ECEN326: Electronic Circuits
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Lab 10: Design of a BJT Shunt-Series Feedback Amp

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From a feedback perspective, this circuit can be viewed as a current amplifier with the source current amplified to form the signal current through Q2.

Thus, we have **current-current feedback** with a parallel or “shunt” feedback resistor $R_F$ and a “series” sensor resistor $R_{E2}$.

In the lab, it is easiest to measure this as a voltage amplifier with a standard voltage source input and taking the output as the Q2 collector.
Feedback Equivalent Circuit – Open Loop

Assuming $\alpha = 1$

Open - Loop Current Gain :

$$a = \frac{i_o}{i_e} = -\frac{(R_S\parallel(R_F + R_{E2})\|r_{\pi1})(R_{C1}\|R_{i2})}{r_{e1}(r_{e2} + (R_F\parallel R_{E2}))} \approx -\frac{R_Sg_{m1}R_{C1}}{R_{E2}}$$

Feedback Factor :

$$f = -\frac{R_{E2}}{R_{E2} + R_F} \approx -\frac{R_{E2}}{R_F}$$

$$z_i = R_S\parallel(R_F + R_{E2})\|r_{\pi1} \approx R_S$$

$$z_o = R_T + r_{o2} + g_{m2} \frac{r_{\pi2}}{r_{\pi2} + (r_{o1}\parallel R_{C1})} \approx g_{m2}r_{o2}R_{E2}$$

$$R_T = R_F\parallel R_{E2}\parallel(r_{\pi2} + (r_{o1}\parallel R_{C1})) \approx R_{E2}$$
Feedback Equivalent Circuit – Closed Loop

\[ A_i = \frac{i_o}{i_s} = \frac{a}{1 + af} \approx -\frac{R_F}{R_{E2}} \]

\[ Z_i = \frac{z_i}{1 + af} \approx \frac{R_F}{g_m R_{C1}} \]

\[ Z_o = z_o(1 + af) \approx g_{m2} r_{o2} R_{E2} \left( 1 + \frac{R_S g_m R_{C1}}{R_F} \right) \]
Converting to a Voltage-Mode Amplifier

See details in lab manual
Design Procedure

1. Using Isupply spec, apply most of the current to the output stage (7-8mA) for good distortion performance
2. The first stage should work well with 0.5-1mA
3. From DC conditions, set RE1, RE2, and RC1
4. Using load line analysis (Eq 7), calculate RC2
5. Set RF to meet the voltage gain spec
6. Verify that you meet the af spec (Eq 19 & 20)