Uppgift 1. a) Symmetriska laster ger $\bar{I}_{L1} = \bar{I}_{L2} = \bar{I}_{L2}$, med $\bar{U}_i$ som referns.

$$
\begin{aligned}
P_{Last1} &= \frac{P_{avg}}{\eta} = \frac{40}{0.9} = 44.4kW \\
P_{Last2} &= 30kW \\
Q_{Last1} &= \frac{P_{Last1}\sin\varphi_1}{\cos\varphi_1} = 33.3kVAr \\
Q_{Last2} &= \frac{P_{Last2}\sin\varphi_2}{\cos\varphi_2} = 9.9kVAr \\
S_{tot} &= \sqrt{P_{tot}^2 + Q_{tot}^2} = 86.1kVA \\
I_{L1} &= \frac{S_{tot}}{U_H\sqrt{3}} = 124A \\
\cos\varphi_{tot} &= \frac{P_{tot}}{S_{tot}} = 0.86
\end{aligned}
$$

Vilket alltså ger $I_{Li} = 124e^{-j30.2^\circ}A$ med U_i som referens.

b)

c) Y-kopplad last drar trev ggr mindre effekt.

$$
\begin{aligned}
P_{Last2,Y} &= \frac{P_{Last2}}{3} = 10kW \\
Q_{Last2,Y} &= \frac{P_{Last2,Y}\sin\varphi_2}{\cos\varphi_2} = 3.3kVAr \Longrightarrow \\
&\Longrightarrow \cos\varphi_{tot,Y} = \frac{P_{tot,Y}}{S_{tot,Y}} = \frac{44.4+10}{\sqrt{(44.4+10)^2 + (33.3+3.3^2}} = 0.83
\end{aligned}
$$

Uppgift 2. a)

$$
\begin{aligned}
P_1 &= U_a I_a + U_m I_m \\
I_m &= \frac{U_m}{R_m} = 1A \\
P_1 &= 200\cdot 9 + 220\cdot 1 = 2020W \\
E &= U_a - R_a I_a = 200 - 2.3\cdot 9 = 179.3V \\
P_2 &= EI_a = 179.3\cdot 9 = 1613.7W \\
\eta &= \frac{P_2}{P_1} = 0.80
\end{aligned}
$$

b)

$$
\begin{aligned}
I_{a,II} &= 0.5I_a \\
P_{1,II} &= 200\cdot 4.5 + 220\cdot 1 = 1120W \\
E_{II} &= U_a - R_a I_a = 200 - 2.3\cdot 4.5 = 189.7V \\
P_{2,II} &= EI_a = 189.7\cdot 4.5 = 844.4W \\
\eta_{II} &= \frac{P_2}{P_1} = 0.75
\end{aligned}
$$

c)

$$U_{a,I} - R_a I_{a,I} - k_1 \Phi n_I = 0 \Longrightarrow k1_\Phi = \frac{200 - 2.3 \cdot 9}{1100} = 0.1629$$
$$I_{a,III} = I_{a,I} = 9A$$
$$U_{a,III} - R_a I_{a,III} - 0.1629 n_{III} = 0 \Longrightarrow n_{III} = 487rpm$$

Uppgift 3. a) Motorns poltal är 6, och det synkrona varvtalet $n_1 = 1000rpm$.

b)

$$s = \frac{n_1 - n_2}{n_1} = \frac{1000 - 950}{1000} = 0.05$$

c)

$$s_I = \frac{n_1 - n_{2,I}}{n_1} = \frac{1000 - 950}{1000} = 0.05$$
$$s_I = \frac{n_1 - n_{2,II}}{n_1} = \frac{1000 - 800}{1000} = 0.20$$
$$M_I = kU^2 \frac{s_I}{R_2}$$
$$M_{II} = kU^2 \frac{s_{II}}{R_2 + R_y}$$
$$M\_I = M_{II}$$
$$\frac{M_I}{M_{II}} = \frac{kU^2 \frac{0.05}{0.10}}{kU^2 \frac{0.20}{0.10 + R_y}} \Longrightarrow$$
$$\Longrightarrow 1 = \frac{0.5(0.1 + R_y)}{0.20} \Longrightarrow R_y = 0.30\Omega$$

d) Exempelvis att förlusterna ökar eftersom eftersläpningen ökar.

Uppgift 4. c)

$$U_L = \frac{1}{T}\int_0^T u(t)dt = \frac{3}{T}\int_{\frac{T}{x}}^{\frac{T}{2}} 230\sqrt{2}\sin(\omega t)dt = /T = \frac{2\pi}{\omega}/ =$$
$$= \frac{230\sqrt{2}3\omega}{2\pi}\left[-\frac{\cos(\omega t)}{\omega}\right]_{\frac{2\pi}{x\omega}}^{\frac{\pi}{\omega}} = 155.3\left(1 + \cos\left(\frac{2\pi}{x}\right)\right)$$
$$U_L = 100V \Longrightarrow \cos\left(\frac{2\pi}{x}\right) = \frac{100 - 155.3}{155.3} \Longrightarrow$$
$$\frac{2\pi}{x} = 1.93 \Longrightarrow x = 3.24$$

$\frac{T}{3.24}$ motsvarar vinkeln $\frac{360^\circ}{3.24} = 110.9^\circ$. Tändvinkeln blir då

$$\alpha = 110.9^\circ - 30^\circ = 80.9^\circ$$