Example:
(P14.3)
Design the circuit below using a +-9V supply to provide a design capable of +-7V outputs with a 1kohm load. Use the smallest possible total supply current.

Example #2:
(D14.14)
A class B output stage is required to deliver an average power of 100W into a 16ohm load. The power supply should be 4V greater than the corresponding peak sine-wave output voltage. Determine the power-supply voltage required (to the nearest volt), the peak current from each supply, the total supply power, and the power-conversion efficiency.

Class AB stage:

- This type of stage uses both the “A” and the “B” to produce a “push-pull” operation without the deadband.
Output Stages

- The voltage offset at the input crossover distortion

\[ I_Q = I_S e^{\frac{V_{BB}}{V_T}} \Rightarrow V_{BB} = 2V_T \ln \frac{I_Q}{I_S} \]

\[ i_N = I_S e^{\frac{V_{BEN}}{V_T}} \Rightarrow V_{BEN} = V_T \ln \frac{i_N}{I_S} \]

\[ i_P = I_S e^{\frac{V_{EBP}}{V_T}} \Rightarrow V_{EBP} = V_T \ln \frac{i_P}{I_S} \]

\[ V_{BEN} + V_{EBP} = V_{BB} \]

\[ \Rightarrow V_T \ln \left( \frac{i_N}{I_S} \right) + V_T \ln \left( \frac{i_P}{I_S} \right) = 2V_T \ln \frac{I_Q}{I_S} \]

\[ \Rightarrow i_N i_P = I_Q^2 \quad \text{smooth transition at } V_o = 0 \]

Output resistance:
- This will change as \( V_o \) changes \( \Rightarrow \) Therefore, only find for a fixed value of \( V_o \).
**OUTPUT STAGES**

Biasing Class AB stage:

- Biasing with diodes:

  ![Diagram of Class AB biasing with diodes]

  - If output transistor emitter area is n times larger than diode junction area, then
    
    \[
    i_N = I_S e^{\frac{V_{BEN}}{V_T}} \\
    i_P = I_S e^{\frac{V_{BE1}}{V_T}} \\
    i_{Diode} = \frac{I_S}{n} e^{\frac{V_{BE2}}{V_T}} \\
    \]

    \[
    I_Q = n I_{bias}
    \]

- Biasing using a \(V_{BE}\) multiplier

  ![Diagram of Class AB biasing using a \(V_{BE}\) multiplier]
Output Stages

$V_{BB}$ can be set using resistors adjusted to get the right $I_Q$:

```
\begin{center}
\includegraphics[width=0.3\textwidth]{dummy.png}
\end{center}
```

**Thermal Runaway in BJT’s:**

- As Temperature $\uparrow$ by 1°C:
  - If collector current is fixed, $V_{BE}$ drops by 2mV \{VBE dependence $\Rightarrow -2mV/°C$\}
  - If $V_{BE}$ is fixed, collector current increases 8%

- As collector current $\uparrow$, BJT Temp $\uparrow$ which causes collector current $\uparrow$, …
  - THERMAL RUNAWAY

**Solution is to:**

- Place D1, D2 or Q1 in ________________________________
  - IC Design $\Rightarrow$ place them __________________
  - In discrete design $\Rightarrow$ mount D1, D2, or Q1 on the _____________