Correction to Answer for Common-Source Amplifier Example

Part (f): This problem was a bit “trickier” than originally intended!

For \( R_D = 25 \, \text{k}\Omega \), the MOSFET would be operating in the linear region, with \( v_{DS} = v_{OUT} = 0.5 \, \text{V} \). (This is obtained by load-line analysis, i.e. carefully sketching the \( i_D-v_{DS} \) curve for \( v_{GS} = 3 \, \text{V} \), then sketching the load line, then finding the value of \( v_{DS} \) at the point where these curves intersect.) The formula for \( g_m \) is then

\[
g_m \equiv \left. \frac{\partial i_D}{\partial v_{GS}} \right|_{v_{GS}=3V} = \left. \frac{\partial W}{\partial v_{GS}} \right|_{v_{GS}=3V} \left[ k' \frac{W}{L} \left( v_{GS} - V_T - \frac{v_{DS}}{2} \right) v_{DS} \right]_{v_{GS}=3V} = k' \frac{W}{L} v_{DS} = 50 \times 10^{-6} \times 0.5 = 7.5 \times 10^{-5} \, \text{S}
\]

The small-signal equivalent circuit for the amplifier is

\[ \text{Diagram of the small-signal equivalent circuit.} \]

From this circuit, it can be seen that the incremental change in the output voltage, \( v_{out} \), is simply \(-g_m v_{gs} R_D = -(7.5 \times 10^{-5})(0.1)(25000) = 0.1875 \, \text{V} \). This is larger than the value of 0.15 V which we obtained for \( R_D = 5 \, \text{k}\Omega \).

**RL Circuit Answer**

\( t < 0: v = 2 \, \text{V} \)
\( t > 0: v = 10 - 8e^{-1000t} \)

(Note that \( v \) is a continuous function of time, because the current flowing through the inductor is a continuous function of time.)

**RC Circuit Answer**

\( t < 0: v = 0 \, \text{V} \)
\( t > 0: v = -1.5e^{-100t} \, \text{Volts} \)

(Note that \( v \) is discontinuous at \( t = 0 \).)

**Diode Circuit #1 (left) Answer**

D1 is ON \( (V_{D1} = 0, \, I_{D1} > 0; \, i.e. \text{ short circuit with positive current flow}) \)
D2 is OFF \( (V_{D2} < 0, \, I_{D2} = 0; \, i.e. \text{ open circuit with negative voltage drop}) \)
\( V = 6 \, \text{V}; \, I = 6 \, \text{mA} \)

**Diode Circuit #2 (right) Answer**

D1 is ON \( (V_{D1} = 0, \, I_{D1} > 0; \, i.e. \text{ short circuit with positive current flow}) \)
D2 is OFF \( (V_{D2} < 0, \, I_{D2} = 0; \, i.e. \text{ open circuit with negative voltage drop}) \)
\( V = 10 \, \text{V}; \, I = 0 \)