Solution (T-Line & Field)

1. $$\tan\theta_1 = \frac{B_{1t}}{B_{1n}} \quad \text{and} \quad \tan\theta_2 = \frac{B_{2t}}{B_{2n}}$$

But $B_{2n} = B_{1n}$ and $\dfrac{B_{2t}}{\mu_2} = \dfrac{B_{1t}}{\mu_1}$, Hence

$$\tan\theta_2 = \frac{B_{1t}}{B_{1n}}\frac{\mu_2}{\mu_1} = \frac{\mu_2}{\mu_1}\tan\theta_1$$

we note that $\theta_2 = \theta_3$ and

$$\tan\theta_4 = \frac{\mu_3}{\mu_2}\tan\theta_3 = \frac{\mu_3}{\mu_2}\tan\theta_2 = \frac{\mu_3}{\mu_2}\frac{\mu_2}{\mu_1}\tan\theta_1$$
$$= \frac{\mu_3}{\mu_1}\tan\theta_1$$

which is independent of μ_2

2. The magnetic field at $P(0,0,h)$ is composed of H_1 due to the loop and H_2 due to the wire:

$$\vec{H} = \vec{H}_1 + \vec{H}_2$$

We know that

$$\vec{H}_1 = \hat{z}\frac{I_1 a^2}{2(a^2+h^2)^{3/2}} \quad (A/m)$$

$$\vec{H}_2 = \hat{\phi}\frac{I_2}{2\pi y_0} \quad (A/m)$$

where $\hat{\phi}$ is defined with respect to the coordinate system of the wire. Point P is located at an angel $\phi = -90°$ with respect to the wire coordinates.

$$\hat{\phi} = -\hat{x}\sin\phi + \hat{y}\cos\phi = \hat{x} \quad (\phi = -90°)$$

Hence,
$$\vec{H} = \hat{z}\frac{I_1 a^2}{2(a^2+h^2)^{3/2}} + \hat{x}\frac{I_2}{2\pi y_0} \quad (A/m)$$

Solution (T- line & Field)

3. (a) $\Gamma = \dfrac{Z_L - Z_0}{Z_L + Z_0} = \dfrac{50 + j100 - 100}{50 + j100 - 100} = \dfrac{-50 + j100}{150 + j100}$

$= 0.62\, e^{j82.9^\circ}$

The time average power dissipation in the load is.

$$P_{av} = \frac{1}{2} \left| \tilde{I}_L \right|^2 R_L = \frac{1}{2} \left| \frac{\tilde{V}_L}{Z_L} \right|^2 \cdot R_L$$

$$= \frac{1}{2} \frac{|\tilde{V}_L|^2}{|Z_L|^2} \cdot R_L = \frac{1}{2} \times 12^2 \times \frac{50}{50^2 + 100^2} = 0.29\,W$$

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

Hence, $P_{av}^{i} = \dfrac{P_{av}}{1 - |\Gamma|^2} = \dfrac{0.29}{1 - 0.62^2} = 0.47\,W$

(c) $P_{av}^{r} = - |\Gamma| P_{av}^{i} = -(0.62)^2 \times 0.47$

$= -0.18\,W$