3.5 Computer program: Design of Armature main dimensions

Problem:

A 250 kw, 460V, 600r.p.m, 6 pole dc is built with an armature diameter of 72cm and core length 27 cm. The lap armature winding has 660 conductors. Using this data obtain preliminary dimensions for the armature, core, number of armature conductors and commutator segments for a 350kw, 500V, 725 r.p.m, 6 pole dc. Assume a square pole with pole arc = .7 pole pitch.

Solution:

Given,

Po = 250kw

N = 600 r.p.m so Ns = N/60 = 10r.p.s

Assume Po = Pa

D = 72 cm = .72m

L = 27 cm = .27m

Pa = CoD2LNs

so Co = Pa/(D2LNs) = 250/(.722*.27*10) = 178.6

Number of conductors per parallel path Zpath = 660/6 = 110

why 6?? cause its a lap wound so parallel path = number of poles.

Hence mean emf induced/conductor ez = 460/110 = 4.18V

Also ez = Bav*L*Va = Bav*L*pi*D*Ns

or Bav = ez/(L*pi*D*Ns) = 4.18/(.27*pi*.72*10) = .68Wb/m2

Now for other dc machine… We have

N = 725r.p.m so Ns = N/60 = 12.08

Pa = 350 kw we already have Co = 178.6

So D2L = Pa/(CoNs) = 350/(178.6*12.08) = .16222m3

L = .7*pi*D/6 = .36652D

giving D3 = .4426

so D = .76m hence length L = .28m

Now ez = Bav*L*Va = .68*.28*pi*.76*12.08 = 5.53V

Number of conductors per parallel path = 500/5.53 = 90

Number of conductors using lap winding = 90*6 = 540

Using single turn coil….

Number of coils = 540/2 = 270

Number of commutator segments = number of coils = 270

Check for minimim pitch of commutator segments….

Commutator diameter = .7D = .7*.76 = .53m

Therefore pitch of commutator segment = pi*.53 = 6.17*10-3m

AS this is more than the minimum allowable pitch of 4mm

Thus 270 commutator segments are well within the limit.

Program:

```
function design_dc_machine_series_connected
%Given
Po = 250;
N = 600;
Ns = N/60;
%Assume
Pa = Po;
```

```
D = .72;

L = .27;

%number of conductors

Z = 660;

pole = 6;

Vin = 460;%V

%Pa = CoD2LNs

Co = Pa/(D*D*L*Ns);

%Number of conductors per parallel path

%as lap winding so number of parallel path = number of poles

Ppath = pole;

Zpath = Z/Ppath;

fprintf('\nProgram to Design a series connected DC machine');

fprintf('\n————————————————————————————————');

fprintf('\nNumber of conductors per parallel path = ');

disp(Zpath);

fprintf('\nHence mean emf induced per conductor = ');

ez = Vin/Zpath;

disp(ez);

%now Bav

Bav = ez/(L*pi*D*Ns);

fprintf('\nAverage Flux density Bav = ');

disp(Bav);
```

```
% for other Dc machine

N1 = 725;

N1s = N1/60;

P1a = 350;

%D2L = Pa/CoNs

%L = .7piD/Pole

% square pole with pole arc = .7 pole pitch.

D3 = (P1a*pole)/(Co*N1s*.7*pi);

D = D3^(1/3);

%hence

L = .7*pi*D/pole;

fprintf('\nDiameter D of the other machine = ');

disp(D);

fprintf('\nLength L of the other machine = ');

disp(L);

%now ez

ez = Bav*L*N1s*D*pi;

%number of conductors per parallel path

%number of conductor Z1

Vin1 = 500;

Zpath = Vin1/ez;

fprintf('\nNumber of conductors per parallel path = ');

disp(round(Zpath));
```

```
fprintf('\nNumber of conductors using lap winding = ');
Zlap = round(Zpath)*pole;
disp(Zlap);
fprintf('\nChecking for minimum pitch of commutator segments…');
CommutatorDia = .7*D;
Commutatorpitch = pi*CommutatorDia;
if(Commutatorpitch>.004)
fprintf('\nYes this is alloeable as Commutator pitch greater than 4mm');
else
fprintf('\nNo thisn is not allowable as Commutator pitch is less than 4mm');
end
```

Output:

```
Number of conductors per parallel path = 110
Hence mean emf induced per conductor = 4.1818
Average Flux density Bav = 0.6847
Diameter D of the other machine = 0.7620
Length L of the other machine = 0.2793
Number of conductors per parallel path = 90
Number of conductors using lap winding = 540
Checking for minimum pitch of commutator segments…
Yes this is alloeable as Commutator pitch greater than 4mm
```