72. Consider the below characteristic curves of an npn bipolar transistor. Calculate $h_{fe} = \beta$. Assume the npn transistor is part of a common emitter amplifier with a supply voltage of 12 V. Directly on the below plot, draw in the load line for a 2 kΩ collector resistor, and mark a nice operating point $Q$. At $Q$, what is the change in the collector voltage $\Delta V_{CE}$ for a change in the base current $\Delta I_B = .01$ mA? Calculate $h_{ie}$ using your operating point's base current. What change in the base voltage $\Delta V_{BE}$ will accompany the change in the base current $\Delta I_B = .01$ mA? Calculate the ac voltage gain: $\Delta V_{CE}/\Delta V_{BE}$. At your operating point, how much power is dissipated in the transistor?

$h_{ie} = (\beta+1) r_e = 151 \frac{25}{3}$

$= 1.26\ k\Omega$

$\Delta I_B h_{ie} = \Delta V_B$

$(.01)(1.26k) = .0126\ V$

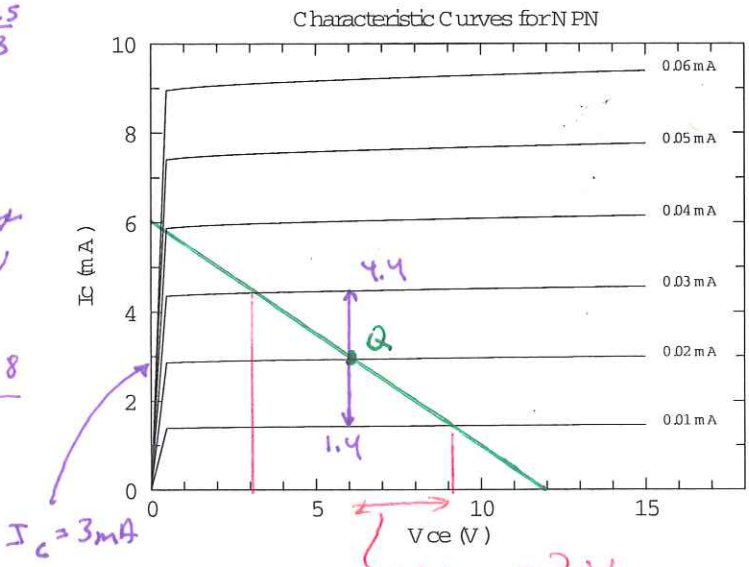
$gain = \frac{3}{.0126} = 238$

$h = \frac{4.4 - 1.4\ mA}{.02\ mA}$

$= 150$

$power = (6\ V)(3\ mA)$

$= 18\ mW$




$I_c = 3mA$

$\Delta V_{ce} = 3\ V$

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A Source follower

B common emitter amp

C differential Amp

D emitter follower

E Current mirror

F push-pull follower

G Common source amp

H common emitter amp

I FET current source

J BJT current source

problems.pdf: 67, 72, 74

67: $z_{out} = 5K \Rightarrow R_C = 5K$ ; by $\frac{V_{cc}}{3} \Rightarrow R_{E1} = 5K$

$$Gain = -20 = \frac{-R_C}{R_{E2} + r_e} \Rightarrow R_{E2} + r_e = \frac{5\,K}{20} = 250\Omega$$

Select $V_{cc} = 15\,V$ so $V_E = 5V$ so $I_E = 1mA$ so $r_e = 25\Omega$

$R_{E2} = 220\Omega$ ↑ standard value

$I_B \approx \frac{1}{100} 1mA = .01\,mA$

$V_B = \frac{V_{cc}}{3} + .6 = 5.6\,V$

HH: $R_{B1} \| R_{B2} = \frac{1}{10}(\beta+1)(r_e + R_{E1}) = 10 \cdot 5K = 50K$ (10 ≈ β, DC)

$$\frac{V_B}{V_{cc}} = \frac{R_{B1} \| R_{B2}}{R_{B1}} \Rightarrow R_{B1} = \frac{R_{B1} \| R_{B2}}{V_B / V_{cc}} = \frac{50}{5.6/15} = 134$$

$$\frac{1}{R_{B2}} = \frac{1}{R_{B1} \| R_{B2}} - \frac{1}{R_{B1}} = \frac{1}{50} - \frac{1}{134} \Rightarrow R_{B2} = 80K$$

if $\beta = \infty$ $V_B = V_C \frac{R_{B1}}{R_{B1} + R_{B2}} = 5.6$ (as designed)

if $\beta = 100 \rightarrow I_B = .01\,mA$ $droop = (R_{B1} \| R_{B2}) I_B = 50K \cdot .01mA = .5V$

$V_B = 5.6 - .5 = 5.1$

$\frac{\Delta V_E}{V_E} = \frac{.5}{5} = 10\%$

TK: $R_{B1} = \frac{V_{cc} - V_B}{10 I_B} = \frac{15 - 5.6}{.1\,mA} = 94K$

$R_{B2} = \frac{V_B}{9 I_B} = \frac{5.6}{.09mA} = 62K$

$R_{B1} \| R_{B2} = 37K$

$\beta = \infty$ (pure voltage divider) $\frac{6.2}{6.2+94} 12 = 5.96$ ↑ $droop = (37)(.01) = .37$

$\frac{\Delta V_E}{V_E} = \frac{.36}{5} = 7\%$ 5.6 (as designed)

$C_{out} = \frac{1}{2\pi \cdot 1600 \cdot 5000} = .03\,\mu F$ $f_{min} = 1000\,Hz$

$Z_{in}(TK) = 37K \| \underbrace{(\beta+1) R_{E2}}_{24.8K} = 14.8\,K$ ← slight miss (245)

$Z_{in}(HH) = 50K \| (\beta+1) R_{E2} = 16.6$ ← OK

$C_{in} = \frac{10}{2\pi f\, 16.6 K\Omega} = .01\,\mu F$ $C_E = \frac{10}{2\pi f\, 220} = 7.2\,\mu F$