Synchrone machine

S	4	Power in [KVA]
U	398.37168574084	Grid voltage Line-Line RMS
Us	230	Grid voltage Line-Neutral RMS
T	20	Load torque

Calculate

Xd	39.675[ohm]
Lm	126.289[mH]
Pmech	3141.593[Watt]
v	0.903[Rad]
lasthoek	51.758[Degrees]
Ie	8.198[A]
Epx	-255.466[V]
Epy	201.339[V]
Exx	255.466[V]
Exy	123.931[V]
Isx	3.124[A]
Isy	-6.439[A]
Is^{rms}	5.061[A]
cos(phi)	0.900[.]
Pcalculated	3141.593[Watt]

Synchronous Machine

S[VA]=4000[kVA]
Sb[VA]=S/3=1333[kVA] per phase

Line and neutral voltage:
U[V]=230[Vrms Line-Neutral] * sqrt(3)= 398[Vrms Line-Line]

Mechanical power:
Te=20[Nm] and n=3000/2=>ω=157.1[Rad/s]
P[Watt]=Te*ω=20*157=3142[Watt]

Calculate base impedance:
$Zb[V]=U^2/Sb=230*230/1333=52900/1333=39.68$

Assume 1pu for the synchronous impedance/inductance:
Xd[ohm]=Zb*1p.u.=40[ohm]
Ld[mH]=Xd/314.15927=39.68/314.15927=126[mH]

Calculate load angle from power equation:
sin(υ)=Pm/S=3142/4000=0.785
υ=arcsin(0.785)=0.9[Rad]=52[degrees]

Calculate Ie in case of nominal operation, so Ep=Us
Ie=U*sqrt(2)/Xd=1.414*230/39.68=325/39.68=8.2[A]

Calculate the induced back emf from the rotorfield:
Epx[v]=-sqrt(2)*U*sin(υ)=-sqrt(2)*230*sin(0.9)=-255[v]
Epy[v]= sqrt(2)*U*cos(υ)= sqrt(2)*230*cos(0.9)=201[v]
Note that we are using the maximum amplitude of the voltage, while calculating voltages and currents!

Calculate the voltage Ux between the induced back emf and the grid voltage:
Ux(x)[v]=0 - Epx= 0 -(-255)=255[v]
Ux(y)[v]=sqrt(2)*Us - Epy= 325-201=124[v]
I=Ux/Xd

Stator current lags Ux with 90 degrees:
with xy components Ix=Ux(y)/Xd and Ix=-Ux(x)/Xd
Ix=Ux(y)/Xd = 124/39.68=3.1
Iy=-Ux(x)/Xd = -255/39.68=-6.4

RMS value of the stator current:
$Is = sqrt(Ix^2+Iy^2)/sqrt(2)=sqrt(10+41)/1.414=5.06$
and the cos(ϕ)
cos(ϕ)=-cos(atan2(Ix,Iy))=-cos(atan2(3.1,-6.4))=0.9

from which we can recalculate and check the real power:
P=3*Us*Is*cos(ϕ)=230*5.06*0.9=3142
S=3*Us*Is*cos(ϕ)=230*5.06*0.9=3492