

MIDDLE EAST TECHNICAL UNIVERSITY

DEPARTMENT OF

ELECTRICAL AND ELECTRONICS

ENGINEERING

EE568 - Special Topics on Electrical Machines

Project #2

Motor Winding Design and Analysis

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# Introduction

In this project, we are aiming to design windings of motors with integral slot winding and fractional slot winding. In the first part, we are designed the winding of integral slot winding motor which has 120 slots, 20 pole and 3 phase. After tha, the distribution factor and pitch factor are calculated for the fundamental, 3rd and 5th harmonic components and results are compared.

In the second part, fractional slot winding machine is considered. Same calculations with the previous part are obtained.

In the final part, 2D model of our motor is modeled and some results including airgap flux density distribution, induced voltage waveforms and cogging torque are given.

# Integral-Slot Winding Design

In this part, a motor which has 120 slots, 20 poles and 3 phases is considered. It is assumed that the winding is full-pitched and winding diagram for one pole pair is designed and given in below.

q is defined as number of slot per poles per phases is calculated as follow;

where, Q is the number of slots : 120

p is the number of poles: 20

m is the number of phases: 3

One pole pair has 120/10 = 12 slots.

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Slot number | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
|  | A1 | A2 | -C1 | -C2 | B1 | B2 | -A1 | -A2 | C1 | C2 | -B1 | -B2 |

Fig. 1: Winding diagram of the given integral slot machine for one pole pair

Distribution factor, kd is defined as

where, q is no. of slots per no. of poles per no. of phases: 2

n is the number of order of harmonic

: is the angle between slots in electrical :30

for the fundamental component kd is calculated as follows;

= 0.96

Pitch factor, kp is defined as

where, n is the number of order of harmonic

is the pitch angle : 180

for the fundamental component kp is calculated as follows;

Winding factor is defined as

For the fundamental harmonic

kw = 0.96

For the third harmonic component

For the fifth harmonic component