Problem 1:

(1)

$$V_{o\,rms} = \sqrt{\frac{1}{T}\int_0^T [1+2\sin(100t+30^\circ)]^2 dt} = \sqrt{\frac{1}{T}\int_0^T [1+4\sin(100t+30^\circ)+4\cdot\frac{1-\cos(100t+60^\circ)}{2}] dt}$$

$$= \sqrt{\frac{1}{T}\int_0^T [3+4\sin(100t+30^\circ)-2\cos(200t+60^\circ)] dt} = \sqrt{\frac{1}{T}(3T+4\cdot[\frac{-\cos(100t+30^\circ)}{100}]_0^T-2\cdot[\frac{\sin(200t+60^\circ)}{200}]_0^T}$$

$$= \sqrt{3}\ V.$$

(2)

$$I_o = \begin{cases} I_s & t\in[0,0.5T) \\ -\frac{4I_s}{T}\cdot t+2I_s & t\in[0.5T,\frac{3}{4}T) \\ \frac{4I_s}{T}\cdot t-4I_s & t\in[\frac{3}{4}T,T) \end{cases}$$

Then $I_{o\,rms} = \sqrt{\frac{1}{T}\int_0^T I_o^2\, dt}$

Here

$$\int_0^T I_o^2 dt = \int_0^{0.5T} I_s^2\, dt + \int_{0.5T}^{0.75T}(-\frac{4t}{T}+2)^2 I_s^2\, dt + \int_{0.75T}^{T}(\frac{4t}{T}-4)^2 I_s^2 dt$$

$$= I_s^2\cdot \int_0^{0.5T} 1\, dt + \int_{0.5T}^{0.75T}(\frac{16}{T^2}t^2-\frac{16}{T}t+4)\, dt + \int_{0.75T}^{T}(\frac{16}{T^2}t^2-\frac{32}{T}t+16)\, dt$$

$$= \frac{2}{3}T\cdot I_s^2.$$

So

$$I_{o\,rms} = \sqrt{\frac{1}{T}\int_0^T I_o^2 dt} = \sqrt{\frac{2}{3}I_s^2} = \frac{\sqrt{6}}{3}I_s.$$

Problem 2:

$$I = \frac{\tilde{V}_{TH}}{Z_{eq}+Z_L} = \frac{\tilde{V}_{TH}}{(R_{eq}+R_L)+j(X_{eq}+X_L)}$$

Then

$$P_L = \frac{1}{2}I^2R_L = \frac{1}{2}\frac{V_{TH}^2\cdot R_L}{(R_{eq}+R_L)^2+(X_{eq}+X_L)^2}$$

To find the maximum, we need to find its derivative.

$$\frac{\partial P_L}{\partial R_L}=0 \Rightarrow \underbrace{(X_{eq}+X_L)^2+R_{eq}^2-R_L^2}_{\cdots}=0 \Rightarrow R_{eq}^2=R_L^2$$

$$\frac{\partial P_L}{\partial X_L}=0 \Rightarrow \underbrace{R_L(X_{eq}+X_L)}_{\cdots}=0 \Rightarrow X_{eq}=-X_L$$

(1) For $R_{eq}>0$, $Z_L = R_{eq}-jX_{eq}$

(2) For $R_{eq}<0$, $Z_L = -R_{eq}-jX_{eq}$.