1. (a)

$$i_l = (I_{dc} + I_m \frac{\cos(wt + \phi - arctan(\frac{wL}{R}))}{\sqrt{1 + (\frac{wL}{R})^2}})(1 - e^{\frac{t_0 - t}{L/R}})$$

$$v_r = R(I_{dc} + I_m \cos(wt + \phi) - i_l)$$

(b)

$$v_c = (V_{dc} + V_m \frac{\cos(wt + \phi - arctan(\frac{wL}{R}))}{\sqrt{1 + (\frac{wL}{R})^2}})(1 - e^{\frac{t_0 - t}{L/R}})$$

$$v_r = \frac{(V_{dc} + V_m \cos(wt + \phi) - v_c)}{R}$$

2.

$$i = \begin{cases} 5(1 - e^{-2t}) & t < 2s \\ \frac{10}{3}(1 + \frac{1 - 3e^{-4}}{2} e^{6-3t}) & t \geq 2s \end{cases}$$

3.

$$i_l = \begin{cases} 10(1 - e^{-10t}) & t < 0.5s \\ -0.0001e^{-10(t-0.5) + 9.93e^{(-999990(t-0.5))}} & t \geq 0.5s \end{cases}$$

$$v_c = \begin{cases} 10(1 - e^{-10t}) & t < 0.5s \\ 9.93e^{-10(t-0.5)} & t \geq 0.5s \end{cases}$$

4. $P_1 \approx 0.05$, $Q_1 \approx 1.59$, $P_2 \approx 4.9 \times e^{-6}$, $Q_2 \approx -0.016$

5. for $t < t_0$

$$i_l(t) = \frac{V}{R_1}(1 - e^{\frac{-R_1 t}{L_1}})$$

for $t > t_0$ solve the differential equation

$$(L_1 + L_2) i_l''(t) + R_2 i_l'(t) + \frac{i_l(t)}{C} = 0, \quad i_l(t_0) = i_0, \quad (L_1 + L_2) i_l'(t) = -R_2 i_0$$

6. for $t < t_0$

$$V_c(t_0) = V, \quad i_L(t_0) = \frac{V}{R}$$

for $t > t_0$ solve the differential equation

$$i_L(t) = C V_c'(t) + \frac{V_c(t)}{R}, \quad i_c(t) = C V_c'(t), \quad LC i_L''(t) = -i_c(t)$$

7. for $t < t_0$ solve the differential equation

$$L i_L'(t) + R i_L(t) - V_m \cos(wt + \phi) = 0$$

for $t > t_0$ solve the differential equation

$$L i_L''(t) + R_2 i_L'(t) + \frac{i_L(t)}{C} = 0, \quad i_L(t_0) = i_0, \quad L i_L'(t_0) = -R_2 i_0$$