Volume 2, No.6, June 2013 International Journal of Advances in Computer Science and Technology Available Online at http://warse.org/pdfs/2013/ijacst01262013.pdf



Design and Optimization of Three Phase Induction Motor using Genetic Algorithm

Dr.A.Raghuram<sup>1</sup>, V. Shashikala<sup>2</sup>

<sup>1</sup>Associate Professor, Department of Electrical Engineering, India, raghuram\_a@yahoo.co.in <sup>2</sup>Department of Electrical Engineering, India, shashi.vikkirala@gmail.com

### ABSTRACT

With the increase of modernized equipments in our day-to-day life, demand for energy also increases, therefore to solve this energy crisis many new efforts have been made by exploiting renewable sources for obtaining energy or by improving the operating efficiency of devices requiring bulk consumption of electric energy. The design of induction motor using simplified method of Genetic algorithm is carried out with the objective of maximizing efficiency.

### **1. INTRODUCTION**

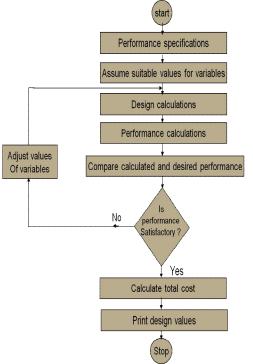
Induction motors[1] have many applications in the industries because of their low cost maintenance and robustness. Induction motors are used in very large numbers in a variety of applications. Design may be defined as a creative physical realization of theoretical concepts. Engineering design is application of science, technology and invention to produce machines to perform specified tasks with optimum economy and efficiency. Engineering is the economical application of scientific principles to practical design problems. If the items of cost and durability are omitted from a problem, the results obtained have no engineering value.

The problem of design and manufacture of electric machinery is to build, as economically as possible, a machine which fulfils a certain set of specifications and guarantees. Thus design is subordinated to the question of economic manufacture. In the past, the design of induction motor has been attempted for achieving better performance characteristics or reducing the cost. Any significant improvement in the operating efficiency[3] of induction motor helps into energy conservation.

### 1.1 Introduction to Genetic Algorithm

Genetic algorithm is one of the optimization methods inspired by the natural genetics. Genetic algorithm is a directed random search technique that is widely applied in optimization problems. This is especially useful for complex optimization problems where the number of parameters is large and the analytical global solutions are difficult to obtain. Due to GA's capability of finding the global optimum in the wide range of the functions, it has numerous applications in the optimization problems. In this method the use of random but intelligent search in a predefined area, the parameters of the proposed function lead to their optimum values. This method is a conventional procedure to solve nonlinear equations. In the Genetic algorithm the search of the optimal solution is basically performed proceeding from one group (population) of possible points in the search space to another, according to procedures that resemble those of natural selection and genetics and designed such as to steer the search towards better solutions.

The flow chart for design of three phase induction motor [1] which is shown in Figure 1:



**Figure 1**: Flow chart for design of three phase induction motor

In this dissertation work an attempt has been made to optimize the design of induction motor using Genetic Algorithm with the objective of maximizing the efficiency.

#### 2. RESULTS AND DISCUSSIONS

#### 2.1 The optimization problem:

The design optimization of induction motor can be expressed mathematically as follows.

Find  $X(x_1, x_2, x_3, x_4, x_5, x_6, \dots, x_1)$ 

Such that F(X) is maximum

Where  $X(x_1, x_2, x_3, x_4, x_5, x_6, \dots, x_1)$  is the set of independent variables.

F(X) is the objective function.

The eight basic variables with their upper and lower bounds are as follows:

1.	
	wb/m <sup>2</sup>
2.	Ampere conductors $5000 \le x_2 \le 45000$
	A/m
3.	Stator core depth $0.0175 \le x_3 \le 0.026$
	m
4.	Stator winding current density $3 \le x_4 \le 8$
	A/mm <sup>2</sup>
5.	Rotor winding current density $4 \le x_5 \le 10$
	A/mm <sup>2</sup>
6.	
0.	m
7.	
7.	
0	$x_{7} \leq 4.5$
8.	Rotor slot depth to width ratio $1.0 \le x_8 \le$
	2.0
	The objective function to be maximized is $F(X)$ . The
	following constraints are imposed on the design
	optimization problem.
	1. Maximum stator/rotor tooth flux density $\leq 2.0$
	2. per unit maximum torque $\leq$
	1.0
	3. per unit starting torque $\leq 1.0$
	4. per unit starting current $\leq$
	6.5
	5 Full load slip <0.055

	0.5	
5.	Full load slip	≤0.055
6.	Full load power factor	$\geq 0.8$
7.	Full load efficiency	$\geq 0.8$
8.	per unit no load current	$\leq$
	0.5	

#### 2.2 Optimization using Genetic Algorithm Toolbox:

To open the tool, enter

#### gatool

at the MATLAB prompt. This opens the Genetic Algorithm Tool, as shown in the figure 2

Fitness function is **Efficiency** Number of variables = **8** i.e.  $x_1$  to  $x_8$ Population = **100** Initial range = [**0.3 50000.0175340.000351.51.0**; **0.65 45000 0.02608100.000704.52.0**]

Enter these values in Genetic Algorithm Toolbox and start the genetic algorithm, then we will get optimum values of variables of a induction motor.

In this paper, to attain optimum results, squirrel cage induction motor[1] with six different ratings has been considered which are mentioned as below:

- 1. 1KW induction motor (efficiency-0.8, pf-0.825)
- 2. 2.2KW induction motor(efficiency-0.8, pf-0.825)
- 3. 5KW induction motor(efficiency-0.86, pf-0.86)
- 4. 6KW induction motor(efficiency-0.83, pf-0.84)
- 5. 8KW induction motor(efficiency-0.86, pf-0.87)
- 6. 10KW induction motor(efficiency-0.86, pf-0.87)

The optimum values of X1 to X8 are calculated by using Genetic Algorithm and are shown in Table 1.

Optimum	Three P	hase Induc	ction Mot	tor Rati	ngs	
values	1KW	2.2KW	5KW	6KW	8KW	10KW
X1	0.585	0.585	0.481	0.584	0.452	0.439
X2	11487.2	11487.2	5509.7	19941.6	34343.9	23262.6
X3	0.023	0.023	0.019	0.022	0.028	0.0237
X4	3.298	3.298	6.544	6.317	7.28	4.0202
X5	6.537	6.537	7.123	8.492	4.057	8.2258
X6	0.001	0.001	0.0015	0.003	0.0045	0.007
X7	4.052	4.052	1.704	3.774	3.766	2.3343
X8	1.559	1.559	1.411	1.957	1.377	1.277
Fitness Function value	0.8055	0.8331	0.8245	0.8345	0.8246	0.8245

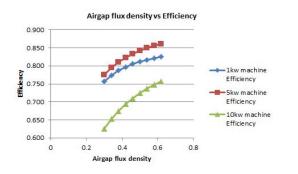
## **Table 1:** Calculated optimum values of different ratings of 3-phase induction motor

#### 3. APPENDIX

#### Table 2: Airgap flux density vs Efficiency

Air gap flux density	0.3	0.34	0.38	0.42	0.46	0.5	0.54	0.58	0.62
1kw machine Efficiency	0.757	0.774	0.787	0.797	0.805	0.812	0.817	0.822	0.826
5kw machine Efficiency	0.775	0.795	0.811	0.823	0.834	0.842	0.850	0.856	0.861
10kw machine Efficiency	0.626	0.653	0.675	0.694	0.710	0.724	0.737	0.748	0.758

#### Figure 2: Airgap flux density vs Efficiency



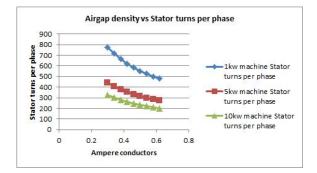
#### Summary of Table 2 and Figure 2

With the increase in Airgap flux density Efficiency increases for 1KW, 5KW and 10KW Machine.

#### Table 3: Airgap flux density vs Stator turns per phase

Air gap flux density	0.3	0.34	0.38	0.42	0.46	0.5	0.54	0.58	0.62
1kw machine Stator turns per phase	777.47	715.23	664.11	621.25	584.69	553.08	525.41	500.97	479.18
5kw machine Stator turns per phase	443.7	408.18	379.18	354.55	333.68	315.64	299.85	285.9	273.47
10kw machine Stator turns per phase	327.25	301.05	279.54	261.49	246.11	232.80	221.16	210.87	201.70

#### Figure 3: Airgap flux density vs Stator turns per phase



**Table 4: Ampere conductors vs Machine Efficiency** 

Ampere Conductors	5000	10000	15000	20000	25000	30000	35000	40000	45000
1kw machine Efficiency	0.7775	0.7611	0.75	0.7414	0.7343	0.7281	0.7227	0.7179	0.7134
5kw machine Efficiency	0.8539	0.836	0.8234	0.8133	0.8047	0.7972	0.7904	0.7842	0.7786
10kw machine Efficiency	0.6256	0.6526	0.675	0.694	0.7102	0.7243	0.7367	0.7477	0.7575

#### Figure 4: Ampere Conductors vs Efficiency

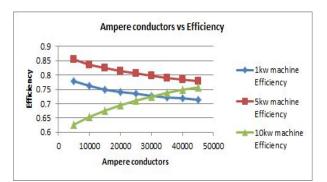
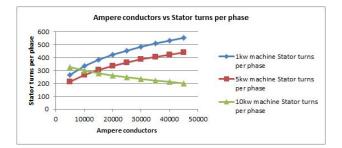


Table 5: Ampere Conductors vs Stator turns per phase

Ampere Conductors	5000	10000	15000	20000	25000	30000	35000	40000	45000
1kw machine Stator turns per phase	265.2811	334.2332	382.6015	421.1075	453.6243	482.0477	507.4644	530.5621	551.8069
5kw machine Stator turns per phase	212.0225	267.1316	305.7893	336.5647	362.5534	385.5534	405.5844	424.045	441.0246
10kw machine Stator turns per phase	327.2506	301.0523	279.5367	261.494	246.1063	232.7991	221.156	210.8673	201.6973

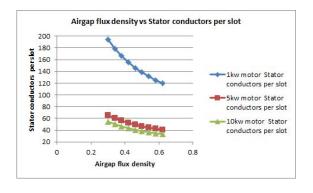
### Figure 5: Ampere conductors vs Stator turns per phase



#### Table 6: Airgap flux density vs Stator conductors per slot

Air gap flux density in wb/m <sup>2</sup>	0.3	0.34	0.38	0.42	0.46	0.5	0.54	0.58	0.62
1kw motor Stator conductors per slot	194.36	178.8	166.02	155.31	146.17	138.27	131.35	125.24	119.79
5kw motor Stator conductors per slot	65.62	60.37	56.05	52.44	49.35	46.68	44.35	42.28	40.44
10kw motor Stator conductors per slot	54.54	50.18	46.59	43.58	41.02	38.80	36.86	35.14	33.62

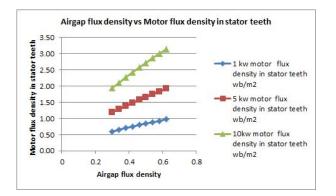
## Figure 6: Airgap Flux density vs Stator conductors per slot



## Table 7: Airgap flux density vs Flux density in stator teeth

Air gap flux density in wb/m <sup>2</sup>	0.3	0.34	0.38	0.42	0.46	0.5	0.54	0.58	0.62
1 kw motor flux density in stator teeth wb/m <sup>2</sup>	0.60	0.65	0.70	0.75	0.80	0.84	0.89	0.93	0.97
5 kw motor flux density in stator teeth wb/m <sup>2</sup>	1.18	1.29	1.39	1.48	1.57	1.66	1.75	1.84	1.92
10kw motor flux density in stator teeth wb/m <sup>2</sup>	1.94	2.10	2.27	2.42	2.57	2.72	2.86	3.00	3.14

## Figure 7: Airgap flux density vs Motor flux density in stator teeth



#### Table 8: Airgap flux density vs End ring current in Amps

Air gap flux density in wb/m <sup>2</sup>	0.3	0.34	0.38	0.42	0.46	0.5	0.54	0.58	0.62
1kw motor End ring current in Amps	356.67	328.12	304.67	285	268.23	253.73	241.04	229.82	219.83
5kw motor End ring current in Amps	560.13	515.29	478.46	447.58	421.24	398.46	378.53	360.92	345.23
10 kw end ring current in Amps	931.035	856.5	795.288	743.956	700.178	662.318	629.194	599.922	573.833

#### Figure 8: Airgap flux density vs end ring current

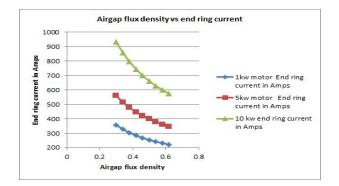
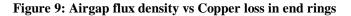
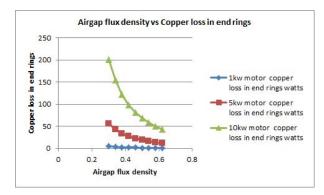


Table 9: Airgap flux density vs Copper loss in End rings

Air gap flux	0.3	0.34	0.38	0.42	0.46	0.5	0.54	0.58	0.62
density in wb/m <sup>2</sup>	0.5	0.51	0.50	0.12	0.10	0.5	0.51	0.50	0.02
1kw motor									
copper loss in	5.64	4.23	3.27	2.59	2.1	1.72	1.44	1.21	1.03
end rings watts									
5kw motor									
copper loss in	56.64	43.32	34.14	27.57	22.7	19.01	16.14	13.86	12.03
end rings watts									
10kw motor									
copper loss in	200.82	154.11	121.87	98.72	81.54	68.46	58.28	50.20	43.69
end rings watts									

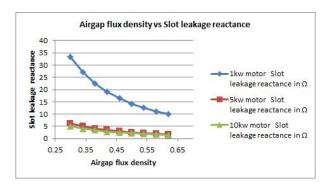






Air gap flux density in wb/m <sup>2</sup>	0.3	0.34	0.38	0.42	0.46	0.5	0.54	0.58	0.62
1kw motor Slot leakage reactance in Ω	33.44	27.15	22.55	19.09	16.4	14.27	12.55	11.14	9.97
5kw motor Slot leakage reactance in Ω	6.26	5.08	4.22	3.57	3.07	2.67	2.35	2.08	1.86
10kw motor Slot leakage reactance in Ω	5.12	4.16	3.45	2.92	2.51	2.19	1.92	1.71	1.53

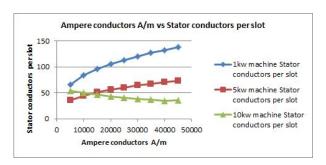
#### Figure 10: Airgap flux density vs Slot leakage reactance



# Table 11: Ampere Conductors vs Stator conductors per slot

Ampere Conductors A/m	5000	10000	15000	20000	25000	30000	35000	40000	45000
1kw machine Stator conductors per slot	66.32	83.55	95.65	105.27	113.4	120.51	126.86	132.64	137.95
5kw machine Stator conductors per slot	35.33	44.52	50.96	56.09	60.42	64.21	67.59	70.67	73.5
10kw machine Stator conductors per slot	54.54	50.18	46.59	43.58	41.02	38.80	36.86	35.14	35.62

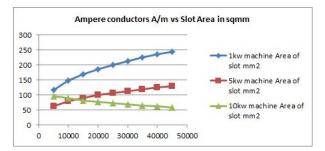
## Figure 11: Ampere conductors A/m vs Stator conductors per slot



#### Table 12: Ampere Conductors vs Slot Area

Ampere									
Conductors A/m	5000	10000	15000	20000	25000	30000	35000	40000	45000
1kw machine									
Area of slot mm <sup>2</sup>	117.52	148.06	169.49	186.55	200.96	213.55	224.81	235.04	244.45
5kw machine									
Area of slot mm <sup>2</sup>	62.61	78.89	90.31	99.4	107.07	113.78	119.78	125.23	130.25
10kw machine									
Area of slot mm <sup>2</sup>	96.65	88.91	82.56	77.23	72.69	68.76	65.32	62.28	59.57

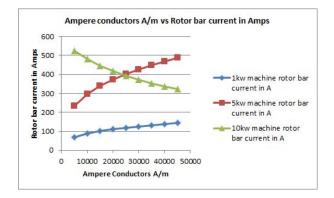
#### Figure 12: Ampere conductors A/m vs Slot area in sqmm



#### Table 13: Ampere Conductors vs Rotor bar current

Ampere Conductors A/m	5000	10000	15000	20000	25000	30000	35000	40000	45000
1kw machine rotor bar current in A	69.51	87.58	100.25	110.34	118.86	126.31	132.97	139.03	144.59
5kw machine rotor bar current in A	234.92	295.98	338.81	372.91	401.71	426.88	449.38	469.84	488.65
10kw machine rotor bar current in A	523.32	481.42	447.02	418.16	393.56	372.28	353.66	337.20	322.54

## Figure 13: Ampere conductors A/m vs Rotor bar current in Amps





Enter fitness function	Genetic Algorithm Tool			
	Fitness function	-	Options:	1.
Enter number of	Number of variables:	-11	Population	
variables for the fitness	Plots		Population type: Double Vector	×
	Pict interval	-11	Population size: 20	
	☐ Best fitness ☐ Best individual ☐ Distance		Creation function: Uniform	
	Expectation Cerealogy CRange			
	☐ Score diversity ☐ Scores ☐ Selection	ŝ.	Initial population:	
	Stopping	25	Initial scores:	
	Custom function:		Initial range 00:11	
	Run solver			
Start the genetic	Start Pavan Dtop		Fifthess scaling	
algorithm.			E Selection	
1	Current generation		Reproduction	
	Status and results	- 1	Mutation	
	1	- 11	Crossover	
Results displayed here —		- 11	Migration	
	1	- 11	Hybrid function	
	1	2	Stopping orderis	
	Final point.	_	Output function	
			E Display to command window	
	*	2	I Vectorize	

## Figure 15: 1KW Induction motor results

le Help		
ubles Setup and Results	Options	
laker qa - Genetic Algorithm	E Population	
holden	Population type: Double Vector	
Fitness function: @optga	Population size: 🕐 Use default: 28	
Namber of variables 1	<ul> <li>Specify: 300</li> </ul>	
Constructor	Creation function: Use constraint dependent default	
Linesr inequalities A		
Linear equalities: Are: bee:	Initial population: @ Use default []	
Bounds Lawer Upper	0 Sector	
Nonlinear constraint function	Initial scores:	
lan salver and view results	() Service	
🛙 Use random states from previous run		
Sat Paur Rop	Specify: [1.3 5000 1.0175 3 4 0.0035 1.3 1.0; 0.45 45000 0.0208 0 30 0.00070 4.5 2.0]	
Current Iteration: 🔟 Clear Results	E Fitness scaling	
Optimization running.	Scaling function: Rank	
<pre>Dptimization terminated. Bejective function value: 0.8055208001602167 Dptimization terminated: everage change in the fitness value less</pre>		
than options.Tolfun.	8 Selection	
	Selection function: Stachastic uniform	
Final point		
1+ 2 1 4 5 4 7 8 6385 11-87280 6033 3288 6337 0.001 4453	S Fapradaction	
(313) 11,40'292 (3323 3.139 6.337 0.312 4.352	Bite count:      Use default 2	

#### Figure 16: 2.2 KW results

la plane de la construcción de l	Image: Section (Section (
a ( g. Sond Synthe )	Spectra
le ge sendergeden in de la geren de la ger	Shark Hole         Brank H
na hanna (karaga (kara	Johnson D:         0 (buckhold I)           Im March (200         10 (buckhold I)           Im March (200         10 (buckhold I)           Im March (200         10 (buckhold I)           Im March (201         10 (buckhold I)
la construit de la construit d	Boydey (M)     Source (M)
	Bite Andrefer         Structures & Discolute Advat         Str           of sprayment         & Discolute Adj         Structures           of sprayment         & Discolute Adj         Structures           of sprayment         & Discolute Adj         Structures         Structures           of sprayment         & Discolute Adj         Structures         S
Annota de la	# Sprofer (# 1)
an emplote A b b b b b b b b b b b b b b b b b b	() Specky     ()
Ang	() Specky     ()
ndi Lauri lagari para sa	# United with []
akte ref view nach liter weider nicht frag periode som ein ferender in Henne periode som ein ferender i Begre stat satter in restatigt som farter i Begre som fa	O Service         O Mu default [15]           W Service         D Mu default [15]           W Service         [15:300:0217:3:4:5017:3:3:0; 6:35:017:3:3:0; 6:35:017:3:3:0; 6:35:017:3:3:0; 6:35:017:3:3:0; 6:35:017:3:3:0; 6:35:017:3:3:0; 6:35:017:3:3:0; 6:35:017:3:3:0; 6:35:017:3:3:0; 6:35:017:3:3:0; 6:35:017:3:017:3:0; 6:35:017:3:000; 6:30:000; 6:30:000; 6:30:000; 6:30:000; 6:30:000; 6:30:000; 6:30:000; 6:30:000; 6:30:000:000; 6:30:000:000; 6:30:000; 6:30:000; 6:30:000; 6:30:000; 6:3
It is readent pitts ham previou nan be ant - Proce - Itage ett honkors - Coar Fanats - Coar Fanats - So Socialization - Incolate, socialization - Incolate, socialization - Incolate, socialization - Socializations	al meger 🕒 Die default (R1) 🕷 Specify: [0:15000-0.01713 4.00107.03.0.0 4000 0.0011 30 0.00170 4.5.2.0]
It is readent pitts ham previou nan be ant - Proce - Itage ett honkors - Coar Fanats - Coar Fanats - So Socialization - Incolate, socialization - Incolate, socialization - Incolate, socialization - Socializations	al meger 🕒 Die default (R1) 🕷 Specify: [0:15000-0.01713 4.00107.03.0.0 4000 0.0011 30 0.00170 4.5.2.0]
ant Proce Supperturbation Constraints Supperturbation Suppertu	Specify: [0.3 5040 L0175 3 4 L30125 1.3 L1; 0.45 4000 L1201 8 20 0.0020 45 2.0]
teriteration () Clear Result. 2 Instantion Functing. Instantion Community () () () () () () () () () () () () ()	
imization running. imization terminated. ective function value: 0.0332130800213019	Fitness scaling
entive function value: 0.8332138869213019	
ective function value: 0.8332138869219019	Ingfunction: Rank
a ortions. Tolfus.	Selection
Se	ection functions - Rechestic uniform
icont	
	Reproduction
	e count: @ Une default: 2
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	
	© - ► @ C 50.00

### Figure 17: 5KW results

Help		
blem Setup and Results	Options	
Aven ga - Genetic Algorithm	E Population	
alen	Population type: Double Vector	•
iters function Gostan	Pepulation site: 🔘 Une default: 20	
lamber of variables:	· Specify: 100	
contraints	Creation function: Use constraint dependent default	
inex inequalities A:		
inear equalities: Aeg: beg:	Initial population: @ Use default []	
lounds: Lower: Upper:	O Specify	
Animeer constraint function	Initial scores: Whe default: []	
in solar and view receipt	О Брейу.	
Use random states from previous run	Initial mose: O Use defaults (R.1)	
Rat Pace Rop	Specify: [0.3 5000 0.0275 1 4 0.0035 1.5 1.0; 0.85 45000 0.0200 0 10 0.00070 4.5 2.0]	
ument iteration: 🗍 Clear Results	E Fitness scaling	
ptimization terminated; average change in the fitness value see than options.Tolfus. ptimization reminated.	Soling function: Rank	
sjective function value: 0.8245664437721072	8 Selection	
ptimization terminated: average change in the fitness value ess than options.TolFun.	Selection function: Stochastic uniform	
•		
nal point		
2 2 4 5 4 7 8	S Reproduction	
5,595,712 0.019 6.544 7.123 0 1.744 1.411	Elte count 🔹 Use default 2	

### Figure : 6KW results

		1222	
roblem Setup and Results		Options	
Salvet ga - Genetic Algorithm		- E Popula	bas
Publies		Population	type: Dauble Vector
Fitners functions		Population	size: 🕐 Use default: 20
Number of variables: 8			Specify: 100
		Crustien fr	inchian: Use canstraint dependent default
Constraints			
Linear inequalities: A:	b		
Linew equalities: Aeg	beq	Initial popu	ulation: 💩 Use default: []
Bounds: Lower:	Opper:		Specify:
Noriènear constraint functions		Initial score	s: 👻 Use default: []
Run solver and view results			C Specify:
🖺 Use random states from previous run		Initial rang	
Ref. Poure Sup			Specify: (0.3 5000 0.0175 3 4 0.00035 15 1,0.65 45010
Current Reration: 🛅		Clear Results E Fitness	scaling
Optimization terminated.		Scaling fur	ction: Rank
Objective function value: 0.8245664437721072			
Optimization terminated: average change in th	e fitness value less than options.TolFur	L	
Optimization running.		E Selector	
Optimization terminated. Objective function value: 0.8245664437721072		<b>E</b>	
Optimization terminated: average change in th	e fitness value less than options.TolFur	L. Selection #	unction Stochastic uniform
		-	
<b>▲▼</b> Final point			
1. 2 1 4 5	4 7 8	E Reprod	uction
	92 0 3.774 1.957	Parameter State	
0.584 19.941.647 0.022 6.317 8.4		Eits count	Ute default 2

### Figure : 8KW results

Optimization Tool	091
le Help	
rublem Setup and Results	Options
Solveri ga - Genetic Algorithm	B Population
haben	Population type: Double Vector
Fitness functions: Overtan	Population size: 🙁 Use default: 20
Number of variables: 8	Specify 201
	Creation function: Use constraint dependent default
Constraints	
Linewinequalities A	
Liresr equalities Aequination bequination of the second seco	Initial population:   Use default []
Bounds: Lower: Upper	O Specify
Nonlinear constraint functions	Initial scores: 🔮 Use default []
Run solver and view results	O Specify.
The random states from previous run	Initial range: O Use default (0.1)
Rat Pass 2sp	Specify: [83 5000 8.0275 3 4 0.0005 15 1; 8.65 6500 8.028 8 20 0.00078 45 2]
Current iteration 🖬 Clear Results	B Fitzess scaling
following error:	Saling function Rank
Rodefined function or method 'optgaß' for input arguments of type 'double'.	
Delimination running.	
Optimination terminated.	E Selector
Bjective function value: 0.8245664437721072	
Optimization terminated: wverage change in the fitness value less than options.TolFun.	Selection function Stochastic unform
•	
Final point:	
1+ 2 3 4 5 6 7 8	E Reproduction
6.452 34,143,923 0.038 7,28 4.657 8 3,766 1,337	Bite count: 🛛 Une default 1
· /	

## Figure : 10KW results

File Help	
Problem Setup and Results	Options
	E Population
Solver ga - Genetic Algorithm .	Population type: Double Vector
Problem Fitzess function: Orono	Providion size: O Use default: 28
Number af variables 8	<ul> <li>Specify 100</li> </ul>
	Creation function: Use constraint dependent default
Contraints	Creation function: Use constraint dependent densit
Linewinequalities & b	
Linear equalities Aeq beq	Initial population:
Bounds Lewen Uppen	O Specify:
Nonlinear constraint function:	Initial scores: 🔹 Use default []
Run solver and view results	() Specify
T Use random states from previous run	Istal mape O Us default (01)
Ruft Paux Itop	Specify: [0.3 5000 0.0275 3 4 0.00135 1.5 1; 0.65 45100 0.025 0 20 0.00071 45 2]
Current territori 2	8 Fitzets scaling
Optimization terminated: average change in the fitness value less than	Scaling function: Rank
options.TolFun.	
Optimization running.	
Optimization terminated.	- 8 Solution
Objective function value: 0.0245664437721072 Optimization terminated: average change in the fitness value less than	Selection function: Stochastic uniform
options.TolFun.	The second
AT	
Final point:	
1.4 2 3 4 5 6 7 8	. ∃ Reproduction
6.439 23,262.644 0.039 5.731 4.319 0 2.135 1.271	Bite count: 🔹 Use default 2
A	0.0.0

## 4. CONCLUSION

The main aim of the present investigation was to optimize the design of the three phase squirrel cage induction motor using MATLAB. In this dissertation work we developed a program for design of three phase induction motor. By using this program we can get the design sheet of any rating of induction motor[6]. This has been successfully achieved for a typical 3-ph, (1kw, 2.2kw, 5kw, 6kw, 8kw, 10kw) 400v, 3-phase, 50 Hz, 1500 synchronous r.p.m. squirrel cage induction motor. The machine is to be started by a star delta starter.

In this dissertation work, the optimum values of variables are taken by using genetic algorithm[4] where the objective function is efficiency. Further, for different rating of machines (i.e. 1kw, 2.2kw, 5kw, 6kw, 8kw, 10kw) by varying the airgap flux density the changes in efficiency has been observed. Similarly, for different rating of machines (i.e. 1kw, 2.2kw, 5kw, 6kw, 8kw, 10kw) by varying the ampere conductors the changes in efficiency has been observed. Results of this investigation have clearly demonstrated that the constraints can easily be incorporated in the design optimization of the induction motor[1]. This will make the design easily acceptable to the manufacturer. This will, in fact, result in reduced cost of manufacturing the machine. However, it is clear that this will, indeed, make the optimized design more acceptable to the manufacturers.

### **5. REFERENCES**

- 1. A.K.SAWHNEY, "**A Course in Electrical** machine design", DHANPATRAI&
- 2. MOHAMMAD AYYUB, S. S. MURTHY, 2000 "Energy Conservation Through improved Design of Induction Motor", Electrical Engineering Department, Indian Institute of Technology, New Delhi, INDIA.
- 3. R. Ong, J. H. Dymond, and R. Findlay, "Stray load loss test methods in induction machine: challenges to manufacturers," *1ZCEM*, *Helsinki*, 28-30 August 2000.
- 4. S. Derrah, "A statistical analysis of experimental data to identify the design parameters that have the greatest influence on stray load losses in induction motors," *M.Eng. thesis, McMaster University, Hamilton, Ontario,* October 2000.
- 5. C. N. Glew, "Stray load losses in induction motors: a challenge to academia", *Power Engineering Journal, pp.* 27-32, February 1998.
- 6. MOHAMMAD AYYUB, S. S. M URTHY, 2000 "Energy Conservation through Improved Design Of Induction Motor", Electrical Engineering Department, Indian Institute of Technology, New Delhi, INDIA.