**Problem 3.69**  The circuit shown in Fig. P3.69 is connected to a variable load \( R_L \) through a resistor \( R_s \). Choose \( R_s \) so that \( I_L \) never exceeds 4 mA, regardless of the value of \( R_L \). Given that choice, what is the maximum power that \( R_L \) can extract from the circuit?

![Figure P3.69: Circuit for Problem 3.69.](image)

**Solution:** We should start by finding the Thévenin equivalent of the circuit to the left of \((a,b)\). Simple source-transformation steps lead to:

\[
\begin{align*}
\text{To satisfy the stated condition, we need to choose } R_s \text{ such that } I_L &= 4 \text{ mA when } R_L = 0. \\
&\text{That is } \\
I_L &= 4 \text{ mA} = \frac{10}{2k + R_s},
\end{align*}
\]

which leads to \( R_s = 0.5 \text{ k}\Omega \).

For maximum power transfer by \( R_L \), it should be equal to:

\[
R_L = 2 \text{ k}\Omega + R_s = 2.5 \text{ k}\Omega
\]

\[
I_L = \frac{10}{5k} = 2 \text{ mA}
\]

\[
P_{\text{max}} = I_L^2 R_L = (2 \times 10^{-3})^2 \times 2.5 \times 10^3 = 10 \text{ (mW)}.
\]