Solution (T-Line & Field)

1. \[ \tan \theta_1 = \frac{B_{lt}}{B_{lm}} \quad \text{and} \quad \tan \theta_2 = \frac{B_{st}}{B_{sm}} \]

But \[ B_{2m} = B_{1m} \quad \text{and} \quad \frac{B_{st}}{B_{sm}} = \frac{B_{lt}}{B_{lm}}, \quad \text{Hence} \]
\[ \tan \theta_2 = \frac{B_{lt}}{B_{lm}} \frac{\mu_2}{\mu_1} = \frac{\mu_2}{\mu_1} \tan \theta_1 \]

We note that \( \theta_2 = \theta_3 \) and
\[ \tan \theta_4 = \frac{\mu_3}{\mu_1} \tan \theta_3 = \frac{\mu_3}{\mu_1} \frac{\mu_2}{\mu_1} \tan \theta_1 = \frac{\mu_3}{\mu_1} \tan \theta_1. \]

Which is independent of \( \mu_2 \).

2. The magnetic field at \( P(0,0,h) \) is composed of \( H_1 \) due to the loop and \( H_0 \) due to the wire:
\[ H = H_1 + H_2 \]

We know that
\[ H_1 = \hat{z} \frac{I_1 A^2}{2(\alpha^2 + h^2)^{3/2}} \quad (A/m) \]
\[ H_2 = \hat{\phi} \frac{I_2}{2\pi y_0} \quad (A/m) \]

where \( \hat{\phi} \) is defined with respect to the coordinate system of the wire. Point \( P \) is located at an angle \( \phi = -90^\circ \) with respect to the wire coordinates.
\[ \hat{\phi} = -\hat{x} \sin \phi + \hat{y} \cos \phi = \hat{x} \quad (\phi = -90^\circ) \]

Hence
\[ H = \hat{z} \frac{I_1 A^2}{2(\alpha^2 + h^2)^{3/2}} + \hat{x} \frac{I_2}{2\pi y_0} \quad (A/m) \]
Solution (T-Line & Field)

3. (a) \[ \Gamma = \frac{Z_L - Z_0}{Z_L + Z_0} = \frac{50 + j100 - 100}{50 + j100 - 100} = \frac{-50 + j100}{150 + j100} \]
   \[ = 0.62 \  e^{-j82.9^\circ} \]

   The time-average power dissipation in the load is
   \[ P_{av} = \frac{1}{2} \left| \frac{V_L}{Z_L} \right|^2 \cdot R_L \]
   \[ = \frac{1}{2} \frac{|V_L|^2}{|Z_L|^2} \cdot R_L = \frac{1}{2} \times 12 \times \frac{50}{50^2 + 100^2} = 0.29 \text{ W} \]

   (b) \[ P_{av} = P_{av} \left( 1 - |\Gamma|^2 \right) \]

   Hence, \[ P_{av} = \frac{P_{av}}{1 - |\Gamma|^2} = \frac{0.29}{1 - 0.62^2} = 0.47 \text{ W} \]

   (c) \[ P_{av} = -|\Gamma| \cdot P_{av}^i = -1.062 \times 0.47 \]
   \[ = -0.18 \text{ W} \]