
$\beta = 100$
S_1

a) CALCULO DE V_C.

$V_C = V_{CC} - I_C' R_C \quad I_C' \cong I_E$

$V_C = V_{CE} + I_C' R_E$

DETERMINAMOS I_C'

$V_{CC} = I_B\left[(\beta+1)(R_C+R_E) + R_f\right] + V_{BE}$

$$I_B = \frac{V_{CC} - V_{BE}}{(\beta+1)(R_C+R_E)+R_f}$$

$$= \frac{30-0.7}{(101)(7.7\times10^3) + 690\times10^3}$$

$$= \frac{29.3}{1467\times10^3}$$

$$= 19.97\ \mu A$$

$I_C' = (\beta+1) I_B$

$= (101)(19.97\times10^{-6})$

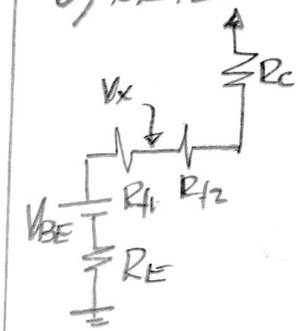
$= 2.01\ mA.$

$V_C = V_{CC} - I_C' R_C$

$= 30 - (2.01\times10^{-3})(6.2\times10^{3})$

$= 17.49V$

b) DETERMINAMOS V_X



$V_X = V_{CC} - I_C' R_C - I_B R_{f2}$

ó

$V_X = I_B R_{f1} + V_{BE} + I_C' R_E$

$V_X = 30 - (2.01\times10^{3})(6.2\times10^{3}) - (19.97\times10^{-6} \times 220\times10^{3})$

$\boxed{V_X = 13.14\ V}$

ó

$V_X = (19.97\times10^{-6})(470\times10^{3}) + 0.7 + (2.01\times10^{-3})(1.5\times10^{3})$

$\boxed{V_X = 13.10}$

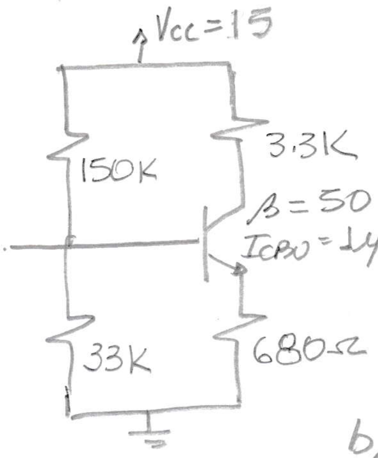
PROBLEMA N°15 DETERMINE V_{CE} EN OPERACIÓN SI LA POTENCIA MAXIMA DE DISIPACION ES $P_D = 25\ mW$ PUEDE EL DISPOSITIVO DISIPAR LA POTENCIA DE TRABAJO.

a) MALLA DE ENTRADA

CIRCUITO THEVENIN EQUIVALENTE.

$$R_{TH} = \frac{R_{B1} R_{B2}}{R_{B1} + R_{B2}} = \frac{(150\times10^3)(33\times10^3)}{(150\times10^3) + (33\times10^3)}$$

8/8



$$R_{TH} = 27K\Omega$$

$$V_{TH} = \frac{15 \times 33 \times 10^3}{150 \times 10^3 + 33 \times 10^3}$$

$$= 2.70V$$

$$I_B = \frac{V_{TH} - V_{BE}}{R_{TH} + (\beta+1)R_E} = \frac{2.7 - 0.7}{27 \times 10^3 + 51 \times .68 \times 10^3}$$

$$I_B = 32.4\ \mu A.$$

b) <u>MALLA DE SALIDA</u>

$$\underline{I_C} = \beta I_B + (\beta+1) I_{CBO}$$

$$= (50)(32.4 \times 10^{-6}) + (51)(1 \times 10^{-6})$$

$$= 1.67 mA$$

$$V_{CE} = V_{CC} - I_C(R_C + R_E)$$

$$= 15 - (1.67 \times 10^{3})(3.3 \times 10^3 + .68 \times 10^3)$$

$$= 8.35$$

c) POTENCIA DE TRABAJO

$$P_T = V_{CEQ} I_{CQ} \qquad P_D = 25mW$$

$$= (8.35)(1.67 \times 10^{-3})$$

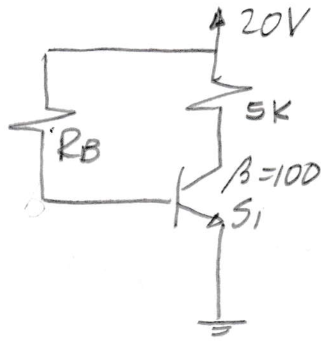
$$= 13.94\ mW$$

$P_T < P_D$ SI FUNCIONA.

<u>PROBLEMA Nº16</u> PARA EL CIRCUITO INDICADO DETERMINE EL VALOR R_B PARA QUE EL PUNTO DE OPERACIÓN ESTE EN EL PUNTO MEDIO DE LA LINEA DE CARGA

$$I_C = \frac{I_{SAT}}{2} = \frac{V_{CC}}{R_C + R_E}$$

$$I_C = \frac{V_{CC}}{R_C} \ ; \ R_E = 0 \quad ó \quad \frac{V_{CE}}{2}$$



$I_{SAT} = \frac{20}{5 \times 10^{-3}} = 4mA$

$I_c = 2mA$

b) CALCULO DE RB

$$R_B = \frac{V_{CC} - V_{BE}}{I_B}$$

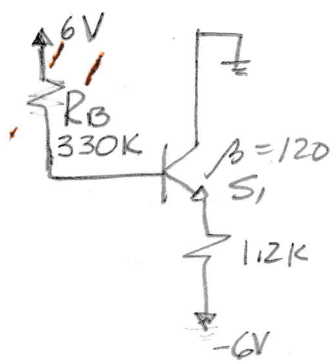
$$I_B = \frac{I_c}{\beta}$$

$$R_c = \frac{\beta(V_{CC} - V_{BE})}{I_c}$$

$$= \frac{100(20-0.7)}{2 \times 10^{-3}}$$

$$= 965K$$

PROBLEMA N°17 DETERMINE VE

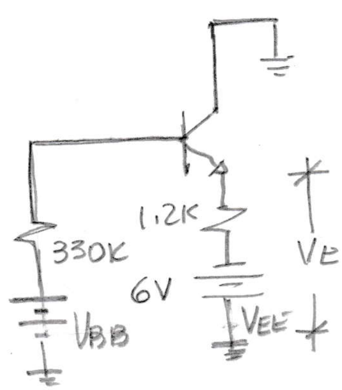


$$V_E = I_E R_E - V_{EE}$$
$$= I_C R_E - V_{EE}$$

$$V_E = \beta I_B R_E - V_{EE}$$

DE LA MALLA DE ENTRADA

$$-V_{BB} + I_B R_B + V_{BE} + (\beta+1) I_B R_E - V_{EE} = 0$$



$$I_B = \frac{V_{EE} + V_{BB} - V_{BE}}{R_B + (\beta+1) R_E}$$

$$= \frac{6 + 6 - 0.7}{330 \times 10^3 + (121)(1.2 \times 10^3)}$$

$$I_B = 24.62 \mu A$$

$$V_E = (120)(24.62 \times 10^{-6})(1.2 \times 10^3) - 6V$$

$$\boxed{V_E = -2.45 \text{ Volt}}$$