## Contents

		page
Abstı		ii
	owledgments	iv
Conte		V
	f Figures	viii
	of Tables	xii
	f Symbols	xiii
List o	f Abbreviations	XV
Chap	eter 1: Introduction	1-6
1.1	Introduction	1
1.2	Solar Radiation Resource & Its Description	1
1.3	Author's Contributions	3
	1.3.1 Problem Description	4
	1.3.2 Proposed Work	4
	1.3.3 Proposed methodology	4
1.4	Thesis Organization	4
	oter 2: Review of Literature	7-22
2.1	Introduction	7
2.2	Creating Reliable Radiation Databases	9
2.3	Solar Radiation Measurement and Identification of Errors	9
	2.3.1 Solar Radiation Components and their Inter-correlation	11
	2.3.2 Solar Radiation Measurement Standards	11
	2.3.3 Factors Affecting Solar Radiation Data Measurement	12
	2.3.4 Errors in Solar Radiation Measurement	13
2.4	Mathematical Models for Radiation Estimation	14
	2.4.1 Solar Radiation Prediction Models	14
	2.4.2 Clear-sky Radiation Models	15
2.5	Identification of Various Sky Condition Days	17
2.6	Solar Radiation Data Quality Control Techniques	18 18
	2.6.1 Basic Quality Control Test Procedure	
2.7	2.6.2 Quartile Analysis Test Solar Radiation Gap Filling Approaches	19 20
2.7 2.8	Statistical Indicators	21
2.9	Summary	22
Chap	oter 3: Site selection, Measuring Instruments and Errors	23-40
3.1	Introduction	23
3.2	Site Selection and Location Information	23
3.3	Solar Radiation Measurement Station and Errors	24
	3.3.1 Instruments at Solar Radiation Measurement Station	25
	3.3.2 Errors in Radiation Database	26
	3.3.3 Operational Problems	28
3.4	Radiation Measurement Error Identification Approaches	29
	3.4.1 Using k <sub>t</sub> -k <sub>n</sub> Plots	29
	3.4.2 Using $k_t$ - $k_n$ and $k_t$ - $k$ Approach	30
	3.4.3 Using Theoretical and Actual GHI Measured Values	30
3.5	Identification of Days According to Cloud Classifications	31
	3.5.1 Cloud Classification Guidelines	31
	3.5.2 Cloud Condition and Respective Instrument Response	33
3.6	Summary	39

Chap	ter 4: Solar Radiation Data Quality Control	41-64
4.1	Introduction	41
4.2	Quality Control Guidelines	41
	4.2.1 Steps in Solar Radiation Data Quality Control	42
	4.2.2 Additional Data Quality Control Tests	44
4.3	Modified Quality Control Guidelines	48
	4.3.1 Erroneous Radiation Component – Flags Determination	48
4.4	Detailed Quality Control Guidelines Applied on Randomly Selected Radiation Dataset	50
	4.4.1 Basic Visual Data Analysis	50
	4.4.2 Advanced Data Quality Control Procedures	55
4.5	Mixed Errors Identification from the Database	58
4.6	Summary	64
Chap	ter 5: Solar Radiation Gap Filling Approaches	65-86
5.1	Introduction	65
5.2	Identification of Gaps in Measurement Database	66
5.3	Traditional Solar Radiation Gap Filling Approaches	66
	5.3.1 Data Filling Using Averaging and Interpolation	67
	5.3.2 Data Filling Using Various Available Clear sky and Overcrowded Models	67
	5.3.3 Manual changes in Data	67
5.4	Suggested Gap Filling Approach for High-Frequency Dataset	67
	5.4.1 Gap Filling Using Meteorological Parameters	67
	5.4.2 Gap Filling Using Approach Given by RMIB	69
	5.4.3 Gap Filling Using Approach Given by GIZ (C-WET)	70
	5.4.4 Gap Filling Using Satellite Database	70
	5.4.5 Gap Filling Using Curve Fitting Approach	71
5.5	Comparison of Various Gap Filling Approaches	71
5.6	Gap Filling Approach for Different Cloud Conditions	71
	5.6.1 Sample Data Preparation for Gap Filling Analysis	71
	5.6.2 Data modification for Determining Gap Filling Approach	73
	5.6.3 Gap Filling Approach Applied for Different Cloud Condition Days	75
	5.6.4 Different Techniques of Gap filling	77
	5.6.5 Guidelines for use of Gap Filling Approaches	80
5.7	Summary	84
_	ter 6: Case Study of IMD Jodhpur Radiation Database	87-136
6.1	Introduction	87
6.2	Quality Control observations of Selected Site	87
	6.2.1 Parameters Selection	87
	6.2.2 Daily Climate Analysis	87
	6.2.3 Daily Quality Control Test Analysis	88
	6.2.4 Data Passed in Quality Control Tests for Two Radiation Databases	89
	6.2.5 Correction in Measured Radiation Components	89
	6.2.6 Coherence Factor for Radiation Quality	90
6.3	Daily Averaged Radiation Results	90
6.4 6.5	Comparison of Databases from Different Sources Summary	92 93
Спар	ter 7: Conclusions and Future Work	137-138
Anne	xure	
Α	Solar Maps	139
	A.1 SRRA Map DNI (Long Term Average)	139
	A.2 SRRA Map GHI (Long Term Average)	140
_	A.3 SRRA Map GHI (Relative Standard Deviation)	141
В	ISO Standard Sheet	142
	B.1 ISO-9060 Specification Summary for Pyrheliometer	142
	B.1 ISO-9060 Specification Summary for Pyranometer	143

C	Climate Classification	144
	C.1 MNRE, Climate Classification	144
	C.2 Köopen Climate Classification	145
D	Clear Sky Equations	146
	D.1 ASHRAE Clear Sky Model	146
Refe	erences	147-152