ПРИЛОЖЕНИЕ

Программа расчетов рабочие характеристики АД при U/f=const или M=const

Ust_RezimP.m

```
script
global f Mc U pol ZR Pz;
clc,
%  TYPE OF MOTOR  << 4A-132-S4-Y3 >>
%  Y-CONNECTED, funtion mom1.m,
P2n= 7500;% Nominal power [Wt](Golgberg."Proektirovanie")
H=132;  % High osi vrasenia, [mm]
%disp(['    ','LAW  M=CONST']);
disp(['         ','=========================']);
%=====================================
fn=50;  % [Hz], nominal frequency
m=3;        % number of phace [ o.e],
pol=2;      % number of par pole [o.e], 2p=4
w1n=2*pi*fn;   %sinxron frequensy of cirquit [1/rad];
nnom=60*fn/pol; % sinxron speed [rout/min]
omegan=2*pi*fn/pol;% sinxron speed [1/c]
Un=220; % [V], nomial  phace voltage
sn=0.026; % nominal slip AD,[o.e]
Mn=P2n/(omegan*(1-sn));% nominal torque [N*m]
kpdn=0.884;% nominal KPD AD,[o.e]
kosn=0.86; % nominal COS(fi) AD,[o.e]
In=P2n/(m*Un*kosn*kpdn);
mk=3;   % mk=Mmax/Mnom [o.e.]
```

```
Bdeln=0.9;% nominal induction in air delta
mk=3;  mp=1.7;  ki=6.7;
Mc=Mn;% Torque of load [N*m]
%=======================================
f=fn;
%=======================================
% Input new parametrs of motor
%============================================================
disp('    After vvoda New value - push the button <<ENTER>>');
k=1;
 while k<4
    k=menu('What will vary ',...
   sprintf('Voltage- U=%g V ',Un),...
   sprintf('Frequency- f=%g Hz ',f),...
   sprintf('Torque - Mc=%g N*m. ',Mc),...
         'Nothinng not will vary');
       if k==1,
Un=input([sprintf(' Initial value U=%g',Un)...
       ' V, New value U= ']);
    elseif k==2,
f=input([sprintf(' Initial value f=%g',f)...
       '  Hz, New value f= ']);
     elseif k==3,
Mc=input([sprintf(' Initial torque Mc=%g',Mc)...
       '  N*m, New value Mc= ']);
     end
end
clc,
```

```
disp(['    ','================================']);
%=========================================
% LAW ( Mc = const)
%=========================================
w1=2*pi*f;   % frequensy of circuit [1/rad];
n1=60*f/pol;  % sinxron speed [rout/min]
%=========================================
% Parametrs of T-basic circuit AD
% =========================================
Rs=0.524;  % Resistance of phace stator,[Om]
Rr=0.328;  % Resistance of phace rotor,[Om]
Xs=1.49*f/50;  % Leakage reactance of phace stator,[Om]
Xr=1.67*f/50;  % Leakage reactance of phace  rotor,[Om]
Xm=38*f/50; % Main reactance of phace  stator and rotor,[Om]
Rmn=2.58; % Resistance of iron losses for f=50Hz,[Om]
Rm=Rmn*(f/50)^1.5; % Resistance of iron losses,[Om]
ZR=[Rs Rr Xs Xr Xm Rm];
%Rs[om]    Xs[om]    Rr[om]    Xr[om]    Rm[Om]    Xm[Om]
%0.7278    1.2425    0.4302    1.7274    2.1262   36.5979
%=========================================================
Ws1=126; % number wound statora
ko1=0.9598;% obmotocnii koefficient
Da1=0.233; % output diametr of statora ,[M]
Di1=0.153; % input diametr of statora,[M]
li=0.115;% lenght of statora, [M]
tau=pi*Di1/2/pol;% polucnoe delenie
%=========================================
% Callculation Losses
```

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%=======================================
if pol==1
   kt=1.38*(1-Da1);
else
   kt=1;
end
Pmex=kt*(n1^1e-3)^2*(Da1*10)^4;
        %Pmexn=66.6;% [Wt];
        %Pmex=Pmexn*(f/fn)^1.5;
I1nom=P2n/(3*Un*kosn*kpdn);
sin=sqrt(1-kosn^2);
I0=I1nom*(sin-kosn/(2*mk));
Pfe=3*I0^2*Rm;
Pdob=P2n/kpdn*0.005;
Pz=[Pmex Pfe Pdob];
%=====================================
% Callculation charakteristik
%=====================================
   if f<=50
U=Un*f/fn;  % input phace voltage, [V],
else
   U=Un;
end
%=======================================
c1=sqrt(((Rs+Rm)^2+(Xs+Xm)^2)/(Rm^2+Xm^2));
skr=c1*Rr/(sqrt(Rs^2+(Xs^2+c1*Xr)^2));
Mkr=m*U^2*pol/(2*w1*c1*(Rs+sqrt(Rs^2+(Xs+c1*Xr)^2)));
P2kr=Mkr*w1/pol*(1-skr);
```

```
disp(['    ','LAW  M=CONST']);
disp(sprintf(['    ','Mc = %g [N*M]'],Mc));
if Mc<=Mkr
[s]=feval('mom1',Mc);
%=========================================
Rd=Rr/s;
gr=Rd/(Rd^2+Xr^2); gm=Rm/(Rm^2+Xm^2);Rc=1/gm;
br=Xr/(Rd^2+Xr^2); bm=Xm/(Rm^2+Xm^2);Xmu=1/bm;
gz=gr+gm; bz=br+bm;
Rz=gz/(gz^2+bz^2);Xz=bz/(gz^2+bz^2);
R=Rs+Rz; X=Xs+Xz;
Is=U/sqrt(R^2+X^2);
Ed=Is*sqrt(Rz^2+Xz^2);
%=================================
FLUX=Ed/(4.44*f*ko1*Ws1);
Bdel=FLUX/(0.64*tau*li);
%=================================
Im=Ed/sqrt(Rm^2+Xm^2);
Ir=Ed/sqrt(Rd^2+Xr^2);
cos=Is*R/U;
dP=3*(Is^2*Rs+Im^2*Rm+Ir^2*Rr);
kpd=1-dP/(3*Is^2*R);
M=m*Ir^2*Rd*pol/w1;
P1=m*U*Is*cos;
P2=(P1-dP);
P1cu=m*Is^2*Rs;
P2cu=m*Ir^2*Rr;
Pfe=m*Im^2*Rm;
```

```
Pdob=P2n/kpd*0.005;
%====================================
Img=Ed/Rc;
Imr=Ed/Xmu;
Imz=sqrt(Img^2+Imr^2);
omega=2*pi*f/pol*(1-s);
%====================================
disp(['     ','Steady-state rezim']);
disp(['     ','======================']);
disp(sprintf(['    ','f = %g [Hz]'],f));
disp(sprintf(['    ','U = %g [V]'],U));
disp(sprintf(['    ','Skr = %g [o.e]'],skr));
disp(sprintf(['    ','Mkr = %g [N*m]'],Mkr));
disp(['     ','======================']);
disp(['     ','Series connection Rm and Xm']);
disp(sprintf(['    ','Imu = %g [A]'],Im));
disp(['     ','======================']);
disp(sprintf(['    ','S = %g [o.e]'],s));
disp(sprintf(['    ','M = %g [N*m]'],M));
disp(sprintf(['    ','Omegar = %g [1/c]'],omega));
disp(sprintf(['    ','P2 = %g [Wt]'],P2));
disp(sprintf(['    ','Is = %g [A]'],Is));
disp(sprintf(['    ','cos(fi) = %g [o.e.]'],cos));
disp(sprintf(['    ','kpd = %g [o.e.]'],kpd));
disp(sprintf(['    ','Bdel = %g [T]'],Bdel));
%=========================================
disp(['  ============== ','Losses  AD   ','[WT] ===============']);
disp(['     ','P1e','      ','P2e','      ','Pfe','      ','Pmex','    ','Pdob']);
```

```
pot=[P1cu P2cu Pfe Pmex Pdob];
disp(pot);
save 'dat0.mat' pot;
%=========================================
w11=2*pi*f/pol;
c1=sqrt(((Rs+Rm)^2+(Xs+Xm)^2)/(Rm^2+Xm^2));
s1=0:0.01:0.2;
zn1=(s1.*Rs+c1*Rr).^2+s1.^2.*(Xs+c1*Xr).^2;
Mi=m*U^2*Rr.*s1./(w11.*zn1);
figure(1)
H26=plot(s1,Mi,'-b'); grid on, hold on
set(H26,'LineWidth',2);
plot(s,M,'sr');
tt=text(s+0.01,M,'M_c');
set(tt,'FontSize',10,'FontWeight','bold');
hx26=XLABEL('s, [o.e]');
set(hx26,'FontSize',10,'FontWeight','bold');
hy52=YLABEL('Mem [N*m] ');
set(hy52,'FontSize',10,'FontWeight','bold');
ht26=title('Torque vs slip');
set(ht26,'FontSize',12,'FontName','Arial','FontWeight','bold');
disp(['    ','End program' ]);
else
   disp('Attention: Mc>Mkr. It is necessary decrease Mc ' )
   disp(sprintf(['    ','Mkr = %g [N*M]'],Mkr));
end
snom=s;  % nominal slip AD,[o.e] for f
nc=n1;   % sinxron speed,[rou/min]for f
```

Подпрограмма mom1.m

```
function y=mom(Mc),% Callculation slips for Mc=const
global U f pol ZR;% script file Ust_Rezim.m
m=3;      % number of phace, Y-CONNECTED,
%=============================================
% PARAMETRS OF T-oi CIRCUIT AD
Rs=ZR(1);  % Resistance of phace stator,[Om]
Rr=ZR(2);  % Resistance of phace rotor,[Om]
Xs=ZR(3);  % Leakage reactance of phace stator,[Om]
Xr=ZR(4);  % Leakage reactance of phace  rotor,[Om]
Xm=ZR(5); % Main reactance of phace  stator and rotor,[Om]
Rm=ZR(6); % Resistance of iron losses,[Om]
% Callculation sleep s=f(Mc) po ZAICHIKU V.M. "Elektrichestvo" N7,1979
%============================================================
w1=2*pi*f/pol;
c1=sqrt(((Rs+Rm)^2+(Xs+Xm)^2)/(Rm^2+Xm^2));
K=m*U^2/(2*w1*Mc*c1)-Rs;
zk=K+sqrt(K^2-Rs^2-(Xs+c1*Xr)^2);
y=c1*Rr/zk;
```