CLASS A
LARGE SIGNAL

Berube P164

$V_B = 3.134V$

$V_E = 2.408$

$V_C = 12.8V$

$I_{C(SAT)} = \frac{20}{300+15+85}$

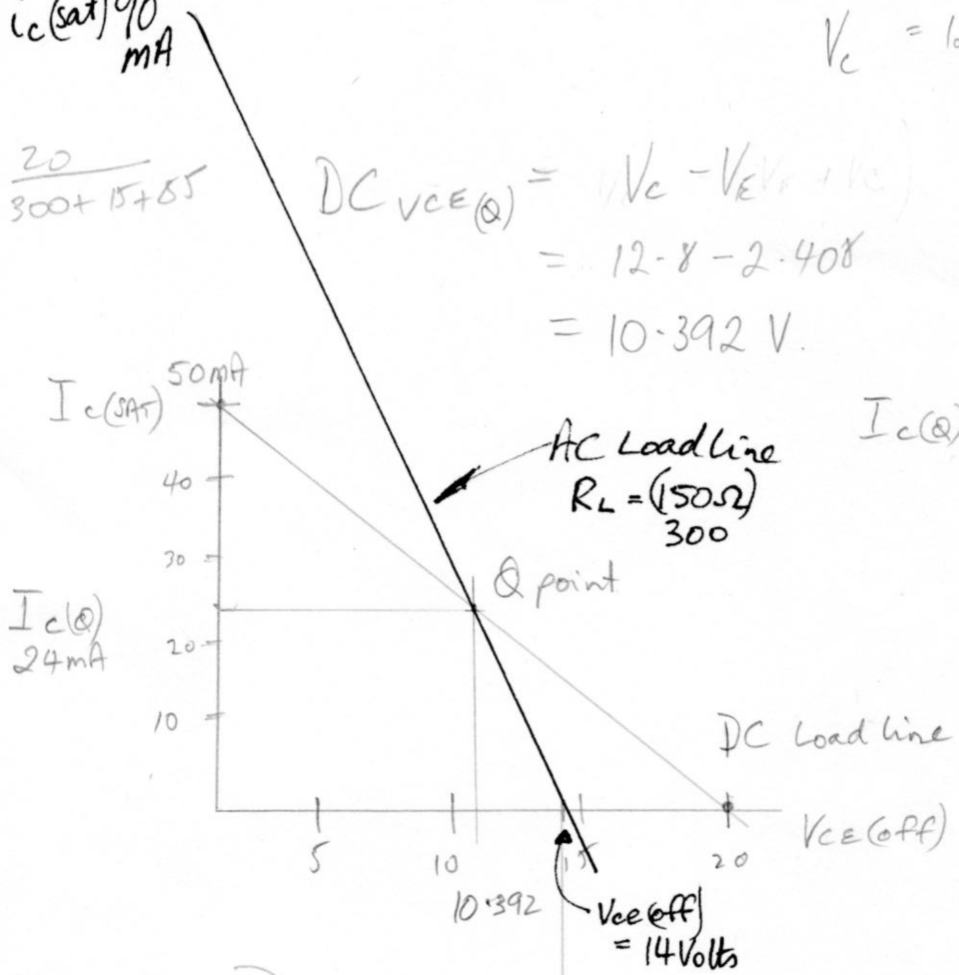
$DC\ V_{CE(Q)} = V_C - V_E$

$= 12.8 - 2.408$

$= 10.392\ V$

$I_{C(Q)} = \frac{2.408}{100}$

$= 24mA$



$R_C = 300\Omega$

$R_L = 300\Omega$

$\therefore r_c = 150\Omega$

$i_{c(SAT)} = I_{c(Q)} + \frac{V_{CE(Q)}}{r_c}$

$= 24mA + \frac{10.4}{150}$

$= 24mA + 69mA$

$= 93mA$

$V_{ce(off)} = V_{ce(Q)} + I_{c(Q)} r_c$

$= 10.4 + 24mA \times 150$

$= 14$ Volts

Compliance

(14 Volts − 10.4) × 2 = 7.2 Volts pp

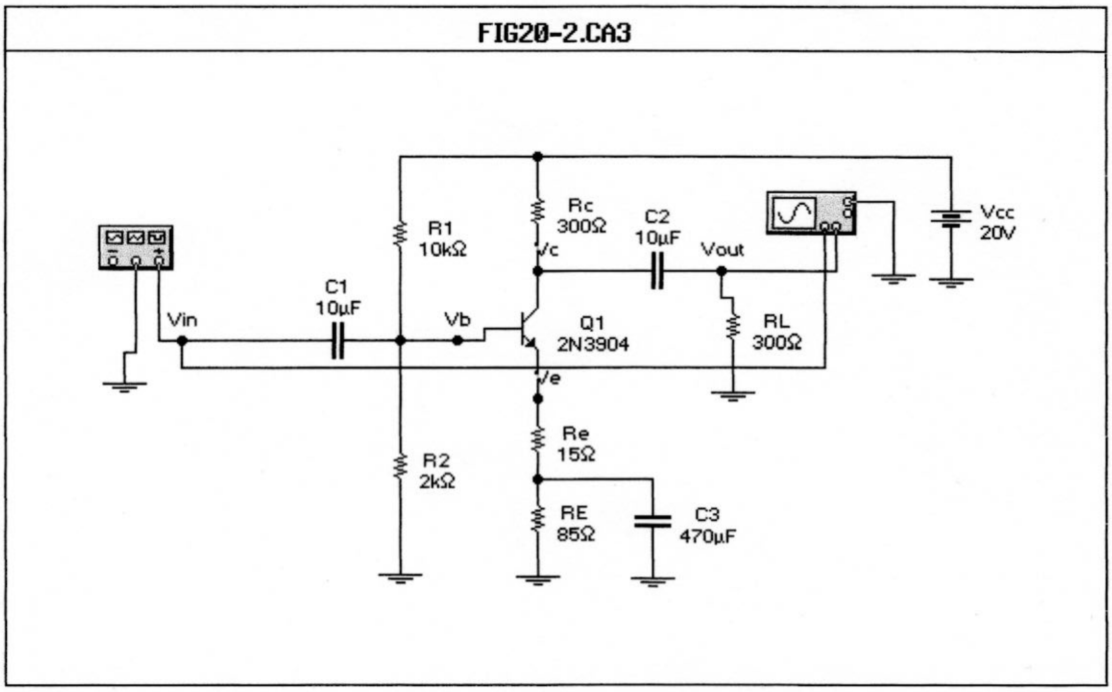
Measured on graph.

Use 2 equations to check.

see over.

Berube P164

(2)



<u>Compliance</u>

Case # 1 Cutoff clipping $= 2\times I_{c(Q)}\, r_c$

$= 2\times 24\,mA \times 150\,\Omega$

$= 7.2\,V_{pp}$ ← Smaller of the two. & equal with graphical results.

Case # 2 saturation clipping $= 2\times V_{CE(Q)}$

$= 2\times 10.4$

$= 20.8$

<u>Measured O/P.</u>

440 mVpk input to produce <u>onset of distortion</u> of positive peaks in O/P signal. $V_{o\,pp} = 4.1 + 3.6 = 7.7\,V_{pp}$

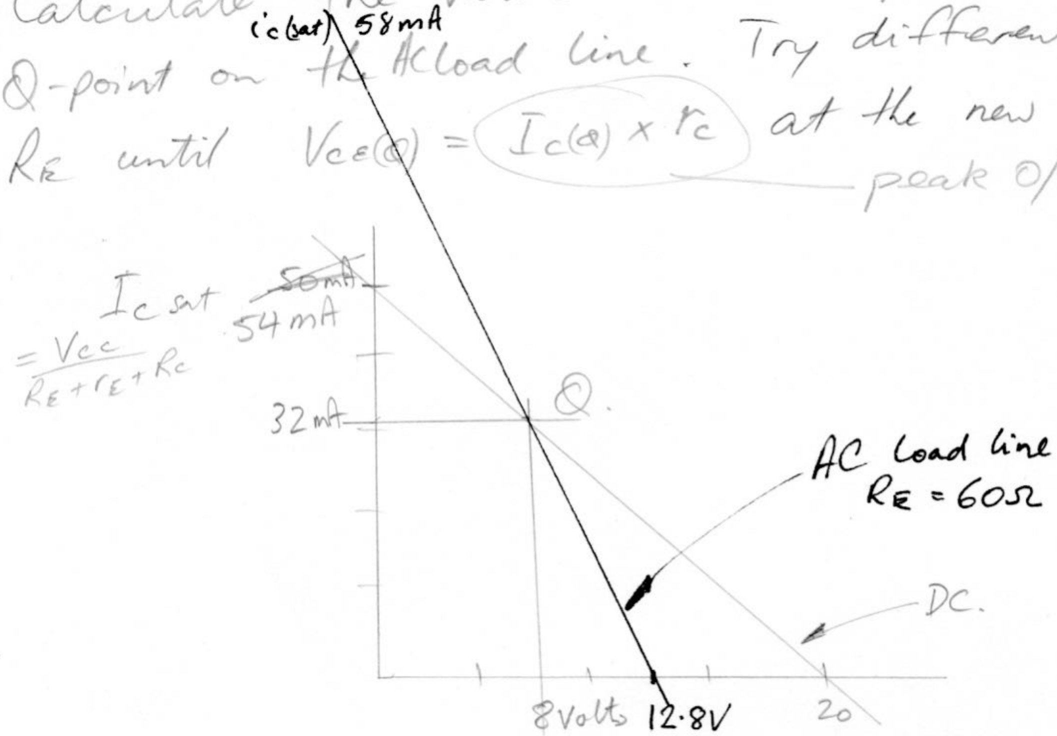
<u>Calculated Av</u> $= \dfrac{r_c}{r'_e + 15\,\Omega}$ ($r'_e = \dfrac{25\,mV}{24\,mA}$)

$= \dfrac{r_c}{16\,\Omega} = 9.4$ $\left(9.4 \times 440\,mV = 8.2\,V_{pp}\right)$ Very close.

Note the amp cannot provide any more o/p due to the limited swing provided by the AC load line position.

Calculate the value for R_E required to center the Q-point on the AC load line. Try different values for R_E until $V_{CE(Q)} = I_{C(Q)} \times r_c$ at the new Q point.

— peak O/P voltage.



Case # 1. $R_E = 60\Omega$ $\quad I_{C(Q)} = \frac{V_E}{R_E} = \frac{2.4}{60+15} = 32\,mA.$

$V_{CE(Q)} = V_{CC} - I_{C(Q)}(R_E + r_E + R_C)$

$= 8$ Volts.

$v_{ce(Q)} = V_{CE(Q)} + I_{C(Q)}\,r_c$
$= 8 + 32\,mA\ 150\Omega$
$= 12.8$ Volts.

$i_{c(sat)} = I_{C(Q)} + \frac{V_{CE(Q)}}{r_c}$
$= 58\,mA.$

Compliance $= (12.8 - 8)\,2$ ← (from graph.)
$= 9.6\,V_{PP}$ ⟶ ie $V_{PP} = 2 \times I_{C(Q)}\,r_c$

Test $\quad r_c \times I_{C(Q)} = V_{CE(Q)}$
$4.8 = 8.$ no good.

Case #2.

$R_E = 50\Omega$

$I_{C(Q)} = \frac{V_E}{R_E} = \frac{2.4}{50+15}$

$\doteq 37\ mA$

$V_{CE(Q)} = V_{CC} - I_{CQ}(R_E + r_E' + R_C)$

$= 20 - (.037 \times 365)$

$= 6.5V$

<u>Test</u> $r_c \times I_{C(Q)} = V_{CEQ}$.

$150 \times .037 = 5.5$

<u>5.5 Vs 6.5</u>

Case # 3

$R_E = 46\Omega$

$I_{C(Q)} = \frac{V_E}{R_E} = \frac{2.4}{46+15}$

$\doteq 41\ mA$

$V_{CE(Q)} = V_{CC} - I_{C(Q)}(R_E + r_E' + R_C)$

$20 - (.041 \times 359)$

$= 20 - 14.7$

$= 5.3$.

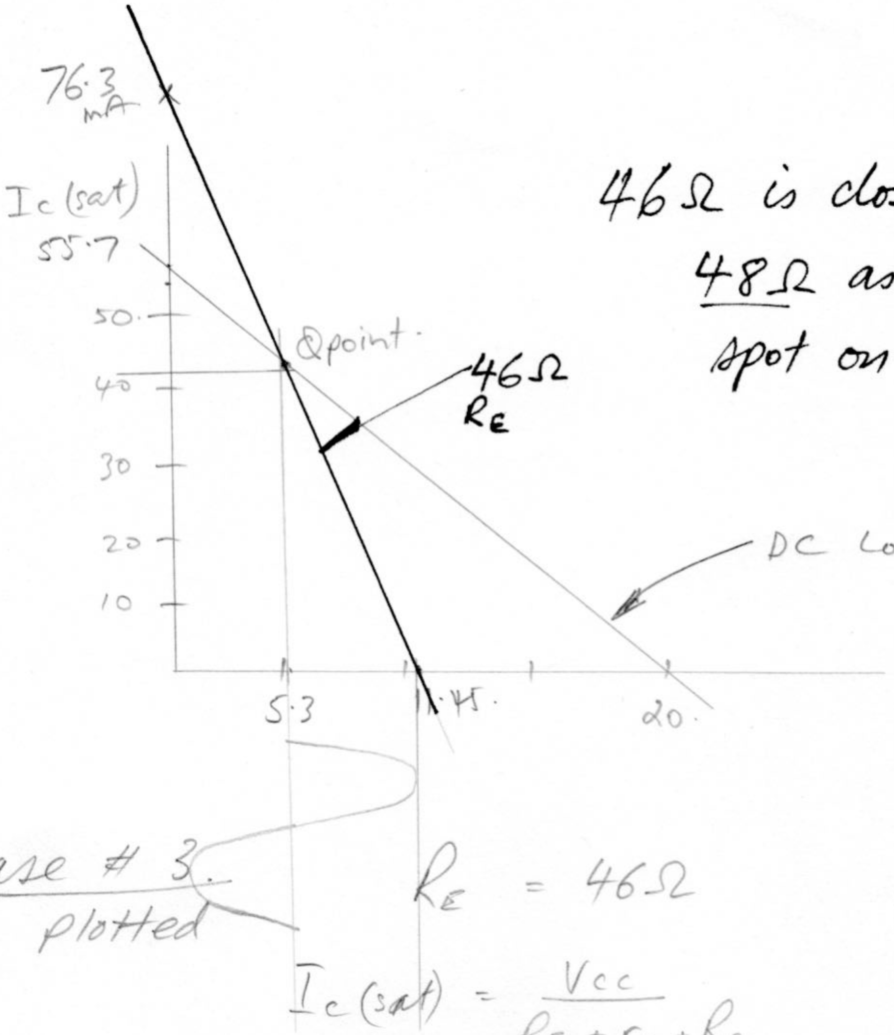
<u>Test</u> $r_c \times I_{C(Q)} = V_{CE(Q)}$?

$150 \times .041 =$

<u>6.15 = 5.3.</u>

gone the other way!

Value must be <u>48Ω</u> ✓



46Ω is close but 48Ω as predicted is spot on when tested in cct.

Case # 3 plotted

$R_E = 46\Omega$

$V_{CE}(Q) = 5.3V$

$I_C(Q) \doteq 41mA$

$I_C(sat) = \frac{V_{CC}}{R_E + r_E + R_C}$

$= \frac{20}{359}$

$= 55.7mA$

$V_{CE}(off) = V_{CE}(Q) + I_C(Q) r_C$

$= 5.3 + (41mA \times 150\Omega)$

$= 11.45V$

$i_C(sat) = I_{CQ} + \frac{V_{CE}(Q)}{r_C}$

$= 41mA + \frac{5.3}{150}$

$= 76.3mA$

Compliance $= (11.45 - 5.3) \times 2$

$= 12.3 \, V_{pp}$. BUT notice $V_{CE} = 0$ Volts is only 5.3 Volts away.

So $V_{pp} = 2 \times V_{CE}(Q) = 2 \times 5.3 = \boxed{10.6 \text{ Volts}}$

not allowing for $V_{CE} < 1$ volt!

$\underline{P_s}$ The input power to the amplifier:

$$I_{cc} = \left(\frac{V_{cc}}{R_1 + R_2}\right) + I_{C(Q)}$$ Case 3.

$$= 1.66\,mA + 41\,mA$$

$$= 42.66\,mA.$$ So $P_s = V_{cc} \times I_{cc}$

$$= 20 \times 42.66$$

$$= 850\,mW.$$

$$P_o = \frac{V_{PP}^2}{8R_L} \doteq \frac{10.6^2}{8 \times 300}$$

$$= 46\,mW.$$

efficiency $\eta = \frac{P_o}{P_s}$

$$= \frac{46}{850}$$

$$= 5.4\%$$