4.

(a) $v_p = c/\sqrt{\epsilon_r} = 3 \times 10^8/2 = 1.5 \times 10^8 (\text{m/sec})$

$$\text{Length} = \frac{1}{2} v_p \cdot 2t_r = \frac{1}{2}(1.5 \times 10^8)(10 \times 10^{-6}) = 750(\text{m})$$

$$Z_0 = V_0/I_0 = 30/0.5 = 60(\Omega)$$

$$\rho_T = \frac{R_T - Z_0}{R_T + Z_0} = \frac{0-60}{0+60} = -1$$

→ from a lattice diagram (such as in part b):

$$V(2t_r) = V_G' + V_G'\rho_T + V_G'\rho_T\rho_g$$

$$15 = 30 + 30(-1) + 30(-1)\rho_g$$

$$\Rightarrow \rho_g = -\frac{1}{2}$$

$$\rho_g = \frac{R_G - Z_0}{R_G + Z_0} \Rightarrow -\frac{1}{2} = \frac{R_G - 60}{R_G + 60} \Rightarrow R_G = \frac{1+\rho_G}{1-\rho_G} Z_0 = \frac{0.5}{1.5} 60 = 20\Omega$$

$$\Rightarrow R_G = 20\Omega$$

$$30(\text{V}) = \frac{Z_0}{Z_0 + R_G} V_0 = \frac{60}{60+20} V_0$$

$$\Rightarrow V_0 = 40(\text{V})$$

(b) $\rho_G = -0.5$, $\rho_T = -1$