

Homework Problems

Transistor Biasing

rev. 3

These problems illustrate the real issues involved in doing circuit design with transistor amplifiers. Each of the first four problems develops a necessary step. The last problem combines the results of the first four problems to do a real design.

1. Given a desired collector current stability factor with temperature ($K_T = I_{C_maximum} / I_{C_minimum}$) and the operating Temperature Minimum and Temperature Maximum and the nominal V_{BE} at 25 deg. C and that the temperature coefficient of V_{BE} is about -2.2 mV/deg. C, determine the minimum value of V_{BB} such that the collector current stability factor with temperature is less than a specified value. Solve symbolically. Use the result to determine V_{BB} min for the following K_T factors, 1.2, 1.1, 1.05, for the following problems:
 1. $T_{min} = 10$ deg. C, $T_{max} = 50$ deg. C
 2. $T_{min} = 0$ deg. C, $T_{max} = 70$ deg. C
 3. $T_{min} = -20$ deg. C, $T_{max} = 75$ deg. C
2. Given a desired collector current stability factor with beta ($K_B = I_{C_maximum} / I_{C_minimum}$) and a minimum and maximum value of beta, determine the maximum value for (R_B / R_E) such that the collector current stability factor with Beta is less than a specified factor, K_B . Solve symbolically. Use the result to determine the maximum value of (R_B / R_E) for the following K_B factors, 1.5, 1.2, and 1.1, for the following problems.
 1. Beta minimum = 50, Beta maximum = 200
 2. Beta minimum = 100, Beta maximum = 300
 3. Beta minimum = 30, Beta maximum = 100
3. Using the nominal value of Beta ($Beta_nominal = \sqrt{Beta_min * Beta_max}$), and the nominal value of V_{BE} ($V_{BE_nominal} = \sqrt{V_{BE_min} * V_{BE_max}}$), and given a desired collector current, I_C , V_{BB} , and (R_B / R_E) , derive the equation for calculating the required value of R_E . Then use the previously determined (R_B / R_E) factor to determine R_B .
4. Given V_{CC} , ($V_{EE} = 0$), and a desired V_{BB} and specified value of R_B , determine the voltage divider resistors, R_{B1} (to V_{CC}) and R_{B2} (to ground). Use the results to determine R_{B1} and R_{B2} for the following problems.
 1. $V_{CC} = 12$, $V_{BB} = 3$, $R_B = 20,000$
 2. $V_{CC} = 5$, $V_{BB} = 1.5$, $R_B = 10,000$
 3. $V_{CC} = 30$, $V_{BB} = 5$, $R_B = 100,000$
5. Given a transistor amplifier with $V_{CC} = 15$ Volts, $V_{EE} = 0$, I_C desired = 1.7 mA, Temperature minimum = 0 degrees C, Temperature maximum = 60 degrees C, Beta minimum = 75, Beta maximum = 250, $K_T = 1.1$, $K_B = 1.05$, V_{BE} at 25 degrees C is 0.62 Volts, use the results of problems 1, 2, 3, and 4 to determine R_E , R_{B1} and R_{B2} for this amplifier.