# CONTENTS

Acknowledgement
Certificate
<b>Candidate's Declaration</b>
Abbreviations
List of figures
List of graphs
List of tables
Abstract

Chapters	
Chapter 1 Introduction	2
Chapter 2 Literature review	3
2.1Critical study of research papers	
Chapter 3 A review of optimization techniques in metal cutting process	s 8
3.1.1 Introduction	8
3.1.2 Statistical regression technique	9
3.1.3 Artificial neural network (ANN)-based modelling	9
3.1.4 Fuzzy set theory-based modelling	10
3.2 Determination of optimal or near-optimal cutting condition(s)	10
3.3. Conventional optimization technique	11
3.3.1 Taguchi method	11
3.3.2 Response surface design methodology (RSM)	12
3.3.3 Iterative mathematical search technique	12
3.4 Non-conventional technique	13
3.4.1 Heuristic search technique	13
3.4.2 Meta heuristic search technique	13
3.5.1 Genetic algorithm (GA)	14
3.5.2 Tabu search (TS)	15
3.5.3 Simulated annealing (SA)	15
Chapter 4 Introduction to Taguchi method	17
4.1 A Historic Perspective	17
4.2 Taguchi Method in Quality Engineering	17
4.3 Off-line quality Engineering	17
• 4.4 On-line quality control	18
4.5 Robust Design	19

4.6 The Taguchi Loss Function	19
Chapter 5 Taguchi Methodology for single objective optimization	21
5.1 Orthogonal Array	22
5.2 Static Problems	24
5.3 Dynamic Problem	24
5.4 Steps in Taguchi Design Method	26
5.5 Analysis of S/N ratio	27
5.6 Analysis of Variance	28
Chapter 6 Taguchi's Methodology for Multi-objective optimization	30
6.1 Taguchi's parameter design (PD) with multiple quality characteristics	
Overview	30
6.2 Proposed methodology for optimization of multiple characteristic in	
Taguchi's PD experiment	30
Chapter 7 Experimental set up and cutting condition	32
7.1 Selection of levels for process parameters	35
7.2 Tabulation work of single objective optimization for surface roughness	36
7.3 Tabulation work of single objective optimization for material removal	37
7.4 Tabulation work of multi-objective optimization	43
Chapter 8 Results and Discussions	48
8.1 Single-objective optimization	48
8.2 Multi-objective optimization	48
Chapter 9 Conclusions	50
References	

### List of figures

- 1) Fig. No.1 Quality loss function
- 2) Fig. No.2 P-Diagram for static problem
- 3) Fig. No.3 P-Diagram for dynamic problem
- 4) Fig. No.4 Block diagram of lathe machine

### List of graphs

- 1) Factors response for surface roughness
- 2) Factor response for material removal

#### List of tables

- 1) Experimental layout using  $L_{27}$  orthogonal array
- 2) Chemical composition of work material
- 3) Factors and level used in experiment
- 4) Measured parameter for different cutting condition
- 5) The experimental results for surface roughness and material removed and their corresponding S/N ratio
- 6) Response table of average S/N for material removal
- 7) Analysis of variance for surface roughness
- 8) Results of confirmation of experiment for surface roughness
- 9) Response table of average S/N for material removal
- 10) Analysis of variance of material removed
- 11) Results of confirmation of experiment for material removal
- 12) Quality loss values for surface roughness and material removal
- 13) Normalised quality loss values for surface roughness and material removed
- 14) Total normalised quality loss (TNQL) and multiple S/N ratio (MSNR)
- 15) Multiple S/N response table (average factor effect at different levels)
- 16) Results of ANNOVA in multiple-objective optimization
- 17) Result of confirmation of experiment in multi-objective optimization
- 18) Comparison of results from single-objective and multiple-objective optimization

## Abbreviations

k	No. of control factors or process parameters
Lj	The total normalised quality loss for $i^{th}$ trial condition or run
Lij	Quality loss values in $i^{th}$ experimental run for $j^{th}$ quality characteristic
$l_{i^*}$	Maximum quality loss for $i^{th}$ quality characteristic among all the
	all the experimental run
Ľ <sub>ij</sub>	Normalised quality loss for $i^{th}$ experimental run for $j^{th}$ quality characteristic
n	No. of experimental run
p	No. of responses for quality characteristic
Wi	Weighting factor assigned to $j^{th}$ quality characteristic
yi	Response or observed quality value in $i^{th}$ quality characteristic
η	S/N ratio
$\eta_m$	Mean value of S/N ratio of all experimental run
$\eta_{opt}$	Predicted S/N ratio at optimum parameter level
$\eta^e_j$	Multiple S/N ratio of $i^{th}$ trial condition or experimental run