

MIDDLE EAST TECHNICAL UNIVERSITY
DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING
EE568 - SELECTED TOPICS ON ELECTRICAL MACHINES
PROJECT #2 REPORT
March 23, 2020

Motor Winding Design and Analysis

1 INTRODUCTION

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2 INTEGRAL-SLOT WINDING DESIGN

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2.1 SINGLE LAYER

biyron tablo

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

winding factorler

	First	Third	Fifth
k_d	0.966	0.707	0.259
k_p	1.000	-1.000	1.000
k_w	0.966	-0.707	0.259

2.2 DOUBLE LAYER, FULL PITCHED

yet another tablo

Slot	1	2	3	4	5	6	7	8	9	10	11	12
Layer 1	A1+	A2+	C1-	C2-	B1+	B2+	A3-	A4-	C3+	C4+	B3-	B4-
Layer 2	A3+	A4+	C3-	C4-	B3+	B4+	A1-	A2-	C1+	C2+	B1-	B2-

winding factorler

	First	Third	Fifth
k_d	0.966	0.707	0.259
k_p	1.000	-1.000	1.000
k_w	0.966	-0.707	0.259

2.3 DOUBLE LAYER, 5/6 PITCHED

bir tane daha

Slot	1	2	3	4	5	6	7	8	9	10	11	12
Layer 1	A1+	A2+	C1-	C2-	B1+	B2+	A3-	A4-	C3+	C4+	B3-	B4-
Layer 2	A4+	C3-	C4-	B3+	B4+	A1-	A2-	C1+	C2+	B1-	B2-	A3+

winding factorler

	First	Third	Fifth
k_d	0.966	0.707	0.259
k_p	0.966	-0.707	0.259
k_w	0.933	-0.500	0.067

2.4 DOUBLE LAYER, 4/6 PITCHED

bi de buraya

Slot	1	2	3	4	5	6	7	8	9	10	11	12
Layer 1	A1+	A2+	C1-	C2-	B1+	B2+	A3-	A4-	C3+	C4+	B3-	B4-
Layer 2	C3-	C4-	B3+	B4+	A1-	A2-	C1+	C2+	B1-	B2-	A3+	A4+

winding factorler

	First	Third	Fifth
k_d	0.966	0.707	0.259
k_p	0.866	0.000	-0.866
k_w	0.837	0.000	-0.224

3 FRACTIONAL-SLOT WINDING DESIGN

3.1 24 SLOTS, 22 POLES

tablo geliyor

Slot	1	2	3	4	5	6	7	8	9	10	11	12
Forward	0	165	330	135	300	105	270	75	240	45	210	15
Reverse	180	345	150	315	120	285	90	255	60	225	30	195
Third	0	135	270	45	180	315	90	225	0	135	270	45
Fifth	0	105	210	315	60	165	270	15	120	225	330	75
Phase	A+	A-	A+	A-	C-	C+	C-	C+	B+	B-	B+	B-
Slot	13	14	15	16	17	18	19	20	21	22	23	24
Forward	180	345	150	315	120	285	90	255	60	225	30	195
Reverse	0	165	330	135	300	105	270	75	240	45	210	15
Third	180	315	90	225	0	135	270	45	180	315	90	225
Fifth	180	285	30	135	240	345	90	195	300	45	150	255
Phase	A-	A+	A-	A+	C+	C-	C+	C-	B-	B+	B-	B+

3.2 30 SLOTS, 22 POLES

bir tablo da buraya geliyor

Slot	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Forward	0	132	264	36	168	300	72	204	336	108	240	12	144	276	48
Reverse	180	312	84	216	348	120	252	24	156	288	60	192	324	96	228
Third	0	36	72	108	144	180	216	252	288	324	0	36	72	108	144
Fifth	0	300	240	180	120	60	0	300	240	180	120	60	0	300	240
Phase	A+	A-	C-	B-	A-	C-	C+	B+	A+	C+	B+	B-	A-	C-	B-
Slot	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Forward	180	312	84	216	348	120	252	24	156	288	60	192	324	96	228
Reverse	0	132	264	36	168	300	72	204	336	108	240	12	144	276	48
Third	180	216	252	288	324	0	36	72	108	144	180	216	252	288	324
Fifth	180	120	60	0	300	240	180	120	60	0	300	240	180	120	60
Phase	A-	A+	C+	B+	A+	C+	C-	B-	A-	C-	B-	B+	A+	C+	B+

4 2D FEA MODELLING

5 CONCLUSION