Table 1.1 Benefits and drawbacks of WECS generators details ..... 21
Table 2.1 Gains of the PID supervisory controller ..... 64
Table 2.2 Gains of the SOF controller ..... 71
Table 2.3 Step response of the supervisory-based (Conventional PID ..... 78 controller) of figure (2.18)
Table 2.4 Step response of figure 2.19 with SOF based controller ..... 79
Table 2.5 Comparison of Settling time and Overshoot between ..... 80 Supervisory and SOF controller
Table 3.1 Gains of the PSO-based controller ..... 87
Table 3.2 Step response observations of figure (3.17) ..... 94
Table 3.3 Comparison of Rise time, Settling time, Peak time and ..... 94 Overshoot as well as Peak between Supervisory and PSO controller
Table 4.1 Gains of the BFO-based controller ..... 107
Table 4.2 Step response observations of figure (4.17) ..... 112
Table 4.3 Comparison of Rise time, Settling time, Peak time and ..... 114 Overshoot as well as Peak between BFO and controller
Table 5.1 Gains of the FFA-based controller ..... 127
Table 5.2 Gains of the DE-based controller ..... 135
Table 5.3 Gains of the GA-based controller ..... 139
Table 5.4 Step response of DFIG (open loop) observations of figure ..... 147
Table 5.5 Step response of DFIG (closed loop) observations of ..... 148 figure(5.29)
Table 5.6 Step response of DFIG (closed loop) observations of figure ..... 149 (5.30)
Table 5.7 Step response of DFIG (closed loop) observations of figure ..... 150
Table 5.8 Comparison of Rise time, Settling time, Peak time and ..... 151 Overshoot as well as Peak, between DE,GA\&FFA-based PID controller
Table 6.1 Finnish wind farm detailed failure and downtime data ..... 192
Table 6.2 Finnish wind farm detailed average failure as well as down ..... 192data
Table 6.3 Summary of the Statics and Critical Component ..... 194
Table 6.4 Equivalent blocks for failure and repair rates ..... 196

