Power Amplifiers Homework Solution

5.1-2: $(P_{L,ac})_{max} = 2W$, $R_L = 10\,\Omega$

$$(P_{L,ac})_{max} = \frac{1}{2} I_{cm,max}^2 R_L = 2W$$

$\therefore I_{cm,max} = 0.6324\ A$

$\therefore I_{CQ} \geq 0.6324\ A$

$\therefore$ let $I_{CQ} = 0.6324\ A$ (minimum rating)

$$P_{CC} = V_{CC} I_{CQ} = 9.5W$$

$$\eta_{,max} = \frac{(P_{L,ac})_{,max}}{P_{CC}} \times 100\% = 21\%$$

$$P_{C,max} = P_{CC} = 9.5W$$

$$i_C(t)_{,max} = I_{CQ} + \frac{V_{CEQ}}{R_{ac}}$$

$$R_{ac} = R_L = 10\,\Omega$$

$\therefore i_C(t)_{,max} = 2.1324\ A$

$$V_{CE}(t)_{,max} = V_{CEQ} + R_{ac} I_{CQ}$$

$$V_{CEQ} = V_{CC}$$

$\therefore V_{CE}(t)_{,max} = 21.324\ V$

5.2-1 $(P_{L,ac})_{max} = 2W$, $V_{CC} = 20V$

$\eta = \eta_{max} = 50\%$

$$\eta_{max} = \frac{(P_{L,ac})_{max}}{P_{CC}} \times 100\%$$

$\therefore P_{CC} = 4W$

$P_{CC} = V_{CC} I_{CQ} = 4W$

$\therefore I_{CQ} = 0.2A$

$i_C(t)_{,max} = 2I_{CQ} = 0.4A$

$v_{CE}(t)_{,max} = 2V_{CC} = 40V$

$P_{C,max} = P_{CC} = 4W$

$$I_{CQ} = \frac{V_{CC}}{R_L^-}$$

$\therefore R_L^- = 100\Omega$

$R_L^- = N^2 10$

$\therefore N = 4$

<u>5.3_2</u> : $BV_{CEO} = 40V$, $(P_{L,ac})_{,max} = 10W$

$R_L = 10\,\Omega$

$2V_{cc} = 40V = BV_{CEO}$

$\therefore V_{cc} = 20V$

$(P_{L,ac})_{max} = \frac{1}{2}\frac{V_{cc}^2}{R_L'} = 10W$

$\therefore R_L' = 20\,\Omega$

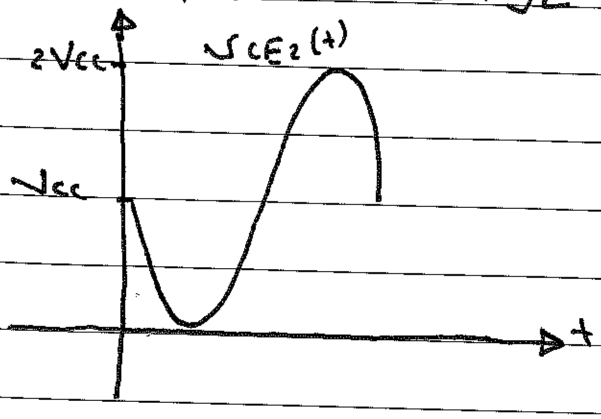
$R_L' = N^2 10$, $\therefore N = 1.414$

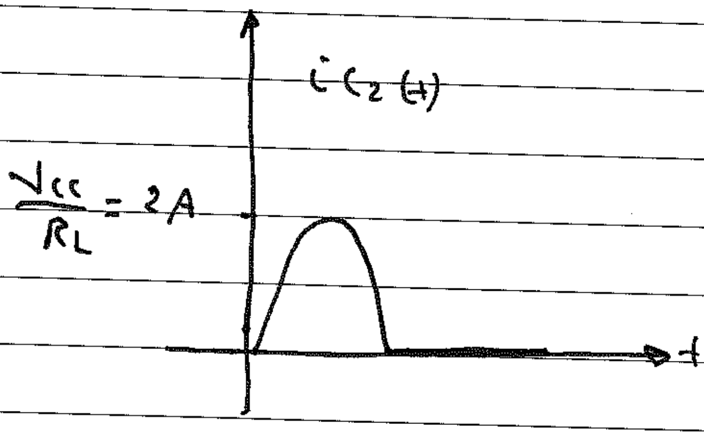
$P_{C,max} = \frac{1}{\pi^2}\frac{V_{cc}^2}{R_L'} = 2.07\,W$

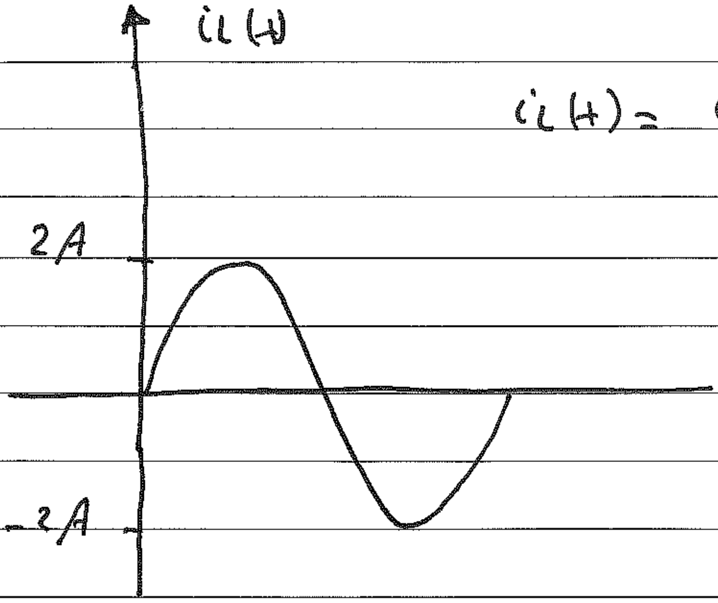
<u>5.4_2</u> : $V_{BE} = 0.65V$; $V_{cc} = 20V$

$V_{BE} = 0.65 = \frac{10k}{10k + R_x}(20V) \Rightarrow$

$R_x = 298k\,\Omega$







$i_L(t) = i_{C2}(t) - i_{C1}(t)$

c) $(P_{L,ac})_{,max} = \frac{1}{2} I_{cm,max}^2 R_L$

$I_{cm,max} = \frac{V_{CC}}{R_L} = 2A$

$\therefore (P_{L,ac})_{,max} = 20W$

$P_{CC} = \frac{2}{\pi} I_{cm} V_{CC} = 25.5W$

$\eta_{max} = \frac{(P_{L,ac})_{,max}}{P_{CC}} \times 100\% = 78.5\%$

d) $I_{cm} = \frac{2}{\pi} \frac{V_{CC}}{R_L} = 1.27A$

$P_{C,max} = \frac{1}{\pi^2} \frac{V_{CC}^2}{R_L} = 4W$

14.1 :

$v_o(t)_{,max} = V_{CC} - V_{CE_1,sat} = 5 - 0.3 = 4.7V$

$v_i(t) = v_{BE}(t) + v_o(t)$; $\therefore v_i(t) = 5.4\,V$

$$I = \frac{V_{CC} - V_{BE_2}}{R} = \frac{5 - 0.7}{1k} = 4.3\,mA$$

$v_o(t)_{,min} = -V_{CC} + V_{CE_2,sat} = -4.7V$

or

$v_o(t)_{,min} = -R_L I = -4.3\,V$

$\therefore v_o(t)_{,min} = -4.3V$

$\therefore$ The Corresponding $v_i(t)_{,min} = -4.3 + 0.7 = -3.6V$

If the EB junction of Q_3 is made twice as big as that of Q_2

$$I = \frac{I_R}{2} = 2.15\,mA$$

$v(t)_{,max} = 4.7V$ as before ; $v_i(t)_{,max} = 5.4V$

$v_o(t)_{,min} = -IR = -2.15V$

$v_i(t)_{,min} = -2.15 + 0.7 = -1.45V$

If the EB junction of Q_3 is made half as big as that of Q_2

$I = 2I_R = 8.6\,mA$

$v_o(t)_{,max} = 4.7V$ as before ; $v_i(t)_{,max} = 5.4V$

$v_o(t)_{,min} = -4.7V$; $v_i(t)_{,min} = -4V$

14.

$I_T = 1mA$; $I_R = 0.5mA$; $\therefore I_C = 0.5mA$

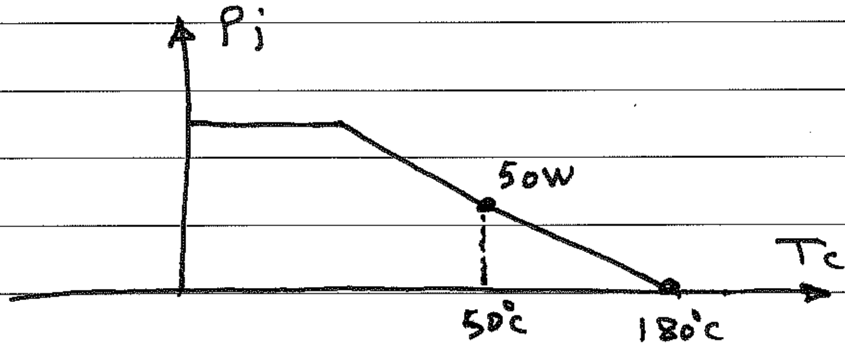
$\therefore V_{BE} = V_T \ln \frac{0.5mA}{1mA} = 0.683V$

$\beta = \infty \longrightarrow I_B = 0$

$\therefore R_1 = R_2 = \frac{V_{BE}}{I_R} = \frac{0.683V}{0.5mA} = 1.565 k\Omega$

$V_{BB} = 2V_{BE} = 1.366V$

14.30 :



$\Theta_{jc} = \frac{180 - 50}{50} = 2.6\ °c/W$

$T_j - T_s = \Theta_{js} P_j$

$\Theta_{js} = \Theta_{jc} + \Theta_{cs} = (2.6 + 0.6) = 3.2\ °c/W$

Assume Case II : $T_j = T_{j,max}$

$T_j - T_s = \Theta_{js} P_j$

$T_{j,max} - T_s = \Theta_{js} P_j$; $P_j = 30W$, $\Theta_{js} = 3.2\ °c/W$

$\therefore T_s = 84°c$

$T_s - T_a = \theta_{sa} P_j$

$84 - 39 = (\theta_{sa})(30)$

$\therefore \theta_{sa} = 1.5\ °C/W$

heat sink length $= \frac{4.5}{1.5} = 3$ cm