Instructions, notes, and hints:

Provide the details of all solutions, including important intermediate steps. You will not receive credit if you do not show your work.

Some problems might be solvable (or must be solved) using good engineering approximations or assumptions. In those cases, your answer might differ from the posted answer by a fairly large margin. Given typical device variations and component tolerances, that amount of discrepancy is often reasonable. If you justify any approximations you make, you will be given full credit for such answers.

All problems: Unless otherwise specified, you may assume that all BJTs are at room temperature, that the emission coefficient $n = 1$, and that the Early voltage $V_A$ is large enough that the effect of $r_o$ can be ignored.

All problems: Capacitors with the $\infty$ symbol next to them can be assumed to have values large enough that they act as shorts at the operating frequency of the amplifier.

Prob. 6.144: The gain of the amplifier in Prob. 6.142 might not evaluate to exactly $-36.6$ V/V. Also note that the $\times 3$ increase in resistor values is a very rough approximation.

Prob. 6.151: The small signal $v_{sig}$ has a zero average DC voltage. The current source at the top of the figure is an ideal DC source. The arrow above the current source indicates a connection to a DC voltage source ($V_{CC}$). Its value is irrelevant to the problem; assume it is large enough for the current source to operate properly and for the BJT to remain in the active region.

Assignment:

Problems 6.142, 6.144, 6.146, and 6.151 in the textbook, plus the following additional problems:

1. Using a Taylor (or Maclaurin) series expansion, prove that for the case $v_{be} \ll V_T$, the approximation

   \[ e^{v_{be}/nV_T} \approx 1 + \frac{v_{be}}{nV_T} \]

   is valid.

(continued on next page)
2. For the common-base amplifier shown below, find symbolic expressions in terms of the values of the resistors and $\beta$ for

   a. the small-signal voltage gain $A_v = \frac{v_o}{v_{in}}$.
   b. the input resistance $R_{in}$ seen by the signal source.
   c. the output resistance $R_o$ seen by the load.

You may assume that $V_{BE} = 0.7$ V, $V_{CE\mid sat} = 0.2$ V, and $V_a \to \infty$. Also, the values of $C_i$, $C_o$, $C_B$, and $C_{CC}$ are large enough that they act as shorts at the operating frequency.