5.8 Computer program: Design of Stator main dimensions

Problem:

Calculate diameter of core, length, size and number of conductors for a 15000kVA; 50Hz; 11kV ; 2 – Pole star connected salient pole cylindrical rotor alternator with armature winding having 600 phase spread. Assume :

avg. magnetic flux Bav = .55Wb/m2

electrical loading ac = 36,000 amp/m

current density J = 5 amp/mm2

peripheral speed Va = 160m/sec

windings should be arranged to eliminate 5th harmonic.

Synchronous speed Ns = 50 r.p.s

Solution:

Given Ns = 50 r.p.s and P = 2 poles

Peripheral speed Va = 160m/sec

Va = pi*D*Ns

Therefore D = Va/(pi*Ns) = 160/(3.14*50) = 1 m

Now Distribution factor for 60o phase spread in order to eliminate 5th harmonic

Kd = .955

cos(5α/2) = 0

giving 5α/2 = 90

giving α = 36o

Pitch factor Kp = cos(α/2) = .951

Now Kw = Kp * Kd = .951 * .955 = .8595

Now Co = 1.11pi2*f*Bav*ac*Kw = 1.11*3.142*50*.55*36000*.8595 = 186.248

D2L = P/(Co*Ns)

L = 15000/(186.248*50*12) = 1.6m

Flux Φ = pi*D*L*Bav = 3.14*1*1.6*.55 = 2.76Wb

Φpole = Φ/pole = 1.38Wb/pole

Tph = Eph/(4.44*f*Kw*Φpole) = (11000/√3)/(4.44*50*.8595*1.38) = 24

Total conductors Z = 6*Tph = 144 = Ss

Conductor per slot = Z/(2*Poles) = 144/4 = 36

Program:

```
function calculate_D_L_size_number_alternator_cylindrical_rotor

%given

Bav = .55;

ac = 36000;

J = 5;

Va = 160;

Ns = 50;

pole = 2;

Q = 15000;

f = 50;

Eline = 11000;

%therfore D

D = Va/(pi*Ns);

%———-

%Now distribution factor for 60 degree phase spread in
```

```
%order to eliminate 5th harmonic
%———————-
Kd = .955;
alpha = (2*acosd(0))/5;
%Why as cos(5*alpha/2) = 0 for 5th harmonic
fprintf('\nProgram to calculate D, L size and numer of conductors of Synch machine');
fprintf('\n————————————');
fprintf('\nFor 5th harmonic elimination we have alpha = ');
disp(alpha);
fprintf('\nUsing alpha we also get…..');
% pitch factor Kp
Kp = cosd(alpha/2);
fprintf('\nPitch factor Kp = ');
disp(Kp);
% giving Kw
fprintf('\nStacking Factor Kw = ');
Kw = Kp*Kd;
disp(Kw);
% using Kw we get output coeffecient
Co = 1.11*pi*pi*f*Bav*ac*Kw*.001
fprintf('\nWe have Diameter D = ');
disp(D);
fprintf('\nLength L = ');
```

```
L = (Q)/(Co*Ns*D*D);
disp(L);
%Now flux phi
phi = pi*D*L*Bav;
fprintf('\nWe got Flux phi = ');
disp(phi);
phipole = phi/pole;
%Turn per phase
Eph = Eline/sqrt(3);
Tph = Eph/(4.44*f*Kw*phipole);
fprintf('\nTurns per phase Tph = ');
disp(Tph);
%total conductors Z
Z = 6*Tph;
fprintf('\nTotal conductors Z = ');
disp(Z);
%copnductors per slot
Ss = Z/(2*pole);
fprintf('\nConductors per slot = ');
disp(Ss);
end
```

Output:

For 5th harmonic elimination we have alpha = 36

Using alpha we also get…..

Pitch factor Kp = 0.9511

Stacking Factor Kw = 0.9083

Co =

9.8507e+003

We have Diameter D = 1.0186

Length L = 0.0294

We got Flux phi = 0.0517

Turns per phase Tph = 1.2194e+003

Total conductors Z = 7.3162e+003

Conductors per slot = 1.8290e+003