List of Figures

Figure Caption	Page No.
Figure 1.1: General Over-view of fault-diagnosis systems	03
Figure 1.2: IEEE study results on induction motor faults	05
Figure 1.3: EPRI study results on induction motor faults	05
Figure 1.4: Prime sources of induction motor faults	06
Figure 1.5: Conventional induction motor faults and their causes	07
Figure 1.6: Different types of failures in stator winding	12
Figure 1.7: Prime sources of noise in induction motors	19
Figure 2.1: Effect of thermal aging on insulation life of motor	38
Figure 2.2: Induction motor's loadability curve in a frequency controlled	39
drive.	
Figure 2.3: Flowchart of the PSO algorithm	48
Figure 2.4: Temperature tracking using PSO	50
Figure 2.5: Best cost Vs iteration using PSO	51
Figure 3.1: Mechanical overload and voltage unbalance protection scheme	59
Figure 3.2: Protection scheme for discrimination of overload and voltage	60
unbalance for Induction Motor	
Figure 3.3: Overload block for IM Protection	61
Figure.3.4: Voltage unbalance block for IM protection	61
Figure 3.5: Decision unit block for IM Protection	62
Figure 3.6: Rated mechanical overload and balanced supply voltage (0%	64
UNB)	
Figure 3.7: Mechanical overloading and balanced supply voltage (0%UNB)	65
Figure 3.8: Rated mechanical and balanced supply voltage (6.25 % UNB)	66
Figure 3.9: Mechanical overload (70%) and balanced supply voltage (6.7 %	67
UNB)	
Figure 3.10: Mechanical overload (80%) and balanced supply voltage	68
(14.01 % UNB)	
Figure 3.11: Signal analysis by STFT using Blackman window	71

Figure 4.1: ANSYS 3-D model of the considered induction motor	75
Figure 4.2: Stator winding currents in induction motor	76
Figure 4.3: Flux linkages in induction motor	76
Figure 4.4: Profile of induced voltages in various phases	77
Figure 4.5: Speed profile of induction motor	77
Figure 4.6: Torque profile of induction motor	78
Figure 4.7: Electrical and Mechanical power developed in induction motor	78
Figure 4.8: Stator winding currents in faulty (5% turns short) condition	79
Figure 4.9: Flux linkages in faulty condition (5% turns short)	80
Figure 4.10: Stator currents in faulty condition (5% turns short)	80
Figure 4.11: Speed profile of in faulty condition (5% turns short)	81
Figure 4.12: Torque profile of in faulty condition (5% turns short)	81
Figure 4.13: Experimental test bed	83
Figure 4.14: Stator currents in healthy condition	83
Figure 4.15: Current signal, FFT and THD of phase A under healthy	84
condition	
Figure 4.16: Current signal, FFT and THD of phase B under healthy	84
condition	
Figure 4.17: Current signal, FFT and THD of phase C under healthy	85
condition	
Figure 4.18: Stator currents under 5% short circuit condition	85
Figure 4.19: Current signal, FFT and THD of phase A under 5% faulty	86
condition	
Figure 4.20: Current signal, FFT and THD of phase B under 5% faulty	86
condition	
Figure 4.21: Current signal, FFT and THD of phase C under 5% faulty	87
condition	
Figure 4.22: Stator currents under 10% short circuit condition	87
Figure 4.23: Current signal, FFT and THD of phase A under 10% faulty	88
condition	
Figure 4.24: Current signal, FFT and THD of phase B under 10% faulty	88
condition	

Figure 4.25: Current signal, FFT and THD of phase C under 10% faulty	89
condition	
Figure 4.26: Stator currents under 15% short circuit condition	89
Figure 4.27: Current signal, FFT and THD of phase A under 15% faulty	90
condition	
Figure 4.28: Current signal, FFT and THD of phase B under 15% faulty	90
condition	
Figure 4.29: Current signal, FFT and THD of phase C under 15% faulty	91
condition	
Figure 4.30: Stator currents under 20% short circuit condition	91
Figure 4.31: Current signal, FFT and THD of phase A under 20% faulty	92
condition	
Figure 4.32: Current signal, FFT and THD of phase B under 20% faulty	92
condition	
Figure 4.33: Current signal, FFT and THD of phase C under 20% faulty	93
condition	
Figure 5.1: The hazard model of induction motor	103
Figure 5.2: Warranty failure of induction motor	105
Figure 5.3: Number of motors failed during 2007-2018	106
Figure 5.4: Types of failure in induction machine in the year 2012-2018	107
Figure 5.5: Number of motors manufactured during 2007-2018	108
Figure 5.6: (a) Reliability v/s MTBF of induction motor	112
Figure 5.6: (b) Reliability v/s Failure rate of induction motor	112
Figure 5.7: Pictorial view of rotor touching the stator winding	116
Figure 5.8: Pictorial view of Feeler Gauge	116
Figure 5.9: Pictorial view of Dial Gauge	117
Figure 5.10: Main terminal box	119
Figure 5.11: Pictorial view of Wiring Box	120
Figure 5.12: Rotor earthing arrangement	122
Figure 5.13: Pictorial view of Grease gun	123
Figure 5.14: Balance pieces riveted on rotor	124