**APPENDIX A**

**Results of IEEE 9-Bus system** **by Newton-Raphson method using Power World Simulator’s program.**

Table A.1.1: Real powers in MW (testing data for case1):

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Load at Bus 5** | **Load at Bus 7** | **Load at Bus 9** | **line (1 - 4)** | **line (2 - 8)** | **line (3 - 6)** | **line (4 - 5)** | **line (5 - 6)** | **line (6 - 7)** |
| 97 | 107 | 132 | 93 | 163 | 85 | 41.1 | 56.2 | 27.5 |
| 93 | 103 | 128 | 81 | 163 | 85 | 35.2 | 58 | 25.6 |
| 89 | 99 | 124 | 69 | 163 | 85 | 29.4 | 59.8 | 23.8 |
| 85 | 95 | 120 | 57.1 | 163 | 85 | 23.6 | 61.5 | 21.9 |
| 81 | 91 | 116 | 45.2 | 163 | 85 | 17.8 | 63.3 | 20.1 |
| **Load at Bus 5** | **Load at Bus 7** | **Load at Bus 9** | **line (7 - 8)** | **line (8 - 9)** | **line (4 - 9)** |
| 97 | 107 | 132 | 80.3 | 82.8 | 51.9 |
| 93 | 103 | 128 | 78.1 | 84.9 | 45.7 |
| 89 | 99 | 124 | 75.9 | 87.1 | 39.6 |
| 85 | 95 | 120 | 73.7 | 89.3 | 35.5 |
| 81 | 91 | 116 | 71.5 | 91.5 | 27.4 |

Table A.1.2: Reactive powers in MVAR (testing data for case1):

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Load at Bus 5** | **Load at Bus 7** | **Load at Bus 9** | **line (1 - 4)** | **line (2 - 8)** | **line (3 - 6)** | **line (4 - 5)** | **line (5 - 6)** | **line (6 – 7)** |
| 97 | 107 | 132 | 25.2 | 15.9 | 7.7 | 12.2 | 17.8 | 23.6 |
| 93 | 103 | 128 | 24.4 | 15.4 | 8.2 | 13 | 17 | 23.6 |
| 89 | 99 | 124 | 24 | 15 | 8.6 | 13.7 | 16.3 | 23.7 |
| 85 | 95 | 120 | 23.8 | 14.6 | 8.9 | 14.4 | 15.6 | 23.8 |
| 81 | 91 | 116 | 23.8 | 14.3 | 9.3 | 15 | 15 | 23.9 |
| **Load at Bus 5** | **Load at Bus 7** | **Load at Bus 9** | **line (7 - 8)** | **line (8 - 9)** | **line (4 - 9)** |
| 97 | 107 | 132 | 11.4 | 15.3 | 34.7 |
| 93 | 103 | 128 | 11.4 | 14.6 | 35.4 |
| 89 | 99 | 124 | 11.3 | 13.9 | 36.1 |
| 85 | 95 | 120 | 11.2 | 13.3 | 36.7 |
| 81 | 91 | 116 | 11.1 | 12.7 | 37.3 |

Table A.1.3: Thermal lines (testing data for case1):

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Load at Bus 5** | **Load at Bus 7** | **Load at Bus 9** | **line (1 - 4)** | **line (2 - 8)** | **line (3 - 6)** | **line (4 - 5)** | **line (5 - 6)** | **line (6 – 7)** |
| 97 | 107 | 132 | 32 | 55 | 28 | 28 | 39 | 24 |
| 93 | 103 | 128 | 28 | 55 | 28 | 25 | 40 | 23 |
| 89 | 99 | 124 | 24 | 55 | 28 | 22 | 42 | 22 |
| 85 | 95 | 120 | 21 | 55 | 28 | 18 | 43 | 22 |
| 81 | 91 | 116 | 17 | 55 | 28 | 15 | 44 | 21 |
| **Load at Bus 5** | **Load at Bus 7** | **Load at Bus 9** | **line (7 - 8)** | **line (8 - 9)** | **line (4 - 9)** |
| 97 | 107 | 132 | 54 | 55 | 41 |
| 93 | 103 | 128 | 52 | 57 | 38 |
| 89 | 99 | 124 | 51 | 58 | 36 |
| 85 | 95 | 120 | 49 | 60 | 33 |
| 81 | 91 | 116 | 48 | 61 | 31 |

Table A.1.4: Voltage magnitudes at various buses (testing data for case1):

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Load at Bus 5** | **Load at Bus 7** | **Load at Bus 9** | **V4(P.U.)** | **V5(P.U.)** | **V6(P.U.)** | **V7(P.U.)** | **V8(P.U.)** | **V9(P.U.)** |
| 97 | 107 | 132 | 0.987 | 0.975 | 1.003 | 0.984 | 0.995 | 0.957 |
| 93 | 103 | 128 | 0.987 | 0.975 | 1.004 | 0.984 | 0.996 | 0.957 |
| 89 | 99 | 124 | 0.987 | 0.976 | 1.004 | 0.985 | 0.996 | 0.958 |
| 85 | 95 | 120 | 0.987 | 0.976 | 1.004 | 0.985 | 0.996 | 0.958 |
| 81 | 91 | 116 | 0.987 | 0.976 | 1.004 | 0.986 | 0.996 | 0.958 |

Table A.2.1: Real powers in MW (training data for case2):

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Load at Bus 5** | **Load at Bus 7** | **Load at Bus 9** | **line (1 - 4)** | **line (2 - 8)** | **line (3 - 6)** | **line (4 - 5)** | **line (5 - 6)** | **line (6 – 7)** |
| 100 | 110 | 135 | 267.1 | 0 | 85 | 106.5 | 4.4 | 89.3 |
| 98 | 108 | 133 | 260.8 | 0 | 85 | 103.3 | 3.4 | 88.3 |
| 96 | 106 | 131 | 254.4 | 0 | 85 | 100.2 | 2.4 | 87.3 |
| 94 | 104 | 129 | 248.1 | 0 | 85 | 97.1 | 1.5 | 86.4 |
| 92 | 102 | 127 | 241.9 | 0 | 85 | 94 | 0.5 | 85.4 |
| 90 | 100 | 125 | 235.6 | 0 | 85 | 91 | 0.5 | 84.4 |
| 88 | 98 | 123 | 229.3 | 0 | 85 | 87.9 | 1.5 | 83.4 |
| 86 | 96 | 121 | 223 | 0 | 85 | 84.8 | 2.5 | 82.5 |
| 84 | 94 | 119 | 216.8 | 0 | 85 | 81.8 | 3.4 | 81.5 |
| 82 | 92 | 117 | 210.6 | 0 | 85 | 78.7 | 4.4 | 80.5 |
| 80 | 90 | 115 | 204.3 | 0 | 85 | 75.6 | 5.4 | 79.6 |
| **Load at Bus 5** | **Load at Bus 7** | **Load at Bus 9** | **line (7 - 8)** | **line (8 - 9)** | **line (4 - 9)** |
| 100 | 110 | 135 | 22.5 | 22.5 | 160.6 |
| 98 | 108 | 133 | 21.4 | 21.4 | 157.4 |
| 96 | 106 | 131 | 20.3 | 20.3 | 154.2 |
| 94 | 104 | 129 | 19.3 | 19.3 | 151 |
| 92 | 102 | 127 | 18.2 | 18.2 | 147.8 |
| 90 | 100 | 125 | 17.1 | 17.1 | 144.6 |
| 88 | 98 | 123 | 16.1 | 16.1 | 141.4 |
| 86 | 96 | 121 | 15 | 15 | 183.2 |
| 84 | 94 | 119 | 13.9 | 13.9 | 135 |
| 82 | 92 | 117 | 12.8 | 12.8 | 131.9 |
| 80 | 90 | 115 | 11.8 | 11.8 | 128.7 |

Table A.2.2: Reactive powers in MVAR (training data for case2):

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Load at Bus 5** | **Load at Bus 7** | **Load at Bus 9** | **line (1 - 4)** | **line (2 - 8)** | **line (3 - 6)** | **line (4 - 5)** | **line (5 - 6)** | **line (6 – 7)** |
| 100 | 110 | 135 | 65.1 | 0 | 18.8 | 7.6 | 33.7 | 25 |
| 98 | 108 | 133 | 61.8 | 0 | 17.3 | 7.7 | 33.2 | 24.6 |
| 96 | 106 | 131 | 58.7 | 0 | 15.9 | 7.8 | 32.6 | 24.2 |
| 94 | 104 | 129 | 55.7 | 0 | 14.5 | 7.9 | 32.1 | 23.7 |
| 92 | 102 | 127 | 52.8 | 0 | 13.2 | 8 | 31.5 | 23.3 |
| 90 | 100 | 125 | 50 | 0 | 11.9 | 8.1 | 31 | 22.9 |
| 88 | 98 | 123 | 47.3 | 0 | 10.6 | 8.2 | 30.5 | 22.5 |
| 86 | 96 | 121 | 44.7 | 0 | 9.4 | 8.2 | 30 | 22.2 |
| 84 | 94 | 119 | 42.2 | 0 | 8.2 | 8.3 | 29.5 | 21.8 |
| 82 | 92 | 117 | 39.8 | 0 | 7 | 8.3 | 29 | 21.5 |
| 80 | 90 | 115 | 37.5 | 0 | 5.9 | 8.3 | 28.5 | 21.1 |
| **Load at Bus 5** | **Load at Bus 7** | **Load at Bus 9** | **line (7 - 8)** | **line (8 - 9)** | **line (4 - 9)** |
| 100 | 110 | 135 | 10 | 29.1 | 29.1 |
| 98 | 108 | 133 | 10.4 | 29 | 28.2 |
| 96 | 106 | 131 | 10.8 | 28.9 | 27.2 |
| 94 | 104 | 129 | 11.3 | 28.7 | 26.4 |
| 92 | 102 | 127 | 11.7 | 28.6 | 25.5 |
| 90 | 100 | 125 | 12.1 | 28.5 | 24.7 |
| 88 | 98 | 123 | 12.5 | 28.3 | 23.9 |
| 86 | 96 | 121 | 12.8 | 28.2 | 23.1 |
| 84 | 94 | 119 | 13.2 | 28 | 22.3 |
| 82 | 92 | 117 | 13.5 | 27.9 | 22.1 |
| 80 | 90 | 115 | 13.9 | 27.8 | 22.2 |

Table A.2.3: Thermal lines (training data for case2):

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Load at Bus 5** | **Load at Bus 7** | **Load at Bus 9** | **line (1 - 4)** | **line (2 - 8)** | **line (3 - 6)** | **line (4 - 5)** | **line (5 - 6)** | **line (6 – 7)** |
| 100 | 110 | 135 | 92 | 0 | 29 | 71 | 23 | 61 |
| 98 | 108 | 133 | 89 | 0 | 29 | 69 | 22 | 60 |
| 96 | 106 | 131 | 87 | 0 | 29 | 67 | 22 | 59 |
| 94 | 104 | 129 | 85 | 0 | 29 | 65 | 21 | 59 |
| 92 | 102 | 127 | 83 | 0 | 29 | 63 | 21 | 58 |
| 90 | 100 | 125 | 80 | 0 | 29 | 61 | 21 | 57 |
| 88 | 98 | 123 | 78 | 0 | 29 | 59 | 20 | 57 |
| 86 | 96 | 121 | 76 | 0 | 29 | 57 | 20 | 56 |
| 84 | 94 | 119 | 74 | 0 | 28 | 55 | 20 | 55 |
| 82 | 92 | 117 | 71 | 0 | 28 | 53 | 20 | 55 |
| 80 | 90 | 115 | 69 | 0 | 28 | 51 | 19 | 54 |
| **Load at Bus 5** | **Load at Bus 7** | **Load at Bus 9** | **line (7 - 8)** | **line (8 - 9)** | **line (4 - 9)** |
| 100 | 110 | 135 | 16 | 25 | 112 |
| 98 | 108 | 133 | 16 | 24 | 109 |
| 96 | 106 | 131 | 15 | 24 | 107 |
| 94 | 104 | 129 | 15 | 23 | 104 |
| 92 | 102 | 127 | 14 | 23 | 102 |
| 90 | 100 | 125 | 14 | 22 | 100 |
| 88 | 98 | 123 | 14 | 22 | 97 |
| 86 | 96 | 121 | 13 | 21 | 95 |
| 84 | 94 | 119 | 13 | 21 | 93 |
| 82 | 92 | 117 | 12 | 21 | 90 |
| 80 | 90 | 115 | 12 | 20 | 88 |

Table A.2.4: Voltage magnitudes at various buses (training data for case2):

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Load at Bus 5** | **Load at Bus 7** | **Load at Bus 9** | **V4(P.U.)** | **V5(P.U.)** | **V6(P.U.)** | **V7(P.U.)** | **V8(P.U.)** | **V9(P.U.)** |
| 100 | 110 | 135 | 0.975 | 0.962 | 0.99 | 0.951 | 0.956 | 0.936 |
| 98 | 108 | 133 | 0.976 | 0.963 | 0.991 | 0.953 | 0.958 | 0.938 |
| 96 | 106 | 131 | 0.977 | 0.965 | 0.992 | 0.955 | 0.96 | 0.94 |
| 94 | 104 | 129 | 0.978 | 0.966 | 0.993 | 0.956 | 0.962 | 0.941 |
| 92 | 102 | 127 | 0.98 | 0.968 | 0.994 | 0.958 | 0.963 | 0.943 |
| 90 | 100 | 125 | 0.981 | 0.969 | 0.994 | 0.96 | 0.965 | 0.945 |
| 88 | 98 | 123 | 0.982 | 0.971 | 0.995 | 0.961 | 0.967 | 0.947 |
| 86 | 96 | 121 | 0.983 | 0.972 | 0.996 | 0.963 | 0.968 | 0.948 |
| 84 | 94 | 119 | 0.984 | 0.973 | 0.996 | 0.964 | 0.97 | 0.95 |
| 82 | 92 | 117 | 0.985 | 0.974 | 0.997 | 0.965 | 0.971 | 0.952 |
| 80 | 90 | 115 | 0.985 | 0.976 | 0.998 | 0.967 | 0.973 | 0.953 |

Table A.3.1: Real powers in MW (training data for case3):

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Load at Bus 5** | **Load at Bus 7** | **Load at Bus 9** | **line (1 - 4)** | **line (2 - 8)** | **line (3 - 6)** | **line (4 - 5)** | **line (5 - 6)** | **line (6 – 7)** |
| 100 | 110 | 135 | 186.6 | 163 | 0 | 98 | 3.7 | 3.8 |
| 98 | 108 | 133 | 180.5 | 163 | 0 | 94.9 | 4.6 | 4.7 |
| 96 | 106 | 131 | 174.3 | 163 | 0 | 91.9 | 5.5 | 5.6 |
| 94 | 104 | 129 | 168.2 | 163 | 0 | 88.9 | 6.4 | 6.5 |
| 92 | 102 | 127 | 162.1 | 163 | 0 | 85.9 | 7.4 | 7.4 |
| 90 | 100 | 125 | 156 | 163 | 0 | 82.9 | 8.3 | 8.3 |
| 88 | 98 | 123 | 149.9 | 163 | 0 | 79.9 | 9.2 | 9.3 |
| 86 | 96 | 121 | 143.8 | 163 | 0 | 76.9 | 10.1 | 10.2 |
| 84 | 94 | 119 | 137.7 | 163 | 0 | 73.9 | 11 | 11.1 |
| 82 | 92 | 117 | 131.6 | 163 | 0 | 71 | 11.9 | 12 |
| 80 | 90 | 115 | 125.5 | 163 | 0 | 68 | 12.8 | 12.9 |
| **Load at Bus 5** | **Load at Bus 7** | **Load at Bus 9** | **line (7 - 8)** | **line (8 - 9)** | **line (4 - 9)** |
| 100 | 110 | 135 | 115 | 48 | 88.7 |
| 98 | 108 | 133 | 113.9 | 49.1 | 85.5 |
| 96 | 106 | 131 | 112.8 | 50.2 | 82.4 |
| 94 | 104 | 129 | 111.7 | 51.3 | 79.3 |
| 92 | 102 | 127 | 110.6 | 52.4 | 76.2 |
| 90 | 100 | 125 | 109.5 | 53.6 | 73 |
| 88 | 98 | 123 | 108.3 | 54.7 | 69.9 |
| 86 | 96 | 121 | 107.2 | 55.8 | 66.8 |
| 84 | 94 | 119 | 106.1 | 56.9 | 63.7 |
| 82 | 92 | 117 | 105 | 58 | 60.6 |
| 80 | 90 | 115 | 103.9 | 59.1 | 57.5 |

Table A.3.2: Reactive powers in MVAR (training data for case3):

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Load at Bus 5** | **Load at Bus 7** | **Load at Bus 9** | **line (1 - 4)** | **line (2 - 8)** | **line (3 - 6)** | **line (4 - 5)** | **line (5 - 6)** | **line (6 – 7)** |
| 100 | 110 | 135 | 33.3 | 19.9 | 0 | 4.7 | 28.6 | 25.7 |
| 98 | 108 | 133 | 31.5 | 19 | 0 | 5 | 28.4 | 26 |
| 96 | 106 | 131 | 29.8 | 18.1 | 0 | 5.4 | 28.1 | 26.4 |
| 94 | 104 | 129 | 28.1 | 17.3 | 0 | 5.7 | 27.9 | 26.7 |
| 92 | 102 | 127 | 26.6 | 16.5 | 0 | 6 | 27.7 | 27 |
| 90 | 100 | 125 | 25.1 | 15.7 | 0 | 6.3 | 27.5 | 27.3 |
| 88 | 98 | 123 | 23.7 | 14.9 | 0 | 6.6 | 27.2 | 27.6 |
| 86 | 96 | 121 | 22.4 | 14.2 | 0 | 6.8 | 27 | 27.8 |
| 84 | 94 | 119 | 21.1 | 13.5 | 0 | 7 | 26.8 | 28.1 |
| 82 | 92 | 117 | 20 | 12.8 | 0 | 7.2 | 26.6 | 28.4 |
| 80 | 90 | 115 | 18.9 | 12.2 | 0 | 7.4 | 26.4 | 28.6 |
| **Load at Bus 5** | **Load at Bus 7** | **Load at Bus 9** | **line (7 - 8)** | **line (8 - 9)** | **line (4 - 9)** |
| 100 | 110 | 135 | 9.3 | 23.5 | 26.5 |
| 98 | 108 | 133 | 9 | 23.1 | 26.9 |
| 96 | 106 | 131 | 8.6 | 22.6 | 27.4 |
| 94 | 104 | 129 | 8.3 | 22.2 | 27.8 |
| 92 | 102 | 127 | 8 | 21.8 | 28.2 |
| 90 | 100 | 125 | 7.7 | 21.4 | 28.6 |
| 88 | 98 | 123 | 7.4 | 21 | 29 |
| 86 | 96 | 121 | 7.2 | 20.6 | 29.4 |
| 84 | 94 | 119 | 6.9 | 20.3 | 29.7 |
| 82 | 92 | 117 | 6.6 | 19.9 | 30.1 |
| 80 | 90 | 115 | 6.4 | 19.5 | 30.5 |

Table A.3.3: Thermal lines (training data for case3):

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Load at Bus 5** | **Load at Bus 7** | **Load at Bus 9** | **line (1 - 4)** | **line (2 - 8)** | **line (3 - 6)** | **line (4 - 5)** | **line (5 - 6)** | **line (6 – 7)** |
| 100 | 110 | 135 | 63 | 55 | 0 | 65 | 19 | 17 |
| 98 | 108 | 133 | 61 | 55 | 0 | 63 | 19 | 18 |
| 96 | 106 | 131 | 59 | 55 | 0 | 61 | 19 | 18 |
| 94 | 104 | 129 | 57 | 55 | 0 | 59 | 19 | 18 |
| 92 | 102 | 127 | 55 | 55 | 0 | 57 | 19 | 19 |
| 90 | 100 | 125 | 53 | 55 | 0 | 55 | 19 | 19 |
| 88 | 98 | 123 | 51 | 55 | 0 | 53 | 19 | 19 |
| 86 | 96 | 121 | 48 | 55 | 0 | 51 | 19 | 20 |
| 84 | 94 | 119 | 46 | 55 | 0 | 50 | 19 | 20 |
| 82 | 92 | 117 | 44 | 55 | 0 | 48 | 19 | 21 |
| 80 | 90 | 115 | 42 | 54 | 0 | 46 | 20 | 21 |
| **Load at Bus 5** | **Load at Bus 7** | **Load at Bus 9** | **line (7 - 8)** | **line (8 - 9)** | **line (4 - 9)** |
| 100 | 110 | 135 | 77 | 35 | 61 |
| 98 | 108 | 133 | 76 | 36 | 59 |
| 96 | 106 | 131 | 75 | 36 | 57 |
| 94 | 104 | 129 | 74 | 37 | 56 |
| 92 | 102 | 127 | 74 | 37 | 54 |
| 90 | 100 | 125 | 73 | 38 | 52 |
| 88 | 98 | 123 | 72 | 38 | 50 |
| 86 | 96 | 121 | 72 | 39 | 48 |
| 84 | 94 | 119 | 71 | 40 | 47 |
| 82 | 92 | 117 | 70 | 40 | 45 |
| 80 | 90 | 115 | 69 | 41 | 43 |

Table A.3.4: Voltage magnitudes at various buses (training data for case3):

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Load at Bus 5** | **Load at Bus 7** | **Load at Bus 9** | **V4(P.U.)** | **V5(P.U.)** | **V6(P.U.)** | **V7(P.U.)** | **V8(P.U.)** | **V9(P.U.)** |
| 100 | 110 | 135 | 0.987 | 0.971 | 0.993 | 0.978 | 0.993 | 0.958 |
| 98 | 108 | 133 | 0.987 | 0.972 | 0.994 | 0.979 | 0.993 | 0.959 |
| 96 | 106 | 131 | 0.988 | 0.974 | 0.995 | 0.98 | 0.994 | 0.96 |
| 94 | 104 | 129 | 0.989 | 0.975 | 0.996 | 0.981 | 0.994 | 0.961 |
| 92 | 102 | 127 | 0.989 | 0.976 | 0.998 | 0.982 | 0.995 | 0.961 |
| 90 | 100 | 125 | 0.99 | 0.977 | 0.998 | 0.982 | 0.995 | 0.962 |
| 88 | 98 | 123 | 0.99 | 0.978 | 0.999 | 0.983 | 0.996 | 0.963 |
| 86 | 96 | 121 | 0.991 | 0.979 | 1 | 0.984 | 0.996 | 0.963 |
| 84 | 94 | 119 | 0.991 | 0.98 | 1.001 | 0.985 | 0.997 | 0.964 |
| 82 | 92 | 117 | 0.991 | 0.981 | 1.002 | 0.986 | 0.997 | 0.965 |
| 80 | 90 | 115 | 0.992 | 0.982 | 1.003 | 0.987 | 0.998 | 0.965 |

Table A.3.5: Real powers in MW (testing data for case3):

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Load at Bus 5** | **Load at Bus 7** | **Load at Bus 9** | **line (1 - 4)** | **line (2 - 8)** | **line (3 - 6)** | **line (4 - 5)** | **line (5 - 6)** | **line (6 – 7)** |
| 97 | 107 | 132 | 177.4 | 163.01 | 0 | 93.4 | 5.1 | 5.1 |
| 93 | 103 | 128 | 165.1 | 163.01 | 0 | 87.4 | 6.9 | 7 |
| 89 | 99 | 124 | 152.9 | 163.01 | 0 | 81.4 | 8.7 | 8.8 |
| 85 | 95 | 120 | 140.7 | 163.01 | 0 | 75.4 | 10.5 | 10.6 |
| 81 | 91 | 116 | 128.5 | 163 | 0 | 69.5 | 12.4 | 12.5 |
| **Load at Bus 5** | **Load at Bus 7** | **Load at Bus 9** | **line (7 - 8)** | **line (8 - 9)** | **line (4 - 9)** |
| 97 | 107 | 132 | 113.3 | 49.7 | 84 |
| 93 | 103 | 128 | 111.1 | 51.9 | 77.7 |
| 89 | 99 | 124 | 108.9 | 54.1 | 71.5 |
| 85 | 95 | 120 | 106.7 | 56.3 | 65.3 |
| 81 | 91 | 116 | 104.5 | 58.5 | 59.1 |

Table A.3.6: Reactive powers in MVAR (testing data for case3):

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Load at Bus 5** | **Load at Bus 7** | **Load at Bus 9** | **line (1 - 4)** | **line (2 - 8)** | **line (3 - 6)** | **line (4 - 5)** | **line (5 - 6)** | **line (6 – 7)** |
| 97 | 107 | 132 | 30.6 | 18.5 | 0 | 5.2 | 28.3 | 26.2 |
| 93 | 103 | 128 | 27.3 | 16.9 | 0 | 5.9 | 27.8 | 26.8 |
| 89 | 99 | 124 | 24.4 | 15.3 | 0 | 6.4 | 27.4 | 27.4 |
| 85 | 95 | 120 | 21.7 | 13.8 | 0 | 6.9 | 26.9 | 28 |
| 81 | 91 | 116 | 19.4 | 12.5 | 0 | 7.3 | 26.5 | 28.5 |
| **Load at Bus 5** | **Load at Bus 7** | **Load at Bus 9** | **line (7 - 8)** | **line (8 - 9)** | **line (4 - 9)** |
| 97 | 107 | 132 | 8.8 | 22.8 | 27.1 |
| 93 | 103 | 128 | 8.2 | 22 | 28 |
| 89 | 99 | 124 | 7.6 | 21.2 | 28.8 |
| 85 | 95 | 120 | 7 | 20.4 | 29.5 |
| 81 | 91 | 116 | 6.5 | 19.7 | 30.3 |

Table A.3.7: Thermal lines (testing data for case3):

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Load at Bus 5** | **Load at Bus 7** | **Load at Bus 9** | **line (1 - 4)** | **line (2 - 8)** | **line (3 - 6)** | **line (4 - 5)** | **line (5 - 6)** | **line (6 – 7)** |
| 97 | 107 | 132 | 60 | 55 | 0 | 62 | 19 | 18 |
| 93 | 103 | 128 | 56 | 55 | 0 | 58 | 19 | 18 |
| 89 | 99 | 124 | 52 | 55 | 0 | 54 | 19 | 19 |
| 85 | 95 | 120 | 47 | 55 | 0 | 51 | 19 | 20 |
| 81 | 91 | 116 | 43 | 54 | 0 | 47 | 19 | 21 |
| **Load at Bus 5** | **Load at Bus 7** | **Load at Bus 9** | **line (7 - 8)** | **line (8 - 9)** | **line (4 - 9)** |
| 97 | 107 | 132 | 76 | 36 | 58 |
| 93 | 103 | 128 | 74 | 37 | 55 |
| 89 | 99 | 124 | 73 | 38 | 51 |
| 85 | 95 | 120 | 71 | 39 | 47 |
| 81 | 91 | 116 | 70 | 40 | 44 |

Table A.3.8: Voltage magnitudes at various buses (testing data for case3):

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Load at Bus 5** | **Load at Bus 7** | **Load at Bus 9** | **V4(P.U.)** | **V5(P.U.)** | **V6(P.U.)** | **V7(P.U.)** | **V8(P.U.)** | **V9(P.U.)** |
| 97 | 107 | 132 | 0.988 | 0.973 | 0.995 | 0.979 | 0.994 | 0.96 |
| 93 | 103 | 128 | 0.989 | 0.975 | 0.997 | 0.981 | 0.995 | 0.961 |
| 89 | 99 | 124 | 0.99 | 0.978 | 0.999 | 0.983 | 0.996 | 0.962 |
| 85 | 95 | 120 | 0.991 | 0.98 | 1.001 | 0.985 | 0.997 | 0.964 |
| 81 | 91 | 116 | 0.992 | 0.981 | 1.002 | 0.986 | 0.997 | 0.965 |

Table A.4.1: Real powers in MW (training data for case4):

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Load at Bus 5** | **Load at Bus 7** | **Load at Bus 9** | **line (1 - 4)** | **line (2 - 8)** | **line (3 - 6)** | **line (4 - 5)** | **line (5 - 6)** | **line (6 – 7)** |
| 100 | 110 | 135 | 105.3 | 163 | 85 | 0 | 100 | 20 |
| 98 | 108 | 133 | 98.9 | 163 | 85 | 0 | 98 | 17.8 |
| 96 | 106 | 131 | 92.5 | 163 | 85 | 0 | 96 | 15.6 |
| 94 | 104 | 129 | 86.2 | 163 | 85 | 0 | 94 | 13.4 |
| 92 | 102 | 127 | 79.9 | 163 | 85 | 0 | 92 | 11.1 |
| 90 | 100 | 125 | 73.6 | 163 | 85 | 0 | 90 | 8.9 |
| 88 | 98 | 123 | 67.4 | 163 | 85 | 0 | 88 | 6.8 |
| 86 | 96 | 121 | 61.2 | 163 | 85 | 0 | 86 | 4.6 |
| 84 | 94 | 119 | 55.1 | 163 | 85 | 0 | 84 | 2.4 |
| 82 | 92 | 117 | 49 | 163 | 85 | 0 | 82 | 0.2 |
| 80 | 90 | 115 | 42.9 | 163 | 85 | 0 | 80 | 2 |
| **Load at Bus 5** | **Load at Bus 7** | **Load at Bus 9** | **line (7 - 8)** | **line (8 - 9)** | **line (4 - 9)** |
| 100 | 110 | 135 | 131.7 | 31.3 | 105.3 |
| 98 | 108 | 133 | 127.3 | 35.7 | 98.9 |
| 96 | 106 | 131 | 123 | 40 | 92.5 |
| 94 | 104 | 129 | 118.7 | 44.3 | 86.2 |
| 92 | 102 | 127 | 114.4 | 48.6 | 79.9 |
| 90 | 100 | 125 | 110.1 | 52.9 | 73.6 |
| 88 | 98 | 123 | 105.8 | 57.2 | 67.4 |
| 86 | 96 | 121 | 101.5 | 61.5 | 61.2 |
| 84 | 94 | 119 | 97.2 | 65.8 | 55.1 |
| 82 | 92 | 117 | 93 | 70 | 49 |
| 80 | 90 | 115 | 88.8 | 74.2 | 42.9 |

Table A.4.2: Reactive powers in MVAR (training data for case4):

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Load at Bus 5** | **Load at Bus 7** | **Load at Bus 9** | **line (1 - 4)** | **line (2 - 8)** | **line (3 - 6)** | **line (4 - 5)** | **line (5 - 6)** | **line (6 – 7)** |
| 100 | 110 | 135 | 24.4 | 24.5 | 30.7 | 0 | 30 | 24.9 |
| 98 | 108 | 133 | 23.5 | 23.4 | 28.9 | 0 | 30 | 24.4 |
| 96 | 106 | 131 | 22.7 | 22.4 | 27.2 | 0 | 30 | 24 |
| 94 | 104 | 129 | 22 | 21.5 | 25.6 | 0 | 30 | 23.7 |
| 92 | 102 | 127 | 21.5 | 20.6 | 24 | 0 | 30 | 23.3 |
| 90 | 100 | 125 | 21.1 | 19.9 | 22.6 | 0 | 30 | 22.9 |
| 88 | 98 | 123 | 20.9 | 19.3 | 21.1 | 0 | 30 | 22.6 |
| 86 | 96 | 121 | 20.7 | 18.7 | 19.8 | 0 | 30 | 22.3 |
| 84 | 94 | 119 | 20.8 | 18.2 | 18.5 | 0 | 30 | 21.9 |
| 82 | 92 | 117 | 20.9 | 17.8 | 17.2 | 0 | 30 | 21.6 |
| 80 | 90 | 115 | 21.1 | 17.5 | 16.1 | 0 | 30 | 21.3 |
| **Load at Bus 5** | **Load at Bus 7** | **Load at Bus 9** | **line (7 - 8)** | **line (8 - 9)** | **line (4 - 9)** |
| 100 | 110 | 135 | 10.1 | 25.9 | 24.1 |
| 98 | 108 | 133 | 10.6 | 24.9 | 25.1 |
| 96 | 106 | 131 | 11 | 23.9 | 26.1 |
| 94 | 104 | 129 | 11.3 | 22.9 | 27.1 |
| 92 | 102 | 127 | 11.7 | 21.9 | 28.1 |
| 90 | 100 | 125 | 12.1 | 20.8 | 29.1 |
| 88 | 98 | 123 | 12.4 | 19.8 | 30.2 |
| 86 | 96 | 121 | 12.7 | 18.8 | 31.2 |
| 84 | 94 | 119 | 13.1 | 17.8 | 32.2 |
| 82 | 92 | 117 | 13.4 | 16.8 | 33.2 |
| 80 | 90 | 115 | 13.7 | 15.8 | 34.2 |

Table A.4.3: Thermal lines (training data for case4):

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Load at Bus 5** | **Load at Bus 7** | **Load at Bus 9** | **line (1 - 4)** | **line (2 - 8)** | **line (3 - 6)** | **line (4 - 5)** | **line (5 - 6)** | **line (6 – 7)** |
| 100 | 110 | 135 | 36 | 55 | 30 | 0 | 71 | 21 |
| 98 | 108 | 133 | 34 | 55 | 30 | 0 | 70 | 20 |
| 96 | 106 | 131 | 32 | 55 | 30 | 0 | 68 | 19 |
| 94 | 104 | 129 | 30 | 55 | 30 | 0 | 67 | 18 |
| 92 | 102 | 127 | 28 | 55 | 29 | 0 | 65 | 17 |
| 90 | 100 | 125 | 26 | 55 | 29 | 0 | 63 | 16 |
| 88 | 98 | 123 | 24 | 55 | 29 | 0 | 62 | 16 |
| 86 | 96 | 121 | 22 | 55 | 29 | 0 | 61 | 15 |
| 84 | 94 | 119 | 20 | 55 | 29 | 0 | 59 | 15 |
| 82 | 92 | 117 | 18 | 55 | 29 | 0 | 58 | 14 |
| 80 | 90 | 115 | 16 | 55 | 29 | 0 | 57 | 14 |
| **Load at Bus 5** | **Load at Bus 7** | **Load at Bus 9** | **line (7 - 8)** | **line (8 - 9)** | **line (4 - 9)** |
| 100 | 110 | 135 | 89 | 27 | 71 |
| 98 | 108 | 133 | 86 | 29 | 67 |
| 96 | 106 | 131 | 83 | 31 | 63 |
| 94 | 104 | 129 | 79 | 33 | 60 |
| 92 | 102 | 127 | 76 | 35 | 56 |
| 90 | 100 | 125 | 74 | 37 | 52 |
| 88 | 98 | 123 | 71 | 40 | 49 |
| 86 | 96 | 121 | 68 | 42 | 46 |
| 84 | 94 | 119 | 65 | 44 | 42 |
| 82 | 92 | 117 | 62 | 47 | 39 |
| 80 | 90 | 115 | 59 | 50 | 36 |

Table A.4.4: Voltage magnitudes at various buses (training data for case4):

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Load at Bus 5** | **Load at Bus 7** | **Load at Bus 9** | **V4(P.U.)** | **V5(P.U.)** | **V6(P.U.)** | **V7(P.U.)** | **V8(P.U.)** | **V9(P.U.)** |
| 100 | 110 | 135 | 0.988 | 0.892 | 0.983 | 0.972 | 0.99 | 0.959 |
| 98 | 108 | 133 | 0.988 | 0.895 | 0.984 | 0.973 | 0.991 | 0.959 |
| 96 | 106 | 131 | 0.988 | 0.899 | 0.985 | 0.974 | 0.991 | 0.96 |
| 94 | 104 | 129 | 0.989 | 0.902 | 0.986 | 0.975 | 0.992 | 0.96 |
| 92 | 102 | 127 | 0.989 | 0.905 | 0.987 | 0.976 | 0.992 | 0.96 |
| 90 | 100 | 125 | 0.989 | 0.907 | 0.988 | 0.976 | 0.993 | 0.961 |
| 88 | 98 | 123 | 0.989 | 0.91 | 0.989 | 0.977 | 0.993 | 0.961 |
| 86 | 96 | 121 | 0.989 | 0.913 | 0.99 | 0.978 | 0.994 | 0.961 |
| 84 | 94 | 119 | 0.989 | 0.915 | 0.99 | 0.979 | 0.994 | 0.961 |
| 82 | 92 | 117 | 0.988 | 0.918 | 0.991 | 0.979 | 0.994 | 0.96 |
| 80 | 90 | 115 | 0.988 | 0.92 | 0.992 | 0.98 | 0.994 | 0.96 |

Table A.4.5: Real powers in MW (testing data for case4):

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Load at Bus 5** | **Load at Bus 7** | **Load at Bus 9** | **line (1 - 4)** | **line (2 - 8)** | **line (3 - 6)** | **line (4 - 5)** | **line (5 - 6)** | **line (6 – 7)** |
| 97 | 107 | 132 | 95.7 | 163.01 | 85 | 0 | 97 | 16.7 |
| 93 | 103 | 128 | 83 | 163.01 | 85 | 0 | 93 | 12.2 |
| 89 | 99 | 124 | 70.5 | 163.01 | 85 | 0 | 89 | 7.8 |
| 85 | 95 | 120 | 58.1 | 163.01 | 85 | 0 | 85 | 3.5 |
| 81 | 91 | 116 | 45.9 | 163 | 85 | 0 | 81 | 0.9 |
| **Load at Bus 5** | **Load at Bus 7** | **Load at Bus 9** | **line (7 - 8)** | **line (8 - 9)** | **line (4 - 9)** |
| 97 | 107 | 132 | 125.2 | 37.8 | 95.7 |
| 93 | 103 | 128 | 116.5 | 46.5 | 83 |
| 89 | 99 | 124 | 107.9 | 55.1 | 70.5 |
| 85 | 95 | 120 | 99.4 | 63.6 | 58.1 |
| 81 | 91 | 116 | 90.9 | 72.1 | 45.9 |

Table A.4.6: Reactive powers in MVAR (testing data for case4):

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Load at Bus 5** | **Load at Bus 7** | **Load at Bus 9** | **line (1 - 4)** | **line (2 - 8)** | **line (3 - 6)** | **line (4 - 5)** | **line (5 - 6)** | **line (6 – 7)** |
| 97 | 107 | 132 | 23 | 22.9 | 28 | 0 | 30 | 24.2 |
| 93 | 103 | 128 | 21.7 | 21 | 24.8 | 0 | 30 | 23.5 |
| 89 | 99 | 124 | 21 | 19.6 | 21.8 | 0 | 30 | 22.8 |
| 85 | 95 | 120 | 20.7 | 18.4 | 19.1 | 0 | 30 | 22.1 |
| 81 | 91 | 116 | 21 | 17.6 | 16.7 | 0 | 30 | 21.5 |
| **Load at Bus 5** | **Load at Bus 7** | **Load at Bus 9** | **line (7 - 8)** | **line (8 - 9)** | **line (4 - 9)** |
| 97 | 107 | 132 | 10.8 | 24.4 | 25.6 |
| 93 | 103 | 128 | 11.5 | 22.4 | 27.6 |
| 89 | 99 | 124 | 12.2 | 20.3 | 29.6 |
| 85 | 95 | 120 | 12.9 | 18.3 | 31.7 |
| 81 | 91 | 116 | 13.5 | 16.3 | 33.7 |

Table A.4.7: Thermal lines (testing data for case4):

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Load at Bus 5** | **Load at Bus 7** | **Load at Bus 9** | **line (1 - 4)** | **line (2 - 8)** | **line (3 - 6)** | **line (4 - 5)** | **line (5 - 6)** | **line (6 – 7)** |
| 97 | 107 | 132 | 33 | 55 | 30 | 0 | 69 | 20 |
| 93 | 103 | 128 | 29 | 55 | 30 | 0 | 66 | 18 |
| 89 | 99 | 124 | 25 | 55 | 29 | 0 | 63 | 16 |
| 85 | 95 | 120 | 21 | 55 | 29 | 0 | 60 | 15 |
| 81 | 91 | 116 | 17 | 55 | 29 | 0 | 58 | 14 |
| **Load at Bus 5** | **Load at Bus 7** | **Load at Bus 9** | **line (7 - 8)** | **line (8 - 9)** | **line (4 - 9)** |
| 97 | 107 | 132 | 84 | 30 | 65 |
| 93 | 103 | 128 | 78 | 34 | 58 |
| 89 | 99 | 124 | 72 | 39 | 51 |
| 85 | 95 | 120 | 66 | 43 | 44 |
| 81 | 91 | 116 | 61 | 48 | 38 |

Table A.4.8: Voltage magnitudes at various buses (testing data for case4):

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Load at Bus 5** | **Load at Bus 7** | **Load at Bus 9** | **V4(P.U.)** | **V5(P.U.)** | **V6(P.U.)** | **V7(P.U.)** | **V8(P.U.)** | **V9(P.U.)** |
| 97 | 107 | 132 | 0.988 | 0.897 | 0.985 | 0.973 | 0.991 | 0.959 |
| 93 | 103 | 128 | 0.989 | 0.903 | 0.987 | 0.975 | 0.992 | 0.96 |
| 89 | 99 | 124 | 0.989 | 0.909 | 0.988 | 0.977 | 0.993 | 0.961 |
| 85 | 95 | 120 | 0.989 | 0.914 | 0.99 | 0.978 | 0.994 | 0.961 |
| 81 | 91 | 116 | 0.988 | 0.919 | 0.992 | 0.98 | 0.994 | 0.96 |

Table A.5.1: Real powers in MW (training data for case5):

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Load at Bus 5** | **Load at Bus 7** | **Load at Bus 9** | **line (1 - 4)** | **line (2 - 8)** | **line (3 - 6)** | **line (4 - 5)** | **line (5 - 6)** | **line (6 – 7)** |
| 100 | 110 | 135 | 107.2 | 163 | 85 | 102.1 | 0 | 85 |
| 98 | 108 | 133 | 101.3 | 163 | 85 | 100.1 | 0 | 85 |
| 96 | 106 | 131 | 95.4 | 163 | 85 | 98 | 0 | 85 |
| 94 | 104 | 129 | 89.5 | 163 | 85 | 95.9 | 0 | 85 |
| 92 | 102 | 127 | 83.6 | 163 | 85 | 93.8 | 0 | 85 |
| 90 | 100 | 125 | 77.8 | 163 | 85 | 91.7 | 0 | 85 |
| 88 | 98 | 123 | 71.9 | 163 | 85 | 89.7 | 0 | 85 |
| 86 | 96 | 121 | 66.1 | 163 | 85 | 87.6 | 0 | 85 |
| 84 | 94 | 119 | 60.2 | 163 | 85 | 85.5 | 0 | 85 |
| 82 | 92 | 117 | 54.3 | 163 | 85 | 83.5 | 0 | 85 |
| 80 | 90 | 115 | 48.6 | 163 | 85 | 81.4 | 0 | 85 |
| **Load at Bus 5** | **Load at Bus 7** | **Load at Bus 9** | **line (7 - 8)** | **line (8 - 9)** | **line (4 - 9)** |
| 100 | 110 | 135 | 26.6 | 136.4 | 5 |
| 98 | 108 | 133 | 24.5 | 138.5 | 1.2 |
| 96 | 106 | 131 | 22.5 | 140.5 | 2.6 |
| 94 | 104 | 129 | 20.5 | 142.5 | 6.4 |
| 92 | 102 | 127 | 18.5 | 144.5 | 10.2 |
| 90 | 100 | 125 | 16.5 | 146.5 | 14 |
| 88 | 98 | 123 | 14.5 | 148.5 | 17.8 |
| 86 | 96 | 121 | 12.5 | 150.5 | 21.5 |
| 84 | 94 | 119 | 10.5 | 152.5 | 25.3 |
| 82 | 92 | 117 | 8.5 | 154.6 | 29.1 |
| 80 | 90 | 115 | 6.5 | 156.5 | 32.8 |

Table A.5.2: Reactive powers in MVAR (training data for case5):

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Load at Bus 5** | **Load at Bus 7** | **Load at Bus 9** | **line (1 - 4)** | **line (2 - 8)** | **line (3 - 6)** | **line (4 - 5)** | **line (5 - 6)** | **line (6 – 7)** |
| 100 | 110 | 135 | 67.9 | 32.7 | 5.9 | 30 | 0 | 14.4 |
| 98 | 108 | 133 | 67.5 | 32.9 | 5.8 | 30 | 0 | 14.4 |
| 96 | 106 | 131 | 67.2 | 33.1 | 5.8 | 30 | 0 | 14.4 |
| 94 | 104 | 129 | 66.9 | 33.3 | 5.7 | 30 | 0 | 14.3 |
| 92 | 102 | 127 | 66.8 | 33.5 | 5.7 | 30 | 0 | 14.3 |
| 90 | 100 | 125 | 66.7 | 33.8 | 5.7 | 30 | 0 | 14.3 |
| 88 | 98 | 123 | 66.7 | 34.1 | 5.7 | 30 | 0 | 14.3 |
| 86 | 96 | 121 | 66.8 | 34.4 | 5.7 | 30 | 0 | 14.3 |
| 84 | 94 | 119 | 67 | 34.8 | 5.7 | 30 | 0 | 14.3 |
| 82 | 92 | 117 | 67.3 | 35.1 | 5.7 | 30 | 0 | 14.3 |
| 80 | 90 | 115 | 67.6 | 35.5 | 5.8 | 30 | 0 | 14.4 |
| **Load at Bus 5** | **Load at Bus 7** | **Load at Bus 9** | **line (7 - 8)** | **line (8 - 9)** | **line (4 - 9)** |
| 100 | 110 | 135 | 20.6 | 8.5 | 45.3 |
| 98 | 108 | 133 | 20.6 | 8.7 | 46.1 |
| 96 | 106 | 131 | 20.6 | 8.9 | 46.8 |
| 94 | 104 | 129 | 20.7 | 9.1 | 47.6 |
| 92 | 102 | 127 | 20.7 | 9.4 | 48.3 |
| 90 | 100 | 125 | 20.7 | 9.7 | 49 |
| 88 | 98 | 123 | 20.7 | 10 | 49.8 |
| 86 | 96 | 121 | 20.7 | 10.4 | 50.5 |
| 84 | 94 | 119 | 20.7 | 10.7 | 51.2 |
| 82 | 92 | 117 | 20.7 | 11.1 | 51.9 |
| 80 | 90 | 115 | 20.6 | 11.6 | 52.6 |

Table A.5.3: Thermal lines (training data for case5):

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Load at Bus 5** | **Load at Bus 7** | **Load at Bus 9** | **line (1 - 4)** | **line (2 - 8)** | **line (3 - 6)** | **line (4 - 5)** | **line (5 - 6)** | **line (6 – 7)** |
| 100 | 110 | 135 | 42 | 55 | 28 | 71 | 0 | 57 |
| 98 | 108 | 133 | 41 | 55 | 28 | 69 | 0 | 57 |
| 96 | 106 | 131 | 39 | 55 | 28 | 68 | 0 | 57 |
| 94 | 104 | 129 | 37 | 55 | 28 | 66 | 0 | 57 |
| 92 | 102 | 127 | 36 | 55 | 28 | 65 | 0 | 57 |
| 90 | 100 | 125 | 34 | 55 | 28 | 63 | 0 | 57 |
| 88 | 98 | 123 | 33 | 56 | 28 | 62 | 0 | 57 |
| 86 | 96 | 121 | 31 | 56 | 28 | 61 | 0 | 57 |
| 84 | 94 | 119 | 30 | 56 | 28 | 59 | 0 | 57 |
| 82 | 92 | 117 | 29 | 56 | 28 | 58 | 0 | 57 |
| 80 | 90 | 115 | 28 | 56 | 28 | 57 | 0 | 57 |
| **Load at Bus 5** | **Load at Bus 7** | **Load at Bus 9** | **line (7 - 8)** | **line (8 - 9)** | **line (4 - 9)** |
| 100 | 110 | 135 | 22 | 93 | 30 |
| 98 | 108 | 133 | 21 | 94 | 31 |
| 96 | 106 | 131 | 20 | 95 | 31 |
| 94 | 104 | 129 | 19 | 97 | 32 |
| 92 | 102 | 127 | 18 | 98 | 33 |
| 90 | 100 | 125 | 18 | 99 | 34 |
| 88 | 98 | 123 | 17 | 101 | 35 |
| 86 | 96 | 121 | 16 | 102 | 37 |
| 84 | 94 | 119 | 15 | 104 | 38 |
| 82 | 92 | 117 | 15 | 105 | 40 |
| 80 | 90 | 115 | 14 | 106 | 41 |

Table A.5.4: Voltage magnitudes at various buses (training data for case5):

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Load at Bus 5** | **Load at Bus 7** | **Load at Bus 9** | **V4(P.U.)** | **V5(P.U.)** | **V6(P.U.)** | **V7(P.U.)** | **V8(P.U.)** | **V9(P.U.)** |
| 100 | 110 | 135 | 0.963 | 0.916 | 0.998 | 0.972 | 0.985 | 0.928 |
| 98 | 108 | 133 | 0.963 | 0.917 | 0.998 | 0.972 | 0.985 | 0.927 |
| 96 | 106 | 131 | 0.963 | 0.917 | 0.998 | 0.972 | 0.985 | 0.927 |
| 94 | 104 | 129 | 0.963 | 0.918 | 0.998 | 0.973 | 0.984 | 0.927 |
| 92 | 102 | 127 | 0.963 | 0.918 | 0.998 | 0.973 | 0.984 | 0.926 |
| 90 | 100 | 125 | 0.963 | 0.919 | 0.998 | 0.973 | 0.984 | 0.926 |
| 88 | 98 | 123 | 0.962 | 0.919 | 0.998 | 0.973 | 0.984 | 0.925 |
| 86 | 96 | 121 | 0.962 | 0.92 | 0.998 | 0.973 | 0.984 | 0.925 |
| 84 | 94 | 119 | 0.962 | 0.92 | 0.998 | 0.973 | 0.984 | 0.924 |
| 82 | 92 | 117 | 0.962 | 0.92 | 0.998 | 0.973 | 0.983 | 0.924 |
| 80 | 90 | 115 | 0.961 | 0.92 | 0.998 | 0.972 | 0.983 | 0.923 |

Table A.5.5: Real powers in MW (testing data for case5):

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Load at Bus 5** | **Load at Bus 7** | **Load at Bus 9** | **line (1 - 4)** | **line (2 - 8)** | **line (3 - 6)** | **line (4 - 5)** | **line (5 - 6)** | **line (6 – 7)** |
| 97 | 107 | 132 | 98.3 | 163.01 | 85 | 99 | 0 | 85 |
| 93 | 103 | 128 | 86.6 | 163.01 | 85 | 94.9 | 0 | 85 |
| 89 | 99 | 124 | 74.8 | 163.01 | 85 | 90.7 | 0 | 85 |
| 85 | 95 | 120 | 63.1 | 163.01 | 85 | 86.6 | 0 | 85 |
| 81 | 91 | 116 | 51.5 | 163.01 | 85 | 82.4 | 0 | 85 |
| **Load at Bus 5** | **Load at Bus 7** | **Load at Bus 9** | **line (7 - 8)** | **line (8 - 9)** | **line (4 - 9)** |
| 97 | 107 | 132 | 23.5 | 139.5 | 0.7 |
| 93 | 103 | 128 | 19.5 | 143.5 | 8.3 |
| 89 | 99 | 124 | 15.5 | 147.5 | 15.9 |
| 85 | 95 | 120 | 11.5 | 151.5 | 23.4 |
| 81 | 91 | 116 | 7.5 | 155.5 | 30.9 |

Table A.5.6: Reactive powers in MVAR (testing data for case5):

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Load at Bus 5** | **Load at Bus 7** | **Load at Bus 9** | **line (1 - 4)** | **line (2 - 8)** | **line (3 - 6)** | **line (4 - 5)** | **line (5 - 6)** | **line (6 – 7)** |
| 97 | 107 | 132 | 67.3 | 33 | 5.8 | 30 | 0 | 14.4 |
| 93 | 103 | 128 | 66.8 | 33.4 | 5.7 | 30 | 0 | 14.3 |
| 89 | 99 | 124 | 66.7 | 33.9 | 5.7 | 30 | 0 | 14.3 |
| 85 | 95 | 120 | 66.9 | 34.6 | 5.7 | 30 | 0 | 14.3 |
| 81 | 91 | 116 | 67.4 | 35.3 | 5.8 | 30 | 0 | 14.3 |
| **Load at Bus 5** | **Load at Bus 7** | **Load at Bus 9** | **line (7 - 8)** | **line (8 - 9)** | **line (4 - 9)** |
| 97 | 107 | 132 | 20.6 | 8.8 | 46.4 |
| 93 | 103 | 128 | 20.7 | 9.3 | 47.9 |
| 89 | 99 | 124 | 20.7 | 9.8 | 49.4 |
| 85 | 95 | 120 | 20.7 | 10.5 | 50.8 |
| 81 | 91 | 116 | 20.7 | 11.3 | 52.2 |

Table A.5.7: Thermal lines (testing data for case5):

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Load at Bus 5** | **Load at Bus 7** | **Load at Bus 9** | **line (1 - 4)** | **line (2 - 8)** | **line (3 - 6)** | **line (4 - 5)** | **line (5 - 6)** | **line (6 – 7)** |
| 97 | 107 | 132 | 40 | 55 | 28 | 68 | 0 | 57 |
| 93 | 103 | 128 | 36 | 55 | 28 | 66 | 0 | 57 |
| 89 | 99 | 124 | 33 | 56 | 28 | 63 | 0 | 57 |
| 85 | 95 | 120 | 31 | 56 | 28 | 60 | 0 | 57 |
| 81 | 91 | 116 | 28 | 56 | 28 | 58 | 0 | 57 |
| **Load at Bus 5** | **Load at Bus 7** | **Load at Bus 9** | **line (7 - 8)** | **line (8 - 9)** | **line (4 - 9)** |
| 97 | 107 | 132 | 21 | 95 | 31 |
| 93 | 103 | 128 | 19 | 97 | 32 |
| 89 | 99 | 124 | 17 | 100 | 35 |
| 85 | 95 | 120 | 16 | 103 | 37 |
| 81 | 91 | 116 | 15 | 106 | 41 |

Table A.5.8: Voltage magnitudes at various buses (testing data for case5):

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Load at Bus 5** | **Load at Bus 7** | **Load at Bus 9** | **V4(P.U.)** | **V5(P.U.)** | **V6(P.U.)** | **V7(P.U.)** | **V8(P.U.)** | **V9(P.U.)** |
| 97 | 107 | 132 | 0.963 | 0.917 | 0.998 | 0.972 | 0.985 | 0.927 |
| 93 | 103 | 128 | 0.963 | 0.918 | 0.998 | 0.973 | 0.984 | 0.927 |
| 89 | 99 | 124 | 0.963 | 0.919 | 0.998 | 0.973 | 0.984 | 0.926 |
| 85 | 95 | 120 | 0.962 | 0.92 | 0.998 | 0.973 | 0.984 | 0.925 |
| 81 | 91 | 116 | 0.962 | 0.92 | 0.998 | 0.972 | 0.983 | 0.923 |

Table A.6.1: Real powers in MW (training data for case6):

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Load at Bus 5** | **Load at Bus 7** | **Load at Bus 9** | **line (1 - 4)** | **line (2 - 8)** | **line (3 - 6)** | **line (4 - 5)** | **line (5 - 6)** | **line (6 – 7)** |
| 100 | 110 | 135 | 102.9 | 163 | 85 | 17.9 | 82.2 | 0 |
| 98 | 108 | 133 | 96.8 | 163 | 85 | 15.9 | 82.2 | 0 |
| 96 | 106 | 131 | 90.8 | 163 | 85 | 13.9 | 82.2 | 0 |
| 94 | 104 | 129 | 84.8 | 163 | 85 | 11.9 | 82.2 | 0 |
| 92 | 102 | 127 | 78.7 | 163 | 85 | 9.8 | 82.2 | 0 |
| 90 | 100 | 125 | 72.7 | 163 | 85 | 7.8 | 82.2 | 0 |
| 88 | 98 | 123 | 66.7 | 163 | 85 | 5.8 | 82.2 | 0 |
| 86 | 96 | 121 | 60.7 | 163 | 85 | 3.8 | 82.2 | 0 |
| 84 | 94 | 119 | 54.7 | 163 | 85 | 1.8 | 82.2 | 0 |
| 82 | 92 | 117 | 48.7 | 163 | 85 | 0.2 | 82.2 | 0 |
| 80 | 90 | 115 | 42.7 | 163 | 85 | 2.2 | 82.2 | 0 |
| **Load at Bus 5** | **Load at Bus 7** | **Load at Bus 9** | **line (7 - 8)** | **line (8 - 9)** | **line (4 - 9)** |
| 100 | 110 | 135 | 111.2 | 51.8 | 85 |
| 98 | 108 | 133 | 109.2 | 53.8 | 81 |
| 96 | 106 | 131 | 107.1 | 55.9 | 76.9 |
| 94 | 104 | 129 | 105.1 | 57.9 | 72.9 |
| 92 | 102 | 127 | 103.1 | 59.9 | 68.9 |
| 90 | 100 | 125 | 101 | 62 | 64.9 |
| 88 | 98 | 123 | 99 | 64 | 60.9 |
| 86 | 96 | 121 | 96.9 | 66.1 | 56.9 |
| 84 | 94 | 119 | 94.9 | 68.1 | 52.9 |
| 82 | 92 | 117 | 92.9 | 70.1 | 48.9 |
| 80 | 90 | 115 | 90.8 | 72.2 | 44.9 |

Table A.6.2: Reactive powers in MVAR (training data for case6):

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Load at Bus 5** | **Load at Bus 7** | **Load at Bus 9** | **line (1 - 4)** | **line (2 - 8)** | **line (3 - 6)** | **line (4 - 5)** | **line (5 - 6)** | **line (6 – 7)** |
| 100 | 110 | 135 | 32.7 | 43.8 | 10.6 | 18 | 12 | 0 |
| 98 | 108 | 133 | 32.1 | 43.1 | 10.8 | 18.1 | 11.9 | 0 |
| 96 | 106 | 131 | 31.4 | 42.5 | 11 | 18.3 | 11.7 | 0 |
| 94 | 104 | 129 | 30.9 | 41.9 | 11.2 | 18.4 | 11.6 | 0 |
| 92 | 102 | 127 | 30.4 | 41.4 | 11.3 | 18.6 | 11.4 | 0 |
| 90 | 100 | 125 | 30 | 40.9 | 11.5 | 18.7 | 11.5 | 0 |
| 88 | 98 | 123 | 29.7 | 40.4 | 11.6 | 18.8 | 11.6 | 0 |
| 86 | 96 | 121 | 29.5 | 39.9 | 11.7 | 18.9 | 11.7 | 0 |
| 84 | 94 | 119 | 29.3 | 39.5 | 11.8 | 19 | 11.8 | 0 |
| 82 | 92 | 117 | 29.2 | 39.1 | 11.9 | 19.1 | 11.9 | 0 |
| 80 | 90 | 115 | 29.2 | 38.7 | 12 | 19.2 | 12 | 0 |
| **Load at Bus 5** | **Load at Bus 7** | **Load at Bus 9** | **line (7 - 8)** | **line (8 - 9)** | **line (4 - 9)** |
| 100 | 110 | 135 | 35 | 18.1 | 31.9 |
| 98 | 108 | 133 | 35 | 17.5 | 32.5 |
| 96 | 106 | 131 | 35 | 17 | 33 |
| 94 | 104 | 129 | 35 | 16.4 | 33.6 |
| 92 | 102 | 127 | 35 | 15.9 | 34.1 |
| 90 | 100 | 125 | 35 | 15.4 | 34.6 |
| 88 | 98 | 123 | 35 | 14.8 | 35.2 |
| 86 | 96 | 121 | 35 | 14.3 | 35.7 |
| 84 | 94 | 119 | 35 | 13.8 | 36.2 |
| 82 | 92 | 117 | 35 | 13.3 | 36.7 |
| 80 | 90 | 115 | 35 | 12.8 | 37.2 |

Table A.6.3: Thermal lines (training data for case6):

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Load at Bus 5** | **Load at Bus 7** | **Load at Bus 9** | **line (1 - 4)** | **line (2 - 8)** | **line (3 - 6)** | **line (4 - 5)** | **line (5 - 6)** | **line (6 – 7)** |
| 100 | 110 | 135 | 36 | 56 | 29 | 17 | 57 | 0 |
| 98 | 108 | 133 | 34 | 56 | 29 | 16 | 57 | 0 |
| 96 | 106 | 131 | 32 | 56 | 29 | 15 | 57 | 0 |
| 94 | 104 | 129 | 30 | 56 | 29 | 15 | 57 | 0 |
| 92 | 102 | 127 | 28 | 56 | 29 | 14 | 57 | 0 |
| 90 | 100 | 125 | 26 | 56 | 29 | 14 | 57 | 0 |
| 88 | 98 | 123 | 24 | 56 | 29 | 13 | 57 | 0 |
| 86 | 96 | 121 | 22 | 56 | 29 | 13 | 57 | 0 |
| 84 | 94 | 119 | 21 | 56 | 29 | 13 | 57 | 0 |
| 82 | 92 | 117 | 19 | 56 | 29 | 13 | 57 | 0 |
| 80 | 90 | 115 | 17 | 56 | 29 | 13 | 57 | 0 |
| **Load at Bus 5** | **Load at Bus 7** | **Load at Bus 9** | **line (7 - 8)** | **line (8 - 9)** | **line (4 - 9)** |
| 100 | 110 | 135 | 77 | 36 | 60 |
| 98 | 108 | 133 | 76 | 37 | 58 |
| 96 | 106 | 131 | 74 | 38 | 55 |
| 94 | 104 | 129 | 73 | 39 | 53 |
| 92 | 102 | 127 | 72 | 41 | 51 |
| 90 | 100 | 125 | 71 | 42 | 49 |
| 88 | 98 | 123 | 69 | 43 | 47 |
| 86 | 96 | 121 | 68 | 44 | 45 |
| 84 | 94 | 119 | 67 | 46 | 43 |
| 82 | 92 | 117 | 66 | 47 | 41 |
| 80 | 90 | 115 | 64 | 48 | 39 |

Table A.6.4: Voltage magnitudes at various buses (training data for case6):

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Load at Bus 5** | **Load at Bus 7** | **Load at Bus 9** | **V4(P.U.)** | **V5(P.U.)** | **V6(P.U.)** | **V7(P.U.)** | **V8(P.U.)** | **V9(P.U.)** |
| 100 | 110 | 135 | 0.983 | 0.97 | 1.005 | 0.943 | 0.978 | 0.95 |
| 98 | 108 | 133 | 0.983 | 0.97 | 1.005 | 0.944 | 0.978 | 0.95 |
| 96 | 106 | 131 | 0.983 | 0.971 | 1.005 | 0.944 | 0.979 | 0.951 |
| 94 | 104 | 129 | 0.983 | 0.971 | 1.005 | 0.945 | 0.979 | 0.951 |
| 92 | 102 | 127 | 0.984 | 0.971 | 1.005 | 0.946 | 0.979 | 0.951 |
| 90 | 100 | 125 | 0.984 | 0.972 | 1.005 | 0.946 | 0.98 | 0.951 |
| 88 | 98 | 123 | 0.984 | 0.972 | 1.006 | 0.947 | 0.98 | 0.952 |
| 86 | 96 | 121 | 0.984 | 0.972 | 1.006 | 0.948 | 0.98 | 0.952 |
| 84 | 94 | 119 | 0.984 | 0.972 | 1.006 | 0.948 | 0.981 | 0.952 |
| 82 | 92 | 117 | 0.984 | 0.973 | 1.006 | 0.949 | 0.981 | 0.952 |
| 80 | 90 | 115 | 0.984 | 0.973 | 1.006 | 0.949 | 0.981 | 0.952 |

Table A.6.5: Real powers in MW (testing data for case6):

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Load at Bus 5** | **Load at Bus 7** | **Load at Bus 9** | **line (1 - 4)** | **line (2 - 8)** | **line (3 - 6)** | **line (4 - 5)** | **line (5 - 6)** | **line (6 – 7)** |
| 97 | 107 | 132 | 93.8 | 163.01 | 85 | 14.9 | 82.2 | 0 |
| 93 | 103 | 128 | 81.7 | 163.01 | 85 | 10.8 | 82.2 | 0 |
| 89 | 99 | 124 | 69.7 | 163.01 | 85 | 6.8 | 82.2 | 0 |
| 85 | 95 | 120 | 57.7 | 163.01 | 85 | 2.8 | 82.2 | 0 |
| 81 | 91 | 116 | 45.7 | 163.01 | 85 | 1.2 | 82.2 | 0 |
| **Load at Bus 5** | **Load at Bus 7** | **Load at Bus 9** | **line (7 - 8)** | **line (8 - 9)** | **line (4 - 9)** |
| 97 | 107 | 132 | 108.2 | 54.8 | 78.9 |
| 93 | 103 | 128 | 104.1 | 58.9 | 70.9 |
| 89 | 99 | 124 | 100 | 63 | 62.9 |
| 85 | 95 | 120 | 95.9 | 67.1 | 54.9 |
| 81 | 91 | 116 | 91.9 | 71.7 | 46.9 |

Table A.6.6: Reactive powers in MVAR (testing data for case6):

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Load at Bus 5** | **Load at Bus 7** | **Load at Bus 9** | **line (1 - 4)** | **line (2 - 8)** | **line (3 - 6)** | **line (4 - 5)** | **line (5 - 6)** | **line (6 – 7)** |
| 97 | 107 | 132 | 31.7 | 42.8 | 10.9 | 18.2 | 11.8 | 0 |
| 93 | 103 | 128 | 30.6 | 41.7 | 11.2 | 18.5 | 11.5 | 0 |
| 89 | 99 | 124 | 29.9 | 40.6 | 11.5 | 18.8 | 11.5 | 0 |
| 85 | 95 | 120 | 29.4 | 39.7 | 11.8 | 19 | 11.8 | 0 |
| 81 | 91 | 116 | 29.2 | 38.9 | 12 | 19.1 | 12 | 0 |
| **Load at Bus 5** | **Load at Bus 7** | **Load at Bus 9** | **line (7 - 8)** | **line (8 - 9)** | **line (4 - 9)** |
| 97 | 107 | 132 | 35 | 17.2 | 32.7 |
| 93 | 103 | 128 | 35 | 16.2 | 33.8 |
| 89 | 99 | 124 | 35 | 15.1 | 34.9 |
| 85 | 95 | 120 | 35 | 14 | 35.9 |
| 81 | 91 | 116 | 35 | 13 | 37 |

Table A.6.7: Thermal lines (testing data for case6):

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Load at Bus 5** | **Load at Bus 7** | **Load at Bus 9** | **line (1 - 4)** | **line (2 - 8)** | **line (3 - 6)** | **line (4 - 5)** | **line (5 - 6)** | **line (6 – 7)** |
| 97 | 107 | 132 | 33 | 56 | 29 | 16 | 57 | 0 |
| 93 | 103 | 128 | 29 | 56 | 29 | 14 | 57 | 0 |
| 89 | 99 | 124 | 25 | 56 | 29 | 13 | 57 | 0 |
| 85 | 95 | 120 | 22 | 56 | 29 | 13 | 57 | 0 |
| 81 | 91 | 116 | 18 | 56 | 29 | 13 | 57 | 0 |
| **Load at Bus 5** | **Load at Bus 7** | **Load at Bus 9** | **line (7 - 8)** | **line (8 - 9)** | **line (4 - 9)** |
| 97 | 107 | 132 | 75 | 38 | 57 |
| 93 | 103 | 128 | 73 | 40 | 52 |
| 89 | 99 | 124 | 70 | 42 | 48 |
| 85 | 95 | 120 | 67 | 45 | 43 |
| 81 | 91 | 116 | 65 | 48 | 40 |

Table A.6.8: Voltage magnitudes at various buses (testing data for case6):

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Load at Bus 5** | **Load at Bus 7** | **Load at Bus 9** | **V4(P.U.)** | **V5(P.U.)** | **V6(P.U.)** | **V7(P.U.)** | **V8(P.U.)** | **V9(P.U.)** |
| 97 | 107 | 132 | 0.983 | 0.97 | 1.005 | 0.944 | 0.979 | 0.951 |
| 93 | 103 | 128 | 0.983 | 0.971 | 1.005 | 0.946 | 0.979 | 0.951 |
| 89 | 99 | 124 | 0.984 | 0.972 | 1.005 | 0.947 | 0.98 | 0.952 |
| 85 | 95 | 120 | 0.984 | 0.972 | 1.006 | 0.948 | 0.981 | 0.952 |
| 81 | 91 | 116 | 0.984 | 0.973 | 1.006 | 0.949 | 0.981 | 0.952 |

Table A.7.1: Real powers in MW (training data for case7):

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Load at Bus 5** | **Load at Bus 7** | **Load at Bus 9** | **line (1 - 4)** | **line (2 - 8)** | **line (3 - 6)** | **line (4 - 5)** | **line (5 - 6)** | **line (6 – 7)** |
| 100 | 110 | 135 | 112.9 | 163 | 85 | 131.6 | 28.5 | 113 |
| 98 | 108 | 133 | 106.5 | 163 | 85 | 127.2 | 26.3 | 110.9 |
| 96 | 106 | 131 | 100.1 | 163 | 85 | 122.9 | 24.2 | 108.8 |
| 94 | 104 | 129 | 93.8 | 163 | 85 | 118.5 | 22 | 106.7 |
| 92 | 102 | 127 | 87.4 | 163 | 85 | 114.2 | 19.9 | 104.6 |
| 90 | 100 | 125 | 81.1 | 163 | 85 | 109.9 | 17.7 | 102.5 |
| 88 | 98 | 123 | 74.8 | 163 | 85 | 105.6 | 15.6 | 100.4 |
| 86 | 96 | 121 | 68.6 | 163 | 85 | 101.3 | 13.4 | 98.3 |
| 84 | 94 | 119 | 62.3 | 163 | 85 | 97 | 11.3 | 96.2 |
| 82 | 92 | 117 | 56 | 163 | 85 | 92.7 | 9.2 | 94.1 |
| 80 | 90 | 115 | 49.8 | 163 | 85 | 88.5 | 7.1 | 92 |
| **Load at Bus 5** | **Load at Bus 7** | **Load at Bus 9** | **line (7 - 8)** | **line (8 - 9)** | **line (4 - 9)** |
| 100 | 110 | 135 | 0 | 163 | 18.8 |
| 98 | 108 | 133 | 0 | 163 | 20.8 |
| 96 | 106 | 131 | 0 | 163 | 22.8 |
| 94 | 104 | 129 | 0 | 163 | 24.8 |
| 92 | 102 | 127 | 0 | 163 | 26.7 |
| 90 | 100 | 125 | 0 | 163 | 28.7 |
| 88 | 98 | 123 | 0 | 163 | 30.7 |
| 86 | 96 | 121 | 0 | 163 | 32.7 |
| 84 | 94 | 119 | 0 | 163 | 34.7 |
| 82 | 92 | 117 | 0 | 163 | 36.7 |
| 80 | 90 | 115 | 0 | 163 | 38.7 |

Table A.7.2: Reactive powers in MVAR (training data for case7):

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Load at Bus 5** | **Load at Bus 7** | **Load at Bus 9** | **line (1 - 4)** | **line (2 - 8)** | **line (3 - 6)** | **line (4 - 5)** | **line (5 - 6)** | **line (6 – 7)** |
| 100 | 110 | 135 | 49.2 | 27.2 | 40.3 | 4.9 | 34.9 | 35 |
| 98 | 108 | 133 | 48 | 26.9 | 38.8 | 4.4 | 34.4 | 35 |
| 96 | 106 | 131 | 46.8 | 26.7 | 37.2 | 4 | 33.9 | 35 |
| 94 | 104 | 129 | 45.7 | 26.5 | 35.8 | 4.5 | 33.4 | 35 |
| 92 | 102 | 127 | 44.8 | 26.3 | 34.4 | 5 | 32.9 | 35 |
| 90 | 100 | 125 | 43.9 | 26.1 | 33 | 5.5 | 32.4 | 35 |
| 88 | 98 | 123 | 43.1 | 26 | 31.7 | 5.9 | 31.9 | 35 |
| 86 | 96 | 121 | 42.4 | 25.8 | 30.4 | 6.3 | 31.4 | 35 |
| 84 | 94 | 119 | 41.8 | 25.7 | 29.1 | 6.7 | 30.9 | 35 |
| 82 | 92 | 117 | 41.2 | 25.6 | 27.9 | 7 | 30.4 | 35 |
| 80 | 90 | 115 | 40.8 | 25.5 | 26.8 | 7.3 | 29.9 | 35 |
| **Load at Bus 5** | **Load at Bus 7** | **Load at Bus 9** | **line (7 - 8)** | **line (8 - 9)** | **line (4 - 9)** |
| 100 | 110 | 135 | 0 | 10.1 | 56.5 |
| 98 | 108 | 133 | 0 | 9.9 | 56.7 |
| 96 | 106 | 131 | 0 | 9.7 | 56.9 |
| 94 | 104 | 129 | 0 | 9.5 | 57 |
| 92 | 102 | 127 | 0 | 9.3 | 57.2 |
| 90 | 100 | 125 | 0 | 9.1 | 57.3 |
| 88 | 98 | 123 | 0 | 9 | 57.4 |
| 86 | 96 | 121 | 0 | 8.8 | 57.5 |
| 84 | 94 | 119 | 0 | 8.7 | 57.6 |
| 82 | 92 | 117 | 0 | 8.6 | 57.7 |
| 80 | 90 | 115 | 0 | 8.5 | 57.8 |

Table A.7.3: Thermal lines (training data for case7):

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Load at Bus 5** | **Load at Bus 7** | **Load at Bus 9** | **line (1 - 4)** | **line (2 - 8)** | **line (3 - 6)** | **line (4 - 5)** | **line (5 - 6)** | **line (6 – 7)** |
| 100 | 110 | 135 | 41 | 55 | 31 | 90 | 30 | 80 |
| 98 | 108 | 133 | 39 | 55 | 31 | 87 | 29 | 77 |
| 96 | 106 | 131 | 37 | 55 | 31 | 84 | 28 | 75 |
| 94 | 104 | 129 | 35 | 55 | 31 | 81 | 27 | 74 |
| 92 | 102 | 127 | 33 | 55 | 31 | 76 | 26 | 72 |
| 90 | 100 | 125 | 31 | 55 | 30 | 73 | 25 | 71 |
| 88 | 98 | 123 | 29 | 55 | 30 | 70 | 24 | 69 |
| 86 | 96 | 121 | 27 | 55 | 30 | 68 | 23 | 68 |
| 84 | 94 | 119 | 25 | 55 | 30 | 65 | 22 | 67 |
| 82 | 92 | 117 | 23 | 55 | 30 | 62 | 21 | 66 |
| 80 | 90 | 115 | 21 | 55 | 30 | 59 | 21 | 64 |
| **Load at Bus 5** | **Load at Bus 7** | **Load at Bus 9** | **line (7 - 8)** | **line (8 - 9)** | **line (4 - 9)** |
| 100 | 110 | 135 | 0 | 110 | 40 |
| 98 | 108 | 133 | 0 | 110 | 40 |
| 96 | 106 | 131 | 0 | 110 | 41 |
| 94 | 104 | 129 | 0 | 110 | 42 |
| 92 | 102 | 127 | 0 | 110 | 42 |
| 90 | 100 | 125 | 0 | 110 | 43 |
| 88 | 98 | 123 | 0 | 110 | 44 |
| 86 | 96 | 121 | 0 | 110 | 44 |
| 84 | 94 | 119 | 0 | 110 | 45 |
| 82 | 92 | 117 | 0 | 110 | 46 |
| 80 | 90 | 115 | 0 | 110 | 47 |

Table A.7.4: Voltage magnitudes at various buses (training data for case7):

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Load at Bus 5** | **Load at Bus 7** | **Load at Bus 9** | **V4(P.U.)** | **V5(P.U.)** | **V6(P.U.)** | **V7(P.U.)** | **V8(P.U.)** | **V9(P.U.)** |
| 100 | 110 | 135 | 0.974 | 0.954 | 0.978 | 0.918 | 0.988 | 0.931 |
| 98 | 108 | 133 | 0.974 | 0.956 | 0.979 | 0.92 | 0.988 | 0.932 |
| 96 | 106 | 131 | 0.975 | 0.957 | 0.979 | 0.922 | 0.989 | 0.932 |
| 94 | 104 | 129 | 0.975 | 0.958 | 0.98 | 0.923 | 0.989 | 0.932 |
| 92 | 102 | 127 | 0.976 | 0.959 | 0.981 | 0.925 | 0.989 | 0.933 |
| 90 | 100 | 125 | 0.976 | 0.96 | 0.982 | 0.927 | 0.989 | 0.933 |
| 88 | 98 | 123 | 0.976 | 0.961 | 0.983 | 0.928 | 0.989 | 0.934 |
| 86 | 96 | 121 | 0.976 | 0.962 | 0.983 | 0.93 | 0.989 | 0.934 |
| 84 | 94 | 119 | 0.977 | 0.963 | 0.984 | 0.931 | 0.989 | 0.934 |
| 82 | 92 | 117 | 0.977 | 0.964 | 0.985 | 0.933 | 0.989 | 0.934 |
| 80 | 90 | 115 | 0.977 | 0.965 | 0.986 | 0.934 | 0.989 | 0.935 |

Table A.7.5: Real powers in MW (testing data for case7):

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Load at Bus 5** | **Load at Bus 7** | **Load at Bus 9** | **line (1 - 4)** | **line (2 - 8)** | **line (3 - 6)** | **line (4 - 5)** | **line (5 - 6)** | **line (6 – 7)** |
| 97 | 107 | 132 | 103.3 | 163.01 | 85 | 125.1 | 25.3 | 109.8 |
| 93 | 103 | 128 | 90.6 | 163.01 | 85 | 116.4 | 20.9 | 105.6 |
| 89 | 99 | 124 | 78 | 163.01 | 85 | 107.7 | 16.6 | 101.4 |
| 85 | 95 | 120 | 65.4 | 163.01 | 85 | 99.1 | 12.4 | 97.2 |
| 81 | 91 | 116 | 52.9 | 163.01 | 85 | 90.6 | 8.1 | 93 |
| **Load at Bus 5** | **Load at Bus 7** | **Load at Bus 9** | **line (7 - 8)** | **line (8 - 9)** | **line (4 - 9)** |
| 97 | 107 | 132 | 0 | 163 | 21.8 |
| 93 | 103 | 128 | 0 | 163 | 25.8 |
| 89 | 99 | 124 | 0 | 163 | 29.7 |
| 85 | 95 | 120 | 0 | 163 | 33.7 |
| 81 | 91 | 116 | 0 | 163 | 37.7 |

Table A.7.6: Reactive powers in MVAR (testing data for case7):

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Load at Bus 5** | **Load at Bus 7** | **Load at Bus 9** | **line (1 - 4)** | **line (2 - 8)** | **line (3 - 6)** | **line (4 - 5)** | **line (5 - 6)** | **line (6 – 7)** |
| 97 | 107 | 132 | 47.3 | 26.8 | 38 | 4.1 | 34.1 | 35 |
| 93 | 103 | 128 | 45.2 | 26.4 | 35.1 | 4.8 | 33.1 | 35 |
| 89 | 99 | 124 | 43.5 | 26.1 | 32.3 | 5.7 | 32.1 | 35 |
| 85 | 95 | 120 | 42 | 25.8 | 29.8 | 6.5 | 31.1 | 35 |
| 81 | 91 | 116 | 41 | 25.5 | 27.4 | 7.1 | 30.2 | 35 |
| **Load at Bus 5** | **Load at Bus 7** | **Load at Bus 9** | **line (7 - 8)** | **line (8 - 9)** | **line (4 - 9)** |
| 97 | 107 | 132 | 0 | 9.8 | 56.8 |
| 93 | 103 | 128 | 0 | 9.4 | 57.1 |
| 89 | 99 | 124 | 0 | 9 | 57.3 |
| 85 | 95 | 120 | 0 | 8.7 | 57.6 |
| 81 | 91 | 116 | 0 | 8.5 | 57.8 |

Table A.7.7: Thermal lines (testing data for case7):

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Load at Bus 5** | **Load at Bus 7** | **Load at Bus 9** | **line (1 - 4)** | **line (2 - 8)** | **line (3 - 6)** | **line (4 - 5)** | **line (5 - 6)** | **line (6 – 7)** |
| 97 | 107 | 132 | 38 | 55 | 31 | 86 | 28 | 76 |
| 93 | 103 | 128 | 34 | 55 | 31 | 78 | 26 | 73 |
| 89 | 99 | 124 | 30 | 55 | 30 | 72 | 24 | 70 |
| 85 | 95 | 120 | 26 | 55 | 30 | 66 | 22 | 67 |
| 81 | 91 | 116 | 22 | 55 | 30 | 61 | 21 | 65 |
| **Load at Bus 5** | **Load at Bus 7** | **Load at Bus 9** | **line (7 - 8)** | **line (8 - 9)** | **line (4 - 9)** |
| 97 | 107 | 132 | 0 | 110 | 41 |
| 93 | 103 | 128 | 0 | 110 | 42 |
| 89 | 99 | 124 | 0 | 110 | 43 |
| 85 | 95 | 120 | 0 | 110 | 45 |
| 81 | 91 | 116 | 0 | 110 | 46 |

Table A.7.8: Voltage magnitudes at various buses (testing data for case7):

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Load at Bus 5** | **Load at Bus 7** | **Load at Bus 9** | **V4(P.U.)** | **V5(P.U.)** | **V6(P.U.)** | **V7(P.U.)** | **V8(P.U.)** | **V9(P.U.)** |
| 97 | 107 | 132 | 0.975 | 0.956 | 0.979 | 0.921 | 0.989 | 0.932 |
| 93 | 103 | 128 | 0.975 | 0.959 | 0.981 | 0.924 | 0.989 | 0.933 |
| 89 | 99 | 124 | 0.976 | 0.961 | 0.982 | 0.928 | 0.989 | 0.933 |
| 85 | 95 | 120 | 0.977 | 0.963 | 0.984 | 0.931 | 0.989 | 0.934 |
| 81 | 91 | 116 | 0.977 | 0.964 | 0.985 | 0.933 | 0.989 | 0.935 |

Table A.8.1: Real powers in MW (training data for case8):

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Load at Bus 5** | **Load at Bus 7** | **Load at Bus 9** | **line (1 - 4)** | **line (2 - 8)** | **line (3 - 6)** | **line (4 - 5)** | **line (5 - 6)** | **line (6 – 7)** |
| 100 | 110 | 135 | 110.1 | 163 | 85 | 27.4 | 127.6 | 50 |
| 98 | 108 | 133 | 104.4 | 163 | 85 | 31.1 | 129.4 | 52 |
| 96 | 106 | 131 | 98.6 | 163 | 85 | 34.8 | 131.1 | 53.9 |
| 94 | 104 | 129 | 92.9 | 163 | 85 | 38.4 | 132.9 | 55.9 |
| 92 | 102 | 127 | 87.2 | 163 | 85 | 42.1 | 134.6 | 57.8 |
| 90 | 100 | 125 | 81.5 | 163 | 85 | 45.7 | 136.3 | 59.8 |
| 88 | 98 | 123 | 75.8 | 163 | 85 | 49.4 | 138 | 61.7 |
| 86 | 96 | 121 | 70.1 | 163 | 85 | 53 | 139.7 | 63.7 |
| 84 | 94 | 119 | 64.4 | 163 | 85 | 56.6 | 141.4 | 65.6 |
| 82 | 92 | 117 | 58.8 | 163 | 85 | 60.2 | 143.1 | 67.6 |
| 80 | 90 | 115 | 53.1 | 163 | 85 | 63.8 | 144.8 | 69.5 |
| **Load at Bus 5** | **Load at Bus 7** | **Load at Bus 9** | **line (7 - 8)** | **line (8 - 9)** | **line (4 - 9)** |
| 100 | 110 | 135 | 163 | 0 | 137.5 |
| 98 | 108 | 133 | 163 | 0 | 135.5 |
| 96 | 106 | 131 | 163 | 0 | 133.4 |
| 94 | 104 | 129 | 163 | 0 | 131.3 |
| 92 | 102 | 127 | 163 | 0 | 129.3 |
| 90 | 100 | 125 | 163 | 0 | 127.2 |
| 88 | 98 | 123 | 163 | 0 | 125.1 |
| 86 | 96 | 121 | 163 | 0 | 123.1 |
| 84 | 94 | 119 | 163 | 0 | 121 |
| 82 | 92 | 117 | 163 | 0 | 119 |
| 80 | 90 | 115 | 163 | 0 | 116.9 |

Table A.8.2: Reactive powers in MVAR (training data for case8):

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Load at Bus 5** | **Load at Bus 7** | **Load at Bus 9** | **line (1 - 4)** | **line (2 - 8)** | **line (3 - 6)** | **line (4 - 5)** | **line (5 - 6)** | **line (6 – 7)** |
| 100 | 110 | 135 | 84.9 | 23.6 | 20.4 | 29.9 | 0.9 | 33.6 |
| 98 | 108 | 133 | 84.7 | 23.6 | 20.8 | 30.7 | 0.7 | 33.6 |
| 96 | 106 | 131 | 84.6 | 23.6 | 21.2 | 31.5 | 1.5 | 33.7 |
| 94 | 104 | 129 | 84.5 | 23.6 | 21.6 | 32.4 | 2.4 | 33.7 |
| 92 | 102 | 127 | 84.6 | 23.6 | 22.1 | 33.2 | 3.2 | 33.7 |
| 90 | 100 | 125 | 84.7 | 23.6 | 22.6 | 34 | 4 | 33.6 |
| 88 | 98 | 123 | 84.9 | 23.6 | 23.2 | 34.8 | 4.8 | 33.6 |
| 86 | 96 | 121 | 85.2 | 23.6 | 23.7 | 35.6 | 5.6 | 33.6 |
| 84 | 94 | 119 | 85.6 | 23.7 | 24.3 | 36.3 | 6.3 | 33.6 |
| 82 | 92 | 117 | 86 | 23.7 | 24.9 | 37.1 | 7.1 | 33.5 |
| 80 | 90 | 115 | 86.6 | 23.8 | 25.5 | 37.9 | 7.9 | 33.5 |
| **Load at Bus 5** | **Load at Bus 7** | **Load at Bus 9** | **line (7 - 8)** | **line (8 - 9)** | **line (4 - 9)** |
| 100 | 110 | 135 | 6.7 | 0 | 56.7 |
| 98 | 108 | 133 | 6.6 | 0 | 56.1 |
| 96 | 106 | 131 | 6.6 | 0 | 55.5 |
| 94 | 104 | 129 | 6.6 | 0 | 54.9 |
| 92 | 102 | 127 | 6.6 | 0 | 54.3 |
| 90 | 100 | 125 | 6.6 | 0 | 53.8 |
| 88 | 98 | 123 | 6.6 | 0 | 53.2 |
| 86 | 96 | 121 | 6.7 | 0 | 52.7 |
| 84 | 94 | 119 | 6.7 | 0 | 52.2 |
| 82 | 92 | 117 | 6.8 | 0 | 51.7 |
| 80 | 90 | 115 | 6.8 | 0 | 51.2 |

Table A.8.3: Thermal lines (training data for case8):

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Load at Bus 5** | **Load at Bus 7** | **Load at Bus 9** | **line (1 - 4)** | **line (2 - 8)** | **line (3 - 6)** | **line (4 - 5)** | **line (5 - 6)** | **line (6 – 7)** |
| 100 | 110 | 135 | 46 | 55 | 29 | 27 | 91 | 41 |
| 98 | 108 | 133 | 45 | 55 | 29 | 29 | 92 | 42 |
| 96 | 106 | 131 | 43 | 55 | 29 | 31 | 94 | 43 |
| 94 | 104 | 129 | 42 | 55 | 29 | 34 | 95 | 44 |
| 92 | 102 | 127 | 40 | 55 | 29 | 36 | 96 | 45 |
| 90 | 100 | 125 | 39 | 55 | 29 | 38 | 97 | 46 |
| 88 | 98 | 123 | 38 | 55 | 29 | 41 | 99 | 47 |
| 86 | 96 | 121 | 37 | 55 | 29 | 43 | 100 | 49 |
| 84 | 94 | 119 | 36 | 55 | 29 | 45 | 101 | 50 |
| 82 | 92 | 117 | 35 | 55 | 30 | 48 | 103 | 51 |
| 80 | 90 | 115 | 34 | 55 | 30 | 50 | 104 | 52 |
| **Load at Bus 5** | **Load at Bus 7** | **Load at Bus 9** | **line (7 - 8)** | **line (8 - 9)** | **line (4 - 9)** |
| 100 | 110 | 135 | 110 | 0 | 104 |
| 98 | 108 | 133 | 110 | 0 | 103 |
| 96 | 106 | 131 | 110 | 0 | 101 |
| 94 | 104 | 129 | 110 | 0 | 100 |
| 92 | 102 | 127 | 110 | 0 | 98 |
| 90 | 100 | 125 | 110 | 0 | 97 |
| 88 | 98 | 123 | 110 | 0 | 95 |
| 86 | 96 | 121 | 110 | 0 | 94 |
| 84 | 94 | 119 | 110 | 0 | 92 |
| 82 | 92 | 117 | 110 | 0 | 91 |
| 80 | 90 | 115 | 110 | 0 | 90 |

Table A.8.4: Voltage magnitudes at various buses (training data for case8):

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Load at Bus 5** | **Load at Bus 7** | **Load at Bus 9** | **V4(P.U.)** | **V5(P.U.)** | **V6(P.U.)** | **V7(P.U.)** | **V8(P.U.)** | **V9(P.U.)** |
| 100 | 110 | 135 | 0.953 | 0.935 | 0.989 | 0.973 | 0.99 | 0.889 |
| 98 | 108 | 133 | 0.953 | 0.935 | 0.989 | 0.973 | 0.991 | 0.889 |
| 96 | 106 | 131 | 0.953 | 0.934 | 0.989 | 0.974 | 0.991 | 0.889 |
| 94 | 104 | 129 | 0.953 | 0.934 | 0.989 | 0.974 | 0.991 | 0.89 |
| 92 | 102 | 127 | 0.953 | 0.933 | 0.988 | 0.974 | 0.991 | 0.89 |
| 90 | 100 | 125 | 0.952 | 0.933 | 0.988 | 0.973 | 0.991 | 0.89 |
| 88 | 98 | 123 | 0.952 | 0.932 | 0.988 | 0.973 | 0.991 | 0.891 |
| 86 | 96 | 121 | 0.952 | 0.931 | 0.987 | 0.973 | 0.99 | 0.891 |
| 84 | 94 | 119 | 0.951 | 0.931 | 0.987 | 0.973 | 0.99 | 0.891 |
| 82 | 92 | 117 | 0.951 | 0.93 | 0.987 | 0.973 | 0.99 | 0.891 |
| 80 | 90 | 115 | 0.951 | 0.929 | 0.986 | 0.973 | 0.99 | 0.891 |

Table A.8.5: Real powers in MW (testing data for case8):

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Load at Bus 5** | **Load at Bus 7** | **Load at Bus 9** | **line (1 - 4)** | **line (2 - 8)** | **line (3 - 6)** | **line (4 - 5)** | **line (5 - 6)** | **line (6 – 7)** |
| 97 | 107 | 132 | 101.5 | 163 | 85 | 32.9 | 130.3 | 53 |
| 93 | 103 | 128 | 90 | 163 | 85 | 40.3 | 133.7 | 56.9 |
| 89 | 99 | 124 | 78.6 | 163 | 85 | 47.5 | 137.1 | 60.8 |
| 85 | 95 | 120 | 67.3 | 163 | 85 | 54.8 | 140.6 | 64.7 |
| 81 | 91 | 116 | 55.9 | 163 | 85 | 62 | 144 | 68.5 |
| **Load at Bus 5** | **Load at Bus 7** | **Load at Bus 9** | **line (7 - 8)** | **line (8 - 9)** | **line (4 - 9)** |
| 97 | 107 | 132 | 163 | 0 | 134.4 |
| 93 | 103 | 128 | 163 | 0 | 130.3 |
| 89 | 99 | 124 | 163 | 0 | 126.2 |
| 85 | 95 | 120 | 163 | 0 | 122 |
| 81 | 91 | 116 | 163 | 0 | 117.9 |

Table A.8.6: Reactive powers in MVAR (testing data for case8):

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Load at Bus 5** | **Load at Bus 7** | **Load at Bus 9** | **line (1 - 4)** | **line (2 - 8)** | **line (3 - 6)** | **line (4 - 5)** | **line (5 - 6)** | **line (6 – 7)** |
| 97 | 107 | 132 | 84.6 | 23.6 | 21 | 31.1 | 1.1 | 33.6 |
| 93 | 103 | 128 | 84.5 | 23.6 | 21.9 | 32.8 | 2.8 | 33.7 |
| 89 | 99 | 124 | 84.8 | 23.6 | 22.9 | 34.4 | 4.4 | 33.6 |
| 85 | 95 | 120 | 85.3 | 23.6 | 24 | 35.9 | 5.9 | 33.6 |
| 81 | 91 | 116 | 86.3 | 23.7 | 25.2 | 37.5 | 7.5 | 33.5 |
| **Load at Bus 5** | **Load at Bus 7** | **Load at Bus 9** | **line (7 - 8)** | **line (8 - 9)** | **line (4 - 9)** |
| 97 | 107 | 132 | 6.6 | 0 | 55.7 |
| 93 | 103 | 128 | 6.6 | 0 | 54.6 |
| 89 | 99 | 124 | 6.6 | 0 | 53.5 |
| 85 | 95 | 120 | 6.7 | 0 | 52.4 |
| 81 | 91 | 116 | 6.8 | 0 | 51.5 |

Table A.8.7: Thermal lines (testing data for case8):

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Load at Bus 5** | **Load at Bus 7** | **Load at Bus 9** | **line (1 - 4)** | **line (2 - 8)** | **line (3 - 6)** | **line (4 - 5)** | **line (5 - 6)** | **line (6 – 7)** |
| 97 | 107 | 132 | 44 | 55 | 29 | 30 | 93 | 42 |
| 93 | 103 | 128 | 41 | 55 | 29 | 35 | 96 | 45 |
| 89 | 99 | 124 | 39 | 55 | 29 | 39 | 98 | 47 |
| 85 | 95 | 120 | 36 | 55 | 29 | 44 | 101 | 49 |
| 81 | 91 | 116 | 34 | 55 | 30 | 49 | 103 | 52 |
| **Load at Bus 5** | **Load at Bus 7** | **Load at Bus 9** | **line (7 - 8)** | **line (8 - 9)** | **line (4 - 9)** |
| 97 | 107 | 132 | 110 | 0 | 102 |
| 93 | 103 | 128 | 110 | 0 | 99 |
| 89 | 99 | 124 | 110 | 0 | 96 |
| 85 | 95 | 120 | 110 | 0 | 93 |
| 81 | 91 | 116 | 110 | 0 | 90 |

Table A.8.8: Voltage magnitudes at various buses (testing data for case8):

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Load at Bus 5** | **Load at Bus 7** | **Load at Bus 9** | **V4(P.U.)** | **V5(P.U.)** | **V6(P.U.)** | **V7(P.U.)** | **V8(P.U.)** | **V9(P.U.)** |
| 97 | 107 | 132 | 0.953 | 0.935 | 0.989 | 0.973 | 0.991 | 0.889 |
| 93 | 103 | 128 | 0.953 | 0.934 | 0.988 | 0.974 | 0.991 | 0.89 |
| 89 | 99 | 124 | 0.952 | 0.932 | 0.988 | 0.973 | 0.991 | 0.89 |
| 85 | 95 | 120 | 0.952 | 0.931 | 0.987 | 0.973 | 0.99 | 0.891 |
| 81 | 91 | 116 | 0.951 | 0.93 | 0.986 | 0.973 | 0.99 | 0.891 |

Table A.9.1: Real powers in MW (training data for case9):

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Load at Bus 5** | **Load at Bus 7** | **Load at Bus 9** | **line (1 - 4)** | **line (2 - 8)** | **line (3 - 6)** | **line (4 - 5)** | **line (5 - 6)** | **line (6 – 7)** |
| 100 | 110 | 135 | 112.1 | 163.06 | 85 | 112.1 | 9.9 | 94.8 |
| 98 | 108 | 133 | 105.1 | 163.06 | 85 | 105.1 | 5.2 | 90.2 |
| 96 | 106 | 131 | 98.3 | 163.05 | 85 | 98.3 | 0.6 | 85.6 |
| 94 | 104 | 129 | 91.5 | 163.05 | 85 | 91.5 | 4 | 81 |
| 92 | 102 | 127 | 84.8 | 163.05 | 85 | 84.8 | 8.5 | 76.5 |
| 90 | 100 | 125 | 78.1 | 163.05 | 85 | 78.1 | 12.9 | 72 |
| 88 | 98 | 123 | 71.5 | 163.05 | 85 | 71.5 | 17.4 | 67.5 |
| 86 | 96 | 121 | 65 | 163.04 | 85 | 65 | 21.7 | 63.1 |
| 84 | 94 | 119 | 58.5 | 163.04 | 85 | 58.5 | 26.1 | 58.7 |
| 82 | 92 | 117 | 52.1 | 163.04 | 85 | 52.1 | 30.4 | 54.3 |
| 80 | 90 | 115 | 45.8 | 163 | 85 | 45.8 | 34.6 | 50 |
| **Load at Bus 5** | **Load at Bus 7** | **Load at Bus 9** | **line (7 - 8)** | **line (8 - 9)** | **line (4 - 9)** |
| 100 | 110 | 135 | 17.2 | 145.8 | 0 |
| 98 | 108 | 133 | 19.7 | 143.4 | 0 |
| 96 | 106 | 131 | 22.1 | 140.9 | 0 |
| 94 | 104 | 129 | 24.5 | 138.5 | 0 |
| 92 | 102 | 127 | 26.9 | 136.1 | 0 |
| 90 | 100 | 125 | 29.3 | 133.8 | 0 |
| 88 | 98 | 123 | 31.7 | 131.4 | 0 |
| 86 | 96 | 121 | 34 | 129 | 0 |
| 84 | 94 | 119 | 36.3 | 126.7 | 0 |
| 82 | 92 | 117 | 38.6 | 124.4 | 0 |
| 80 | 90 | 115 | 40.8 | 122.2 | 0 |

Table A.9.2: Reactive powers in MVAR (training data for case9):

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Load at Bus 5** | **Load at Bus 7** | **Load at Bus 9** | **line (1 - 4)** | **line (2 - 8)** | **line (3 - 6)** | **line (4 - 5)** | **line (5 - 6)** | **line (6 – 7)** |
| 100 | 110 | 135 | 6.6 | 96.6 | 17.5 | 3.2 | 26.8 | 30 |
| 98 | 108 | 133 | 5.4 | 93.2 | 15.6 | 4.2 | 25.8 | 30.5 |
| 96 | 106 | 131 | 4.3 | 90 | 13.9 | 5.3 | 24.7 | 30.9 |
| 94 | 104 | 129 | 3.4 | 87 | 12.2 | 6.3 | 23.7 | 31.3 |
| 92 | 102 | 127 | 2.7 | 84.1 | 10.8 | 7.4 | 22.6 | 31.7 |
| 90 | 100 | 125 | 2.1 | 81.4 | 9.4 | 8.5 | 21.5 | 32.1 |
| 88 | 98 | 123 | 1.7 | 78.9 | 8.2 | 9.5 | 20.5 | 32.5 |
| 86 | 96 | 121 | 1.4 | 76.5 | 7.1 | 10.6 | 19.4 | 32.9 |
| 84 | 94 | 119 | 1.3 | 74.2 | 6.1 | 11.7 | 18.3 | 33.2 |
| 82 | 92 | 117 | 1.3 | 72 | 5.2 | 12.7 | 17.3 | 33.6 |
| 80 | 90 | 115 | 1.4 | 70 | 4.5 | 13.8 | 16.9 | 33.9 |
| **Load at Bus 5** | **Load at Bus 7** | **Load at Bus 9** | **line (7 - 8)** | **line (8 - 9)** | **line (4 - 9)** |
| 100 | 110 | 135 | 8.1 | 82.3 | 0 |
| 98 | 108 | 133 | 8.5 | 79.7 | 0 |
| 96 | 106 | 131 | 8.9 | 77.2 | 0 |
| 94 | 104 | 129 | 9.3 | 74.9 | 0 |
| 92 | 102 | 127 | 9.7 | 72.7 | 0 |
| 90 | 100 | 125 | 10 | 70.7 | 0 |
| 88 | 98 | 123 | 10.3 | 68.7 | 0 |
| 86 | 96 | 121 | 10.6 | 66.8 | 0 |
| 84 | 94 | 119 | 10.9 | 65 | 0 |
| 82 | 92 | 117 | 11.1 | 63.3 | 0 |
| 80 | 90 | 115 | 11.4 | 61.7 | 0 |

Table A.9.3: Thermal lines (training data for case9):

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Load at Bus 5** | **Load at Bus 7** | **Load at Bus 9** | **line (1 - 4)** | **line (2 - 8)** | **line (3 - 6)** | **line (4 - 5)** | **line (5 - 6)** | **line (6 – 7)** |
| 100 | 110 | 135 | 37 | 63 | 29 | 75 | 19 | 65 |
| 98 | 108 | 133 | 35 | 63 | 29 | 70 | 18 | 62 |
| 96 | 106 | 131 | 33 | 62 | 29 | 66 | 16 | 60 |
| 94 | 104 | 129 | 31 | 62 | 29 | 61 | 16 | 57 |
| 92 | 102 | 127 | 28 | 61 | 29 | 57 | 16 | 54 |
| 90 | 100 | 125 | 26 | 61 | 29 | 52 | 17 | 52 |
| 88 | 98 | 123 | 24 | 60 | 28 | 48 | 18 | 49 |
| 86 | 96 | 121 | 22 | 60 | 28 | 43 | 19 | 47 |
| 84 | 94 | 119 | 20 | 60 | 28 | 39 | 21 | 44 |
| 82 | 92 | 117 | 17 | 59 | 28 | 35 | 23 | 42 |
| 80 | 90 | 115 | 15 | 59 | 28 | 32 | 26 | 40 |
| **Load at Bus 5** | **Load at Bus 7** | **Load at Bus 9** | **line (7 - 8)** | **line (8 - 9)** | **line (4 - 9)** |
| 100 | 110 | 135 | 13 | 118 | 0 |
| 98 | 108 | 133 | 14 | 115 | 0 |
| 96 | 106 | 131 | 16 | 113 | 0 |
| 94 | 104 | 129 | 17 | 110 | 0 |
| 92 | 102 | 127 | 19 | 108 | 0 |
| 90 | 100 | 125 | 21 | 106 | 0 |
| 88 | 98 | 123 | 22 | 103 | 0 |
| 86 | 96 | 121 | 24 | 101 | 0 |
| 84 | 94 | 119 | 25 | 99 | 0 |
| 82 | 92 | 117 | 27 | 97 | 0 |
| 80 | 90 | 115 | 28 | 95 | 0 |

Table A.9.4: Voltage magnitudes at various buses (training data for case9):

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Load at Bus 5** | **Load at Bus 7** | **Load at Bus 9** | **V4(P.U.)** | **V5(P.U.)** | **V6(P.U.)** | **V7(P.U.)** | **V8(P.U.)** | **V9(P.U.)** |
| 100 | 110 | 135 | 0.998 | 0.978 | 0.991 | 0.945 | 0.945 | 0.764 |
| 98 | 108 | 133 | 0.999 | 0.979 | 0.992 | 0.947 | 0.947 | 0.77 |
| 96 | 106 | 131 | 0.999 | 0.98 | 0.993 | 0.949 | 0.949 | 0.776 |
| 94 | 104 | 129 | 0.999 | 0.981 | 0.994 | 0.951 | 0.951 | 0.782 |
| 92 | 102 | 127 | 1 | 0.982 | 0.995 | 0.953 | 0.953 | 0.787 |
| 90 | 100 | 125 | 1 | 0.983 | 0.996 | 0.955 | 0.955 | 0.792 |
| 88 | 98 | 123 | 1 | 0.984 | 0.996 | 0.956 | 0.956 | 0.797 |
| 86 | 96 | 121 | 1 | 0.984 | 0.997 | 0.958 | 0.958 | 0.802 |
| 84 | 94 | 119 | 1 | 0.985 | 0.998 | 0.959 | 0.959 | 0.806 |
| 82 | 92 | 117 | 1 | 0.985 | 0.998 | 0.961 | 0.961 | 0.81 |
| 80 | 90 | 115 | 1 | 0.985 | 0.999 | 0.962 | 0.962 | 0.814 |

Table A.9.5: Real powers in MW (testing data for case9):

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Load at Bus 5** | **Load at Bus 7** | **Load at Bus 9** | **line (1 - 4)** | **line (2 - 8)** | **line (3 - 6)** | **line (4 - 5)** | **line (5 - 6)** | **line (6 – 7)** |
| 97 | 107 | 132 | 101.9 | 163 | 85 | 101.9 | 3.1 | 88 |
| 93 | 103 | 128 | 88.3 | 163 | 85 | 88.3 | 6.1 | 78.9 |
| 89 | 99 | 124 | 74.9 | 163 | 85 | 74.9 | 15 | 69.9 |
| 85 | 95 | 120 | 61.8 | 163 | 85 | 61.8 | 23.8 | 61 |
| 81 | 91 | 116 | 49 | 163 | 85 | 49 | 32.4 | 52.1 |
| **Load at Bus 5** | **Load at Bus 7** | **Load at Bus 9** | **line (7 - 8)** | **line (8 - 9)** | **line (4 - 9)** |
| 97 | 107 | 132 | 20.7 | 142.3 | 0 |
| 93 | 103 | 128 | 25.6 | 137.4 | 0 |
| 89 | 99 | 124 | 30.4 | 132.6 | 0 |
| 85 | 95 | 120 | 35.1 | 127.9 | 0 |
| 81 | 91 | 116 | 39.7 | 123.3 | 0 |

Table A.9.6: Reactive powers in MVAR (testing data for case9):

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Load at Bus 5** | **Load at Bus 7** | **Load at Bus 9** | **line (1 - 4)** | **line (2 - 8)** | **line (3 - 6)** | **line (4 - 5)** | **line (5 - 6)** | **line (6 – 7)** |
| 97 | 107 | 132 | 4.9 | 91.8 | 14.8 | 4.7 | 25.3 | 30.7 |
| 93 | 103 | 128 | 3.1 | 85.7 | 11.6 | 6.9 | 23.1 | 31.5 |
| 89 | 99 | 124 | 1.9 | 80.3 | 8.8 | 9 | 21 | 32.3 |
| 85 | 95 | 120 | 1.3 | 75.4 | 6.6 | 11.1 | 18.9 | 33.1 |
| 81 | 91 | 116 | 1.3 | 71 | 4.8 | 13.2 | 16.8 | 33.8 |
| **Load at Bus 5** | **Load at Bus 7** | **Load at Bus 9** | **line (7 - 8)** | **line (8 - 9)** | **line (4 - 9)** |
| 97 | 107 | 132 | 8.7 | 78.7 | 0 |
| 93 | 103 | 128 | 9.5 | 74 | 0 |
| 89 | 99 | 124 | 10.2 | 69.8 | 0 |
| 85 | 95 | 120 | 10.8 | 66 | 0 |
| 81 | 91 | 116 | 11.3 | 62.5 | 0 |

Table A.9.7: Thermal lines (testing data for case9):

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Load at Bus 5** | **Load at Bus 7** | **Load at Bus 9** | **line (1 - 4)** | **line (2 - 8)** | **line (3 - 6)** | **line (4 - 5)** | **line (5 - 6)** | **line (6 – 7)** |
| 97 | 107 | 132 | 34 | 62 | 29 | 68 | 17 | 61 |
| 93 | 103 | 128 | 29 | 61 | 29 | 59 | 16 | 56 |
| 89 | 99 | 124 | 25 | 61 | 28 | 50 | 17 | 51 |
| 85 | 95 | 120 | 21 | 60 | 28 | 41 | 20 | 46 |
| 81 | 91 | 116 | 16 | 59 | 28 | 34 | 25 | 41 |
| **Load at Bus 5** | **Load at Bus 7** | **Load at Bus 9** | **line (7 - 8)** | **line (8 - 9)** | **line (4 - 9)** |
| 97 | 107 | 132 | 15 | 114 | 0 |
| 93 | 103 | 128 | 18 | 109 | 0 |
| 89 | 99 | 124 | 21 | 105 | 0 |
| 85 | 95 | 120 | 24 | 100 | 0 |
| 81 | 91 | 116 | 28 | 96 | 0 |

Table A.9.8: Voltage magnitudes at various buses (testing data for case9):

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Load at Bus 5** | **Load at Bus 7** | **Load at Bus 9** | **V4(P.U.)** | **V5(P.U.)** | **V6(P.U.)** | **V7(P.U.)** | **V8(P.U.)** | **V9(P.U.)** |
| 97 | 107 | 132 | 0.999 | 0.98 | 0.993 | 0.948 | 0.948 | 0.772 |
| 93 | 103 | 128 | 1 | 0.982 | 0.994 | 0.952 | 0.952 | 0.784 |
| 89 | 99 | 124 | 1 | 0.983 | 0.996 | 0.955 | 0.955 | 0.794 |
| 85 | 95 | 120 | 1 | 0.984 | 0.997 | 0.959 | 0.958 | 0.803 |
| 81 | 91 | 116 | 1 | 0.985 | 0.998 | 0.961 | 0.961 | 0.812 |

**APPENDIX B**

**Results of IEEE 9-Bus system using ANN method by MATLAB program.**

Table B.2.1: Values of the thermal lines, statuses and errors between ANN and NR method (results of the training for case2 (outage the line (2-8)))

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Load at Bus 5** | **Load at Bus 7** | **Load at Bus 9** | **Thermal line (1- 4)** | **Errors between ANN and NR** | **Statuses of the Lines** | **Thermal line (2- 8)** | **Errors between ANN and NR** | **Statuses of the Lines** |
| 100 | 110 | 135 | 0.9192811 | 7.19E-04 | 'AS' | -0.0001435 | 1.43E-04 | 'NS' |
| 98 | 108 | 133 | 0.8984193 | -0.0084193 | 'AS' | -0.0020362 | 0.0020362 | 'NS' |
| 96 | 106 | 131 | 0.876505 | -0.006505 | 'AS' | -0.0026314 | 0.0026314 | 'NS' |
| 94 | 104 | 129 | 0.8521855 | -2.19E-03 | 'AS' | -0.0016672 | 0.0016672 | 'NS' |
| 92 | 102 | 127 | 0.8279813 | 0.0020187 | 'AS' | -0.0012292 | 0.0012292 | 'NS' |
| 90 | 100 | 125 | 0.8030207 | -0.0030207 | 'AS' | -0.0005734 | 5.73E-04 | 'NS' |
| 88 | 98 | 123 | 0.7797151 | 0.0002849 | 'NS' | 1.92E-05 | -1.92E-05 | 'NS' |
| 86 | 96 | 121 | 0.6938134 | 0.0661866 | 'NS' | 0.0021261 | -2.13E-03 | 'NS' |
| 84 | 94 | 119 | 0.7349579 | 0.0050421 | 'NS' | -0.0008239 | 0.0008239 | 'NS' |
| 82 | 92 | 117 | 0.7128679 | -0.0028679 | 'NS' | 0.0004612 | -0.0004612 | 'NS' |
| 80 | 90 | 115 | 0.6914139 | -0.0014139 | 'NS' | 0.0048632 | -0.0048632 | 'NS' |
| **Load at Bus 5** | **Load at Bus 7** | **Load at Bus 9** | **Thermal line (3- 6)** | **Errors between ANN and NR** | **Statuses of the Lines** | **Thermal line (4- 5)** | **Errors between ANN and NR** | **Statuses of the Lines** |
| 100 | 110 | 135 | 0.2909647 | -0.0009647 | 'NS' | 0.7095949 | 0.0004051 | 'NS' |
| 98 | 108 | 133 | 0.2925325 | -0.0025325 | 'NS' | 0.6867551 | 0.0032449 | 'NS' |
| 96 | 106 | 131 | 0.2930192 | -0.0030192 | 'NS' | 0.6651845 | 0.0048155 | 'NS' |
| 94 | 104 | 129 | 0.2926205 | -0.0026205 | 'NS' | 0.6460127 | 0.0039873 | 'NS' |
| 92 | 102 | 127 | 0.2914525 | -0.0014525 | 'NS' | 0.6257081 | 0.0042919 | 'NS' |
| 90 | 100 | 125 | 0.289586 | 0.000414 | 'NS' | 0.6081532 | 0.0018468 | 'NS' |
| 88 | 98 | 123 | 0.2872966 | 2.70E-03 | 'NS' | 0.5905767 | -0.0005767 | 'NS' |
| 86 | 96 | 121 | 0.2339113 | 0.0560887 | 'NS' | 0.5447497 | 2.53E-02 | 'NS' |
| 84 | 94 | 119 | 0.2823447 | -0.0023447 | 'NS' | 0.5505874 | -0.0005874 | 'NS' |
| 82 | 92 | 117 | 0.2800502 | -5.02E-05 | 'NS' | 0.528602 | 0.001398 | 'NS' |
| 80 | 90 | 115 | 0.2782576 | 0.0017424 | 'NS' | 0.5078264 | 0.0021736 | 'NS' |
| **Load at Bus 5** | **Load at Bus 7** | **Load at Bus 9** | **Thermal line (5- 6)** | **Errors between ANN and NR** | **Statuses of the Lines** | **Thermal line (6- 7)** | **Errors between ANN and NR** | **Statuses of the Lines** |
| 100 | 110 | 135 | 0.2307382 | -0.0007382 | 'NS' | 0.6101434 | -0.0001434 | 'NS' |
| 98 | 108 | 133 | 0.2283632 | -0.0083632 | 'NS' | 0.6028347 | -0.0028347 | 'NS' |
| 96 | 106 | 131 | 0.2247384 | -0.0047384 | 'NS' | 0.5951477 | -0.0051477 | 'NS' |
| 94 | 104 | 129 | 0.218353 | -0.008353 | 'NS' | 0.5869516 | 0.0030484 | 'NS' |
| 92 | 102 | 127 | 0.2129509 | -0.002951 | 'NS' | 0.5787903 | 0.0012097 | 'NS' |
| 90 | 100 | 125 | 0.2073625 | 0.0026375 | 'NS' | 0.5718715 | -0.0018715 | 'NS' |
| 88 | 98 | 123 | 0.2037401 | -0.0037401 | 'NS' | 0.565937 | 0.004063 | 'NS' |
| 86 | 96 | 121 | 0.3201399 | -0.1201399 | 'NS' | 0.5207254 | 0.0392746 | 'NS' |
| 84 | 94 | 119 | 0.2001098 | -0.0001098 | 'NS' | 0.5539019 | -0.0039019 | 'NS' |
| 82 | 92 | 117 | 0.2003293 | -0.0003293 | 'NS' | 0.5480288 | 1.97E-03 | 'NS' |
| 80 | 90 | 115 | 0.1984334 | -0.0084334 | 'NS' | 0.5409658 | -9.66E-04 | 'NS' |
| **Load at Bus 5** | **Load at Bus 7** | **Load at Bus 9** | **Thermal line (7- 8)** | **Errors between ANN and NR** | **Statuses of the Lines** | **Thermal line (8- 9)** | **Errors between ANN and NR** | **Statuses of the Lines** |
| 100 | 110 | 135 | 0.1591778 | 0.0008222 | 'NS' | 0.2501484 | -0.0001484 | 'NS' |
| 98 | 108 | 133 | 0.1535733 | 0.0064267 | 'NS' | 0.2449253 | -0.0049253 | 'NS' |
| 96 | 106 | 131 | 0.1506645 | -0.0006645 | 'NS' | 0.2382938 | 0.0017062 | 'NS' |
| 94 | 104 | 129 | 0.1472254 | 0.0027746 | 'NS' | 0.2312282 | -0.0012282 | 'NS' |
| 92 | 102 | 127 | 0.144581 | -0.004581 | 'NS' | 0.2272191 | 0.0027809 | 'NS' |
| 90 | 100 | 125 | 0.1408302 | -0.0008302 | 'NS' | 0.223175 | -0.003175 | 'NS' |
| 88 | 98 | 123 | 0.1380118 | 0.0019882 | 'NS' | 0.2176255 | 0.0023745 | 'NS' |
| 86 | 96 | 121 | 0.2613738 | -0.1313738 | 'NS' | 0.0090588 | 0.2009412 | 'NS' |
| 84 | 94 | 119 | 0.1284468 | 0.0015532 | 'NS' | 0.2100488 | -4.88E-05 | 'NS' |
| 82 | 92 | 117 | 0.1203333 | -0.0003333 | 'NS' | 0.2112644 | -0.0012644 | 'NS' |
| 80 | 90 | 115 | 0.1108505 | 0.0091495 | 'NS' | 0.2071374 | -0.0071374 | 'NS' |
| **Load at Bus 5** | **Load at Bus 7** | **Load at Bus 9** | **Thermal line (4- 9)** | **Errors between ANN and NR** | **Statuses of the Lines** |
| 100 | 110 | 135 | 1.1197637 | 0.0002363 | 'ES' |
| 98 | 108 | 133 | 1.0932987 | -0.0032987 | 'ES' |
| 96 | 106 | 131 | 1.0693057 | 0.0006943 | 'ES' |
| 94 | 104 | 129 | 1.0449005 | -0.0049005 | 'ES' |
| 92 | 102 | 127 | 1.0210988 | -0.0010988 | 'ES' |
| 90 | 100 | 125 | 0.9963371 | 0.0036629 | 'ES' |
| 88 | 98 | 123 | 0.9745851 | -0.0045851 | 'AS' |
| 86 | 96 | 121 | 1.1087825 | -0.1587825 | 'ES' |
| 84 | 94 | 119 | 0.9271057 | 0.0028943 | 'AS' |
| 82 | 92 | 117 | 0.9003849 | -0.000385 | 'AS' |
| 80 | 90 | 115 | 0.8728738 | 0.0071262 | 'AS' |

Table B.2.2: Voltage Magnitudes per unit, statuses and errors between ANN and NR method (results of the training for case2 (outage the line (2-8)))

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Load at Bus 5** | **Load at Bus 7** | **Load at Bus 9** | **| V4 | (P.U.)** | **Errors between ANN and NR** | **Statuses of the Buses** | **| V5 | (P.U.)** | **Errors between ANN and NR** | **Statuses of the Buses** |
| 100 | 110 | 135 | 0.97702 | -2.02E-03 | 'NS' | 0.963298 | -1.30E-03 | 'NS' |
| 98 | 108 | 133 | 0.9781962 | -0.0021962 | 'NS' | 0.9647803 | -0.0017803 | 'NS' |
| 96 | 106 | 131 | 0.9792451 | -0.0022451 | 'NS' | 0.9660286 | -0.0010286 | 'NS' |
| 94 | 104 | 129 | 0.9802456 | -2.25E-03 | 'NS' | 0.9674068 | -0.0014068 | 'NS' |
| 92 | 102 | 127 | 0.9811503 | -0.0011503 | 'NS' | 0.9684897 | -0.0004897 | 'NS' |
| 90 | 100 | 125 | 0.9819482 | -0.0009482 | 'NS' | 0.9696626 | -6.63E-04 | 'NS' |
| 88 | 98 | 123 | 0.9824964 | -0.0004964 | 'NS' | 9.71E-01 | 2.79E-04 | 'NS' |
| 86 | 96 | 121 | 0.9836517 | -0.0006517 | 'NS' | 0.9754853 | -3.49E-03 | 'NS' |
| 84 | 94 | 119 | 0.9831553 | 0.0008447 | 'NS' | 0.9722761 | 0.0007239 | 'NS' |
| 82 | 92 | 117 | 0.9833559 | 0.0016441 | 'NS' | 0.9730756 | 0.0009244 | 'NS' |
| 80 | 90 | 115 | 0.9832663 | 0.0017337 | 'NS' | 0.9739872 | 0.0020128 | 'NS' |
| **Load at Bus 5** | **Load at Bus 7** | **Load at Bus 9** | **| V6 | (P.U.)** | **Errors between ANN and NR** | **Statuses of the Buses** | **| V7 | (P.U.)** | **Errors between ANN and NR** | **Statuses of the Buses** |
| 100 | 110 | 135 | 0.9951423 | -0.0051423 | 'NS' | 0.951998 | -0.000998 | 'NS' |
| 98 | 108 | 133 | 0.9950909 | -0.0040909 | 'NS' | 0.9536402 | -0.0006402 | 'NS' |
| 96 | 106 | 131 | 0.9950289 | -0.0030289 | 'NS' | 0.9552028 | -0.0002028 | 'NS' |
| 94 | 104 | 129 | 0.9949244 | -0.0019244 | 'NS' | 0.9566675 | -0.0006675 | 'NS' |
| 92 | 102 | 127 | 0.9947918 | -0.0007918 | 'NS' | 0.9580548 | -5.48E-05 | 'NS' |
| 90 | 100 | 125 | 0.9945394 | -0.0005394 | 'NS' | 0.9595634 | 0.0004366 | 'NS' |
| 88 | 98 | 123 | 0.9942129 | 7.87E-04 | 'NS' | 0.9609988 | 1.24E-06 | 'NS' |
| 86 | 96 | 121 | 0.9936087 | 0.0023913 | 'NS' | 0.9645955 | -1.60E-03 | 'NS' |
| 84 | 94 | 119 | 0.9935153 | 0.0024847 | 'NS' | 0.9635539 | 0.0004461 | 'NS' |
| 82 | 92 | 117 | 0.9931612 | 3.84E-03 | 'NS' | 0.9649487 | 5.13E-05 | 'NS' |
| 80 | 90 | 115 | 0.9928941 | 0.0051059 | 'NS' | 0.9661364 | 0.0008636 | 'NS' |
| **Load at Bus 5** | **Load at Bus 7** | **Load at Bus 9** | **| V8 | (P.U.)** | **Errors between ANN and NR** | **Statuses of the Buses** | **| V9 | (P.U.)** | **Errors between ANN and NR** | **Statuses of the Buses** |
| 100 | 110 | 135 | 0.9594493 | -0.0034493 | 'NS' | 0.9370666 | -0.0010666 | 'NS' |
| 98 | 108 | 133 | 0.9602418 | -0.0022418 | 'NS' | 0.9379285 | 7.15E-05 | 'NS' |
| 96 | 106 | 131 | 0.9612975 | -0.0012975 | 'NS' | 0.9389417 | 0.0010583 | 'NS' |
| 94 | 104 | 129 | 0.9623879 | -0.0003879 | 'NS' | 0.9405646 | 0.0004354 | 'NS' |
| 92 | 102 | 127 | 0.9636727 | -0.0006727 | 'NS' | 0.9419478 | 0.0010522 | 'NS' |
| 90 | 100 | 125 | 0.9649203 | 7.97E-05 | 'NS' | 0.9436201 | 0.0013799 | 'NS' |
| 88 | 98 | 123 | 0.9661465 | 0.0008535 | 'NS' | 0.9457819 | 0.0012181 | 'NS' |
| 86 | 96 | 121 | 0.9684365 | -0.0004365 | 'NS' | 0.9580974 | -0.0100974 | 'NS' |
| 84 | 94 | 119 | 0.968439 | 0.001561 | 'NS' | 0.9506027 | -0.0006027 | 'NS' |
| 82 | 92 | 117 | 0.9696209 | 0.0013791 | 'NS' | 0.9528407 | -8.41E-04 | 'NS' |
| 80 | 90 | 115 | 0.9705698 | 0.0024302 | 'NS' | 0.9556983 | -2.70E-03 | 'NS' |

Classification accuracy for case2 at training stage (%) = (157 / 165) \* 100 = 95.1515 %.

Table B.3.1: Values of the thermal lines, statuses and errors between ANN and NR method (results of the training for case3 (outage the line (3-6)))

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Load at Bus 5** | **Load at Bus 7** | **Load at Bus 9** | **Thermal line (1- 4)** | **Errors between ANN and NR** | **Statuses of the Lines** | **Thermal line (2- 8)** | **Errors between ANN and NR** | **Statuses of the Lines** |
| 100 | 110 | 135 | 0.6282481 | 1.75E-03 | 'NS' | 0.5496737 | 3.26E-04 | 'NS' |
| 98 | 108 | 133 | 0.6109275 | -0.0009275 | 'NS' | 0.5498624 | 0.0001376 | 'NS' |
| 96 | 106 | 131 | 0.5926371 | -0.0026371 | 'NS' | 0.549934 | 6.60E-05 | 'NS' |
| 94 | 104 | 129 | 0.5712337 | -1.23E-03 | 'NS' | 0.5500292 | -2.92E-05 | 'NS' |
| 92 | 102 | 127 | 0.5497958 | 0.0002042 | 'NS' | 0.5498761 | 0.0001239 | 'NS' |
| 90 | 100 | 125 | 0.5266772 | 0.0033228 | 'NS' | 0.5494694 | 5.31E-04 | 'NS' |
| 88 | 98 | 123 | 0.5035406 | 0.0064594 | 'NS' | 5.49E-01 | 1.17E-03 | 'NS' |
| 86 | 96 | 121 | 0.4814876 | -0.0014876 | 'NS' | 0.5490119 | 9.88E-04 | 'NS' |
| 84 | 94 | 119 | 0.461368 | -0.001368 | 'NS' | 0.5499632 | 3.68E-05 | 'NS' |
| 82 | 92 | 117 | 0.4388749 | 0.0011251 | 'NS' | 0.5523484 | -0.0023484 | 'NS' |
| 80 | 90 | 115 | 0.4181155 | 0.0018845 | 'NS' | 0.5569099 | -0.0169099 | 'NS' |
| **Load at Bus 5** | **Load at Bus 7** | **Load at Bus 9** | **Thermal line (3- 6)** | **Errors between ANN and NR** | **Statuses of the Lines** | **Thermal line (4- 5)** | **Errors between ANN and NR** | **Statuses of the Lines** |
| 100 | 110 | 135 | -0.0008025 | 0.0008025 | 'NS' | 0.6493054 | 0.0006946 | 'NS' |
| 98 | 108 | 133 | 2.50E-05 | -2.50E-05 | 'NS' | 0.6297562 | 0.0002438 | 'NS' |
| 96 | 106 | 131 | 0.0003901 | -0.0003901 | 'NS' | 0.6085615 | 0.0014385 | 'NS' |
| 94 | 104 | 129 | 0.0005762 | -0.0005762 | 'NS' | 0.5903669 | -0.0003669 | 'NS' |
| 92 | 102 | 127 | 0.0004818 | -0.0004818 | 'NS' | 0.5692074 | 7.93E-04 | 'NS' |
| 90 | 100 | 125 | 0.0001113 | -0.0001113 | 'NS' | 0.5504543 | -0.0004543 | 'NS' |
| 88 | 98 | 123 | -0.0002454 | 2.45E-04 | 'NS' | 0.5328801 | -2.88E-03 | 'NS' |
| 86 | 96 | 121 | -0.0006689 | 0.0006689 | 'NS' | 0.514492 | -4.49E-03 | 'NS' |
| 84 | 94 | 119 | -0.0003911 | 0.0003911 | 'NS' | 0.4990532 | 0.0009468 | 'NS' |
| 82 | 92 | 117 | -0.000457 | 4.57E-04 | 'NS' | 0.4949156 | -1.49E-02 | 'NS' |
| 80 | 90 | 115 | 0.000735 | -0.000735 | 'NS' | 0.4974538 | -0.0374538 | 'NS' |
| **Load at Bus 5** | **Load at Bus 7** | **Load at Bus 9** | **Thermal line (5- 6)** | **Errors between ANN and NR** | **Statuses of the Lines** | **Thermal line (6- 7)** | **Errors between ANN and NR** | **Statuses of the Lines** |
| 100 | 110 | 135 | 0.1890372 | 0.0009628 | 'NS' | 0.1720352 | -0.0020352 | 'NS' |
| 98 | 108 | 133 | 0.1903587 | -0.0003587 | 'NS' | 0.1763639 | 3.64E-03 | 'NS' |
| 96 | 106 | 131 | 0.1927053 | -0.0027053 | 'NS' | 0.1805858 | -0.0005858 | 'NS' |
| 94 | 104 | 129 | 0.1903927 | -0.0003927 | 'NS' | 0.1837193 | -0.0037193 | 'NS' |
| 92 | 102 | 127 | 0.1911547 | -0.0011547 | 'NS' | 0.1871898 | 0.0028102 | 'NS' |
| 90 | 100 | 125 | 0.189486 | 5.14E-04 | 'NS' | 0.190365 | -0.000365 | 'NS' |
| 88 | 98 | 123 | 0.1880582 | 0.0019418 | 'NS' | 0.1939135 | -0.0039135 | 'NS' |
| 86 | 96 | 121 | 0.18894 | 0.00106 | 'NS' | 0.1974477 | 0.0025523 | 'NS' |
| 84 | 94 | 119 | 0.190428 | -0.000428 | 'NS' | 0.2000242 | -2.42E-05 | 'NS' |
| 82 | 92 | 117 | 0.1802145 | 0.0097855 | 'NS' | 0.2017839 | 8.22E-03 | 'NS' |
| 80 | 90 | 115 | 0.1645728 | 0.0354272 | 'NS' | 0.2015052 | 8.49E-03 | 'NS' |
| **Load at Bus 5** | **Load at Bus 7** | **Load at Bus 9** | **Thermal line (7- 8)** | **Errors between ANN and NR** | **Statuses of the Lines** | **Thermal line (8- 9)** | **Errors between ANN and NR** | **Statuses of the Lines** |
| 100 | 110 | 135 | 0.7692626 | 0.0007374 | 'NS' | 0.3527065 | -0.0027065 | 'NS' |
| 98 | 108 | 133 | 0.7580651 | 0.0019349 | 'NS' | 0.3567756 | 0.0032244 | 'NS' |
| 96 | 106 | 131 | 0.749872 | 0.000128 | 'NS' | 0.361289 | -0.001289 | 'NS' |
| 94 | 104 | 129 | 0.742666 | -0.002666 | 'NS' | 0.3675133 | 0.0024867 | 'NS' |
| 92 | 102 | 127 | 0.7363288 | 0.0036712 | 'NS' | 0.3731162 | -0.0031162 | 'NS' |
| 90 | 100 | 125 | 0.7297928 | 0.0002072 | 'NS' | 0.3807924 | -0.0007924 | 'NS' |
| 88 | 98 | 123 | 0.7231035 | -0.0031035 | 'NS' | 0.3887891 | -0.0087891 | 'NS' |
| 86 | 96 | 121 | 0.7153779 | 0.0046221 | 'NS' | 0.3946452 | -0.0046452 | 'NS' |
| 84 | 94 | 119 | 0.7093544 | 0.0006456 | 'NS' | 0.3996093 | 3.91E-04 | 'NS' |
| 82 | 92 | 117 | 0.7028293 | -0.0028293 | 'NS' | 0.4037684 | -0.0037684 | 'NS' |
| 80 | 90 | 115 | 0.6959525 | -0.0059525 | 'NS' | 0.4040525 | 0.0059475 | 'NS' |
| **Load at Bus 5** | **Load at Bus 7** | **Load at Bus 9** | **Thermal line (4- 9)** | **Errors between ANN and NR** | **Statuses of the Lines** |
| 100 | 110 | 135 | 0.6080291 | 0.0019709 | 'NS' |
| 98 | 108 | 133 | 0.5908557 | -0.0008557 | 'NS' |
| 96 | 106 | 131 | 0.5744588 | -0.0044588 | 'NS' |
| 94 | 104 | 129 | 0.5562667 | 0.0037333 | 'NS' |
| 92 | 102 | 127 | 0.5387051 | 0.0012949 | 'NS' |
| 90 | 100 | 125 | 0.5203614 | -0.0003614 | 'NS' |
| 88 | 98 | 123 | 0.5028364 | -0.0028364 | 'NS' |
| 86 | 96 | 121 | 0.4857343 | -0.0057343 | 'NS' |
| 84 | 94 | 119 | 0.4702421 | -0.0002421 | 'NS' |
| 82 | 92 | 117 | 0.4513169 | -0.0013169 | 'NS' |
| 80 | 90 | 115 | 0.4294267 | 0.0005733 | 'NS' |

Table B.3.2: Voltage Magnitudes per unit, statuses and errors between ANN and NR method (results of the training for case3 (outage the line (3-6)))

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Load at Bus 5** | **Load at Bus 7** | **Load at Bus 9** | **| V4 | (P.U.)** | **Errors between ANN and NR** | **Statuses of the Buses** | **| V5 | (P.U.)** | **Errors between ANN and NR** | **Statuses of the Buses** |
| 100 | 110 | 135 | 0.9869835 | 1.65E-05 | 'NS' | 0.9715347 | -5.35E-04 | 'NS' |
| 98 | 108 | 133 | 0.9874399 | -0.0004399 | 'NS' | 0.9723688 | -0.0003688 | 'NS' |
| 96 | 106 | 131 | 0.9879257 | 7.43E-05 | 'NS' | 0.9733355 | 6.64E-04 | 'NS' |
| 94 | 104 | 129 | 0.9885057 | 4.94E-04 | 'NS' | 0.9744951 | 5.05E-04 | 'NS' |
| 92 | 102 | 127 | 0.9890066 | -6.60E-06 | 'NS' | 0.9756404 | 0.0003596 | 'NS' |
| 90 | 100 | 125 | 0.9896098 | 0.0003902 | 'NS' | 0.976817 | 1.83E-04 | 'NS' |
| 88 | 98 | 123 | 0.9902825 | -0.0002825 | 'NS' | 9.78E-01 | -1.49E-04 | 'NS' |
| 86 | 96 | 121 | 0.9908579 | 0.0001421 | 'NS' | 0.9792642 | -2.64E-04 | 'NS' |
| 84 | 94 | 119 | 0.9915821 | -0.0005821 | 'NS' | 0.9805085 | -5.08E-04 | 'NS' |
| 82 | 92 | 117 | 0.9920117 | -0.0010117 | 'NS' | 0.9814324 | -0.0004324 | 'NS' |
| 80 | 90 | 115 | 0.9924348 | -0.0004348 | 'NS' | 0.9820765 | -7.65E-05 | 'NS' |
| **Load at Bus 5** | **Load at Bus 7** | **Load at Bus 9** | **| V6 | (P.U.)** | **Errors between ANN and NR** | **Statuses of the Buses** | **| V7 | (P.U.)** | **Errors between ANN and NR** | **Statuses of the Buses** |
| 100 | 110 | 135 | 0.996037 | -0.003037 | 'NS' | 0.9773094 | 0.0006906 | 'NS' |
| 98 | 108 | 133 | 9.96E-01 | -2.24E-03 | 'NS' | 0.9785879 | 0.0004121 | 'NS' |
| 96 | 106 | 131 | 0.9964806 | -0.0014806 | 'NS' | 0.9797355 | 0.0002645 | 'NS' |
| 94 | 104 | 129 | 0.9966261 | -0.0006261 | 'NS' | 0.9808338 | 0.0001662 | 'NS' |
| 92 | 102 | 127 | 0.9968202 | 0.0011798 | 'NS' | 0.9819349 | 6.51E-05 | 'NS' |
| 90 | 100 | 125 | 0.9969399 | 0.0010601 | 'NS' | 0.9829893 | -0.000989 | 'NS' |
| 88 | 98 | 123 | 0.9970013 | 2.00E-03 | 'NS' | 0.9839329 | -9.33E-04 | 'NS' |
| 86 | 96 | 121 | 0.9971067 | 0.0028933 | 'NS' | 0.9848075 | -8.08E-04 | 'NS' |
| 84 | 94 | 119 | 0.9971636 | 0.0038364 | 'NS' | 0.9853992 | -0.0003992 | 'NS' |
| 82 | 92 | 117 | 0.9970351 | 4.96E-03 | 'NS' | 0.9861648 | -1.65E-04 | 'NS' |
| 80 | 90 | 115 | 0.9968336 | 0.0061664 | 'NS' | 0.9868813 | 0.0001187 | 'NS' |
| **Load at Bus 5** | **Load at Bus 7** | **Load at Bus 9** | **| V8 | (P.U.)** | **Errors between ANN and NR** | **Statuses of the Buses** | **| V9 | (P.U.)** | **Errors between ANN and NR** | **Statuses of the Buses** |
| 100 | 110 | 135 | 0.9947161 | -0.0017161 | 'NS' | 0.9579323 | 6.77E-05 | 'NS' |
| 98 | 108 | 133 | 0.9945644 | -0.0015644 | 'NS' | 0.9587754 | 2.25E-04 | 'NS' |
| 96 | 106 | 131 | 0.994407 | -0.000407 | 'NS' | 0.9596466 | 0.0003534 | 'NS' |
| 94 | 104 | 129 | 0.9943394 | -0.0003394 | 'NS' | 0.9609337 | 6.63E-05 | 'NS' |
| 92 | 102 | 127 | 0.9942816 | 0.0007184 | 'NS' | 0.9616942 | -0.0006942 | 'NS' |
| 90 | 100 | 125 | 0.9942863 | 7.14E-04 | 'NS' | 0.9624934 | -0.0004934 | 'NS' |
| 88 | 98 | 123 | 0.9942753 | 0.0017247 | 'NS' | 0.9632921 | -0.0002921 | 'NS' |
| 86 | 96 | 121 | 0.9942596 | 0.0017404 | 'NS' | 0.9635114 | -0.0005114 | 'NS' |
| 84 | 94 | 119 | 0.9942178 | 0.0027822 | 'NS' | 0.9635071 | 4.93E-04 | 'NS' |
| 82 | 92 | 117 | 0.9944087 | 0.0025913 | 'NS' | 0.9639767 | 1.02E-03 | 'NS' |
| 80 | 90 | 115 | 0.9946687 | 0.0033313 | 'NS' | 0.96424 | 7.60E-04 | 'NS' |

Classification accuracy for case3 at training stage (%) = (160 / 165) \* 100 = 96.9696 %.

Table B.4.1: Values of the thermal lines, statuses and errors between ANN and NR method (results of the training for case5 (outage the line (5-6)))

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Load at Bus 5** | **Load at Bus 7** | **Load at Bus 9** | **Thermal line (1- 4)** | **Errors between ANN and NR** | **Statuses of the Lines** | **Thermal line (2- 8)** | **Errors between ANN and NR** | **Statuses of the Lines** |
| 100 | 110 | 135 | 0.4198816 | 1.18E-04 | 'NS' | 0.548436 | 1.56E-03 | 'NS' |
| 98 | 108 | 133 | 0.406529 | 0.003471 | 'NS' | 0.5505159 | -0.0005159 | 'NS' |
| 96 | 106 | 131 | 0.3896724 | 3.28E-04 | 'NS' | 0.5512741 | -1.27E-03 | 'NS' |
| 94 | 104 | 129 | 0.3722079 | -2.21E-03 | 'NS' | 0.5523938 | -2.39E-03 | 'NS' |
| 92 | 102 | 127 | 0.3567961 | 3.20E-03 | 'NS' | 0.5531385 | -0.0031385 | 'NS' |
| 90 | 100 | 125 | 0.3423682 | -0.0023682 | 'NS' | 0.5542213 | -4.22E-03 | 'NS' |
| 88 | 98 | 123 | 0.3290221 | 0.0009779 | 'NS' | 5.55E-01 | 4.68E-03 | 'NS' |
| 86 | 96 | 121 | 0.3163382 | -0.0063382 | 'NS' | 0.5567291 | 3.27E-03 | 'NS' |
| 84 | 94 | 119 | 0.3029206 | -0.0029206 | 'NS' | 0.5581207 | 1.88E-03 | 'NS' |
| 82 | 92 | 117 | 0.2901087 | -0.0001087 | 'NS' | 0.5598001 | 0.0001999 | 'NS' |
| 80 | 90 | 115 | 0.2785483 | 0.0014517 | 'NS' | 0.5615814 | -1.58E-03 | 'NS' |
| **Load at Bus 5** | **Load at Bus 7** | **Load at Bus 9** | **Thermal line (3- 6)** | **Errors between ANN and NR** | **Statuses of the Lines** | **Thermal line (4- 5)** | **Errors between ANN and NR** | **Statuses of the Lines** |
| 100 | 110 | 135 | 0.2797305 | 0.0002695 | 'NS' | 0.7092112 | 0.0007888 | 'NS' |
| 98 | 108 | 133 | 2.83E-01 | -3.06E-03 | 'NS' | 0.6901056 | -0.0001056 | 'NS' |
| 96 | 106 | 131 | 0.282354 | -0.002354 | 'NS' | 0.6745193 | 0.0054807 | 'NS' |
| 94 | 104 | 129 | 0.281019 | -0.001019 | 'NS' | 0.6620877 | -0.0020877 | 'NS' |
| 92 | 102 | 127 | 0.279901 | 9.90E-05 | 'NS' | 0.6473134 | 2.69E-03 | 'NS' |
| 90 | 100 | 125 | 0.2793522 | 0.0006478 | 'NS' | 0.6321903 | -0.0021903 | 'NS' |
| 88 | 98 | 123 | 0.2793932 | 6.07E-04 | 'NS' | 0.6172615 | 2.74E-03 | 'NS' |
| 86 | 96 | 121 | 0.279796 | 0.000204 | 'NS' | 0.603552 | 6.45E-03 | 'NS' |
| 84 | 94 | 119 | 0.2799032 | 9.68E-05 | 'NS' | 0.5913494 | -0.0013494 | 'NS' |
| 82 | 92 | 117 | 0.2801679 | -1.68E-04 | 'NS' | 0.5806036 | -6.04E-04 | 'NS' |
| 80 | 90 | 115 | 0.2805243 | -0.0005243 | 'NS' | 0.5683541 | 0.0016459 | 'NS' |
| **Load at Bus 5** | **Load at Bus 7** | **Load at Bus 9** | **Thermal line (5- 6)** | **Errors between ANN and NR** | **Statuses of the Lines** | **Thermal line (6- 7)** | **Errors between ANN and NR** | **Statuses of the Lines** |
| 100 | 110 | 135 | 0.0007942 | -0.000794 | 'NS' | 0.5698638 | 1.36E-04 | 'NS' |
| 98 | 108 | 133 | 0.0005067 | -0.0005067 | 'NS' | 0.5704261 | -4.26E-04 | 'NS' |
| 96 | 106 | 131 | 0.0005767 | -0.0005767 | 'NS' | 0.571165 | -0.001165 | 'NS' |
| 94 | 104 | 129 | -7.43E-05 | 7.43E-05 | 'NS' | 0.569822 | 1.78E-04 | 'NS' |
| 92 | 102 | 127 | 8.59E-05 | -8.59E-05 | 'NS' | 0.5702729 | -0.0002729 | 'NS' |
| 90 | 100 | 125 | 0.0005585 | -5.58E-04 | 'NS' | 0.5705659 | -0.0005659 | 'NS' |
| 88 | 98 | 123 | 0.0012104 | -0.0012104 | 'NS' | 0.5704624 | -0.0004624 | 'NS' |
| 86 | 96 | 121 | 0.0010818 | -0.0010818 | 'NS' | 0.5705226 | -0.0005226 | 'NS' |
| 84 | 94 | 119 | 0.0004094 | -0.0004094 | 'NS' | 0.5699256 | 7.44E-05 | 'NS' |
| 82 | 92 | 117 | -0.0004057 | 0.0004057 | 'NS' | 0.5691549 | 8.45E-04 | 'NS' |
| 80 | 90 | 115 | 0.0009909 | -0.0009909 | 'NS' | 0.5704423 | -4.42E-04 | 'NS' |
| **Load at Bus 5** | **Load at Bus 7** | **Load at Bus 9** | **Thermal line (7- 8)** | **Errors between ANN and NR** | **Statuses of the Lines** | **Thermal line (8- 9)** | **Errors between ANN and NR** | **Statuses of the Lines** |
| 100 | 110 | 135 | 0.2196361 | 0.0003639 | 'NS' | 0.9307502 | -0.0007502 | 'AS' |
| 98 | 108 | 133 | 0.1953813 | 0.0146187 | 'NS' | 0.9404827 | -0.0004827 | 'AS' |
| 96 | 106 | 131 | 0.1885215 | 0.0114785 | 'NS' | 0.9546331 | -0.0046331 | 'AS' |
| 94 | 104 | 129 | 0.1860369 | 0.0039631 | 'NS' | 0.9681181 | 0.0018819 | 'AS' |
| 92 | 102 | 127 | 0.1820964 | -0.0020964 | 'NS' | 0.982981 | -0.002981 | 'AS' |
| 90 | 100 | 125 | 0.1761967 | 0.0038033 | 'NS' | 0.9978131 | -0.0078131 | 'ES' |
| 88 | 98 | 123 | 0.1685658 | 0.0014342 | 'NS' | 1.0117858 | -0.0017858 | 'ES' |
| 86 | 96 | 121 | 0.1603331 | -0.0003331 | 'NS' | 1.0251948 | -0.0051948 | 'ES' |
| 84 | 94 | 119 | 0.1525127 | -0.0025127 | 'NS' | 1.0388035 | 1.20E-03 | 'ES' |
| 82 | 92 | 117 | 0.1456687 | 0.0043313 | 'NS' | 1.0503299 | -0.0003299 | 'ES' |
| 80 | 90 | 115 | 0.1397116 | 0.0002884 | 'NS' | 1.0608315 | -0.0008315 | 'ES' |
| **Load at Bus 5** | **Load at Bus 7** | **Load at Bus 9** | **Thermal line (4- 9)** | **Errors between ANN and NR** | **Statuses of the Lines** |
| 100 | 110 | 135 | 0.2999097 | 9.03E-05 | 'NS' |
| 98 | 108 | 133 | 0.306185 | 0.003815 | 'NS' |
| 96 | 106 | 131 | 0.3131178 | -0.0031178 | 'NS' |
| 94 | 104 | 129 | 0.3194826 | 0.0005174 | 'NS' |
| 92 | 102 | 127 | 0.3289029 | 0.0010971 | 'NS' |
| 90 | 100 | 125 | 0.3397272 | 0.0002728 | 'NS' |
| 88 | 98 | 123 | 0.3520424 | -0.0020424 | 'NS' |
| 86 | 96 | 121 | 0.3652262 | 0.0047738 | 'NS' |
| 84 | 94 | 119 | 0.380016 | -1.60E-05 | 'NS' |
| 82 | 92 | 117 | 0.3952595 | 0.0047405 | 'NS' |
| 80 | 90 | 115 | 0.4121335 | -0.0021335 | 'NS' |

Table B.4.2: Voltage Magnitudes per unit, statuses and errors between ANN and NR (results of the training for case5 (outage the line (5-6)))

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Load at Bus 5** | **Load at Bus 7** | **Load at Bus 9** | **| V4 | (P.U.)** | **Errors between ANN and NR** | **Statuses of the Buses** | **| V5 | (P.U.)** | **Errors between ANN and NR** | **Statuses of the Buses** |
| 100 | 110 | 135 | 0.9594537 | 3.55E-03 | 'NS' | 0.9180777 | -2.08E-03 | 'NS' |
| 98 | 108 | 133 | 0.9592194 | 0.0037806 | 'NS' | 0.9181953 | -0.0011953 | 'NS' |
| 96 | 106 | 131 | 0.9595923 | 3.41E-03 | 'NS' | 0.9179667 | -9.67E-04 | 'NS' |
| 94 | 104 | 129 | 0.960183 | 2.82E-03 | 'NS' | 0.9180836 | -8.36E-05 | 'NS' |
| 92 | 102 | 127 | 0.9607878 | 2.21E-03 | 'NS' | 0.9180194 | -1.94E-05 | 'NS' |
| 90 | 100 | 125 | 0.9614157 | 0.0015843 | 'NS' | 0.9180808 | 9.19E-04 | 'NS' |
| 88 | 98 | 123 | 0.9620351 | -3.51E-05 | 'NS' | 9.18E-01 | 7.19E-04 | 'NS' |
| 86 | 96 | 121 | 0.9627014 | -0.0007014 | 'NS' | 0.9186773 | 1.32E-03 | 'NS' |
| 84 | 94 | 119 | 0.9634848 | -0.0014848 | 'NS' | 0.919019 | 9.81E-04 | 'NS' |
| 82 | 92 | 117 | 0.9642914 | -0.0022914 | 'NS' | 0.9195596 | 0.0004404 | 'NS' |
| 80 | 90 | 115 | 0.9650874 | -0.0040874 | 'NS' | 0.9198864 | 1.14E-04 | 'NS' |
| **Load at Bus 5** | **Load at Bus 7** | **Load at Bus 9** | **| V6 | (P.U.)** | **Errors between ANN and NR** | **Statuses of the Buses** | **| V7 | (P.U.)** | **Errors between ANN and NR** | **Statuses of the Buses** |
| 100 | 110 | 135 | 0.9989953 | -0.0009953 | 'NS' | 0.9742715 | -0.0022715 | 'NS' |
| 98 | 108 | 133 | 9.99E-01 | -7.53E-04 | 'NS' | 0.9742905 | -0.0022905 | 'NS' |
| 96 | 106 | 131 | 0.9984011 | -0.0004011 | 'NS' | 0.9741005 | -0.0021005 | 'NS' |
| 94 | 104 | 129 | 0.9980733 | -7.33E-05 | 'NS' | 0.9738826 | -0.0008826 | 'NS' |
| 92 | 102 | 127 | 0.9976946 | 3.05E-04 | 'NS' | 0.973514 | -5.14E-04 | 'NS' |
| 90 | 100 | 125 | 0.997328 | 0.000672 | 'NS' | 0.9730718 | -7.18E-05 | 'NS' |
| 88 | 98 | 123 | 0.9969872 | 1.01E-03 | 'NS' | 0.9725583 | 4.42E-04 | 'NS' |
| 86 | 96 | 121 | 0.9966428 | 0.0013572 | 'NS' | 0.9720449 | 9.55E-04 | 'NS' |
| 84 | 94 | 119 | 0.9963005 | 1.70E-03 | 'NS' | 0.9714937 | 0.0015063 | 'NS' |
| 82 | 92 | 117 | 0.9959888 | 2.01E-03 | 'NS' | 0.9709148 | 2.09E-03 | 'NS' |
| 80 | 90 | 115 | 0.9957017 | 0.0022983 | 'NS' | 0.9700993 | 0.0019007 | 'NS' |
| **Load at Bus 5** | **Load at Bus 7** | **Load at Bus 9** | **| V8 | (P.U.)** | **Errors between ANN and NR** | **Statuses of the Buses** | **| V9 | (P.U.)** | **Errors between ANN and NR** | **Statuses of the Buses** |
| 100 | 110 | 135 | 0.9876325 | -0.0026325 | 'NS' | 0.9269705 | 1.03E-03 | 'NS' |
| 98 | 108 | 133 | 0.986994 | -0.001994 | 'NS' | 0.9276554 | -6.55E-04 | 'NS' |
| 96 | 106 | 131 | 0.9864096 | -0.001409 | 'NS' | 0.9277486 | -0.000749 | 'NS' |
| 94 | 104 | 129 | 9.86E-01 | -1.75E-03 | 'NS' | 0.9276753 | -6.75E-04 | 'NS' |
| 92 | 102 | 127 | 9.85E-01 | -1.13E-03 | 'NS' | 0.9271028 | -0.001103 | 'NS' |
| 90 | 100 | 125 | 0.9844855 | -4.86E-04 | 'NS' | 0.9262749 | -0.0002749 | 'NS' |
| 88 | 98 | 123 | 0.9838425 | 0.0001575 | 'NS' | 0.9254197 | -0.0004197 | 'NS' |
| 86 | 96 | 121 | 0.9831554 | 0.0008446 | 'NS' | 0.9244219 | 0.0005781 | 'NS' |
| 84 | 94 | 119 | 0.982507 | 0.001493 | 'NS' | 0.9236174 | 3.83E-04 | 'NS' |
| 82 | 92 | 117 | 0.9818346 | 0.0011654 | 'NS' | 0.9230468 | 9.53E-04 | 'NS' |
| 80 | 90 | 115 | 0.9812492 | 0.0017508 | 'NS' | 0.9228267 | 1.73E-04 | 'NS' |

Classification accuracy for case5 at training stage5 (%) = (163 /165) \* 100 = 98.7878 %.

Table B.6.1: Values of the thermal lines, statuses and errors between ANN and NR method (results of the training for case6 (outage the line (6-7)))

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Load at Bus 5** | **Load at Bus 7** | **Load at Bus 9** | **Thermal line (1- 4)** | **Errors between ANN and NR** | **Statuses of the Lines** | **Thermal line (2- 8)** | **Errors between ANN and NR** | **Statuses of the Lines** |
| 100 | 110 | 135 | 0.3607249 | -7.25E-04 | 'NS' | 0.5612726 | -1.27E-03 | 'NS' |
| 98 | 108 | 133 | 0.3395228 | 0.0004772 | 'NS' | 0.5604807 | -0.0004807 | 'NS' |
| 96 | 106 | 131 | 0.3197654 | 2.35E-04 | 'NS' | 0.5597855 | 2.14E-04 | 'NS' |
| 94 | 104 | 129 | 0.3005141 | -5.14E-04 | 'NS' | 0.5591547 | 8.45E-04 | 'NS' |
| 92 | 102 | 127 | 0.2808526 | -8.53E-04 | 'NS' | 0.5593392 | 0.0006608 | 'NS' |
| 90 | 100 | 125 | 0.263056 | -0.003056 | 'NS' | 0.5586674 | 1.33E-03 | 'NS' |
| 88 | 98 | 123 | 0.2452942 | -0.0052942 | 'NS' | 5.59E-01 | 1.13E-03 | 'NS' |
| 86 | 96 | 121 | 0.2276178 | -0.0076178 | 'NS' | 0.5594694 | 5.31E-04 | 'NS' |
| 84 | 94 | 119 | 0.2098518 | 0.0001482 | 'NS' | 0.5599259 | 7.41E-05 | 'NS' |
| 82 | 92 | 117 | 0.192819 | -0.002819 | 'NS' | 0.5608459 | -0.0008459 | 'NS' |
| 80 | 90 | 115 | 0.1784677 | -0.0084677 | 'NS' | 0.5635646 | -3.56E-03 | 'NS' |
| **Load at Bus 5** | **Load at Bus 7** | **Load at Bus 9** | **Thermal line (3- 6)** | **Errors between ANN and NR** | **Statuses of the Lines** | **Thermal line (4- 5)** | **Errors between ANN and NR** | **Statuses of the Lines** |
| 100 | 110 | 135 | 0.2895584 | 0.0004416 | 'NS' | 0.1662457 | 0.0037543 | 'NS' |
| 98 | 108 | 133 | 2.89E-01 | 6.92E-04 | 'NS' | 0.1576239 | 0.0023761 | 'NS' |
| 96 | 106 | 131 | 0.2898811 | 0.0001189 | 'NS' | 0.1512141 | -0.0012141 | 'NS' |
| 94 | 104 | 129 | 0.2897922 | 0.0002078 | 'NS' | 0.1450014 | 0.0049986 | 'NS' |
| 92 | 102 | 127 | 0.2905843 | -0.0005843 | 'NS' | 0.1406931 | -6.93E-04 | 'NS' |
| 90 | 100 | 125 | 0.2901924 | -0.0001924 | 'NS' | 0.1375829 | 0.0024171 | 'NS' |
| 88 | 98 | 123 | 0.2898561 | 1.44E-04 | 'NS' | 0.1341141 | -4.11E-03 | 'NS' |
| 86 | 96 | 121 | 0.2898191 | 0.0001809 | 'NS' | 0.132066 | -2.07E-03 | 'NS' |
| 84 | 94 | 119 | 0.2900038 | -3.82E-06 | 'NS' | 0.1289966 | 0.0010034 | 'NS' |
| 82 | 92 | 117 | 0.2904872 | -4.87E-04 | 'NS' | 0.1269077 | 3.09E-03 | 'NS' |
| 80 | 90 | 115 | 0.291387 | -0.001387 | 'NS' | 0.137766 | -0.007766 | 'NS' |
| **Load at Bus 5** | **Load at Bus 7** | **Load at Bus 9** | **Thermal line (5- 6)** | **Errors between ANN and NR** | **Statuses of the Lines** | **Thermal line (6- 7)** | **Errors between ANN and NR** | **Statuses of the Lines** |
| 100 | 110 | 135 | 0.5698515 | 0.0001485 | 'NS' | 0.0066551 | -6.66E-03 | 'NS' |
| 98 | 108 | 133 | 0.5697327 | 0.0002673 | 'NS' | 0.0021531 | -2.15E-03 | 'NS' |
| 96 | 106 | 131 | 0.5706085 | -0.0006085 | 'NS' | -0.0003773 | 0.0003773 | 'NS' |
| 94 | 104 | 129 | 0.570865 | -0.000865 | 'NS' | -0.0024794 | 2.48E-03 | 'NS' |
| 92 | 102 | 127 | 0.5711787 | -0.0011787 | 'NS' | -0.003054 | 0.003054 | 'NS' |
| 90 | 100 | 125 | 0.570398 | -3.98E-04 | 'NS' | -0.0031253 | 0.0031253 | 'NS' |
| 88 | 98 | 123 | 0.5698497 | 0.0001503 | 'NS' | -0.0026667 | 0.0026667 | 'NS' |
| 86 | 96 | 121 | 0.5690147 | 0.0009853 | 'NS' | -0.0009984 | 0.0009984 | 'NS' |
| 84 | 94 | 119 | 0.5702555 | -0.0002555 | 'NS' | 0.0012661 | -1.27E-03 | 'NS' |
| 82 | 92 | 117 | 0.5709962 | -0.0009962 | 'NS' | 0.0044035 | -4.40E-03 | 'NS' |
| 80 | 90 | 115 | 0.557529 | 0.012471 | 'NS' | 0.0080125 | -8.01E-03 | 'NS' |
| **Load at Bus 5** | **Load at Bus 7** | **Load at Bus 9** | **Thermal line (7- 8)** | **Errors between ANN and NR** | **Statuses of the Lines** | **Thermal line (8- 9)** | **Errors between ANN and NR** | **Statuses of the Lines** |
| 100 | 110 | 135 | 0.7707269 | -0.0007269 | 'NS' | 0.3533152 | 0.0066848 | 'NS' |
| 98 | 108 | 133 | 0.7573631 | 0.0026369 | 'NS' | 0.3684456 | 0.0015544 | 'NS' |
| 96 | 106 | 131 | 0.7432122 | -0.0032122 | 'NS' | 0.3825326 | -0.0025326 | 'NS' |
| 94 | 104 | 129 | 0.7312108 | -0.0012108 | 'NS' | 0.3970745 | -0.0070745 | 'NS' |
| 92 | 102 | 127 | 0.7174706 | 0.0025294 | 'NS' | 0.4101983 | -0.0001983 | 'NS' |
| 90 | 100 | 125 | 0.706097 | 0.003903 | 'NS' | 0.4245566 | -0.0045566 | 'NS' |
| 88 | 98 | 123 | 0.6945464 | -0.0045464 | 'NS' | 0.4386335 | -0.0086335 | 'NS' |
| 86 | 96 | 121 | 0.6821899 | -0.0021899 | 'NS' | 0.450117 | -0.010117 | 'NS' |
| 84 | 94 | 119 | 0.6696925 | 0.0003075 | 'NS' | 0.4600083 | -8.28E-06 | 'NS' |
| 82 | 92 | 117 | 0.6563111 | 0.0036889 | 'NS' | 0.4670013 | 0.0029987 | 'NS' |
| 80 | 90 | 115 | 0.6393082 | 0.0006918 | 'NS' | 0.4671681 | 0.0128319 | 'NS' |
| **Load at Bus 5** | **Load at Bus 7** | **Load at Bus 9** | **Thermal line (4- 9)** | **Errors between ANN and NR** | **Statuses of the Lines** |
| 100 | 110 | 135 | 0.6037944 | -0.0037944 | 'NS' |
| 98 | 108 | 133 | 0.5774806 | 0.0025194 | 'NS' |
| 96 | 106 | 131 | 0.5536815 | -0.0036815 | 'NS' |
| 94 | 104 | 129 | 0.5301889 | -0.000189 | 'NS' |
| 92 | 102 | 127 | 0.5079319 | 0.0020681 | 'NS' |
| 90 | 100 | 125 | 0.4868119 | 0.0031881 | 'NS' |
| 88 | 98 | 123 | 0.4661199 | 0.0038801 | 'NS' |
| 86 | 96 | 121 | 0.4471382 | 0.0028618 | 'NS' |
| 84 | 94 | 119 | 0.4301966 | -0.0001966 | 'NS' |
| 82 | 92 | 117 | 0.4141294 | -0.0041294 | 'NS' |
| 80 | 90 | 115 | 0.3899111 | 8.89E-05 | 'NS' |

Table B.6.2: Voltage Magnitudes per unit, statuses and errors between ANN and NR method (results of the training for case6 (outage the line (6-7)))

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Load at Bus 5** | **Load at Bus 7** | **Load at Bus 9** | **| V4 | (P.U.)** | **Errors between ANN and NR** | **Statuses of the Buses** | **| V5 | (P.U.)** | **Errors between ANN and NR** | **Statuses of the Buses** |
| 100 | 110 | 135 | 0.9836696 | -6.70E-04 | 'NS' | 0.9685046 | 1.50E-03 | 'NS' |
| 98 | 108 | 133 | 0.9835117 | -0.0005117 | 'NS' | 0.9689683 | 0.0010317 | 'NS' |
| 96 | 106 | 131 | 0.9831487 | -1.49E-04 | 'NS' | 0.9696641 | 1.34E-03 | 'NS' |
| 94 | 104 | 129 | 0.9828978 | 1.02E-04 | 'NS' | 0.9703648 | 6.35E-04 | 'NS' |
| 92 | 102 | 127 | 0.9823878 | 1.61E-03 | 'NS' | 0.9712251 | -0.0002251 | 'NS' |
| 90 | 100 | 125 | 0.9822128 | 0.0017872 | 'NS' | 0.9720876 | -8.76E-05 | 'NS' |
| 88 | 98 | 123 | 0.9820055 | 0.0019945 | 'NS' | 9.73E-01 | -9.17E-04 | 'NS' |
| 86 | 96 | 121 | 0.9816903 | 0.0023097 | 'NS' | 0.9737716 | -1.77E-03 | 'NS' |
| 84 | 94 | 119 | 0.9813415 | 0.0026585 | 'NS' | 0.9744788 | -2.48E-03 | 'NS' |
| 82 | 92 | 117 | 0.98093 | 0.00307 | 'NS' | 0.9751238 | -0.0021238 | 'NS' |
| 80 | 90 | 115 | 0.9803499 | 0.0036501 | 'NS' | 0.9761715 | -3.17E-03 | 'NS' |
| **Load at Bus 5** | **Load at Bus 7** | **Load at Bus 9** | **| V6 | (P.U.)** | **Errors between ANN and NR** | **Statuses of the Buses** | **| V7 | (P.U.)** | **Errors between ANN and NR** | **Statuses of the Buses** |
| 100 | 110 | 135 | 1.0045472 | 0.0004528 | 'AS' | 0.944712 | -0.001712 | 'NS' |
| 98 | 108 | 133 | 1.00E+00 | 2.48E-04 | 'AS' | 0.9445454 | 0.0005454 | 'NS' |
| 96 | 106 | 131 | 1.0049774 | 2.26E-05 | 'AS' | 0.9445987 | -0.0005987 | 'NS' |
| 94 | 104 | 129 | 1.0051646 | -0.0001646 | 'AS' | 0.9448603 | 0.0001397 | 'NS' |
| 92 | 102 | 127 | 1.0053877 | -0.0003877 | 'AS' | 0.9453135 | 6.86E-04 | 'NS' |
| 90 | 100 | 125 | 1.005538 | -0.000538 | 'AS' | 0.9459501 | 4.99E-05 | 'NS' |
| 88 | 98 | 123 | 1.0056987 | 3.01E-04 | 'AS' | 0.9468077 | 1.92E-04 | 'NS' |
| 86 | 96 | 121 | 1.0058614 | 0.0001386 | 'AS' | 0.9477512 | 2.49E-04 | 'NS' |
| 84 | 94 | 119 | 1.0060357 | -3.57E-05 | 'AS' | 0.9487786 | -0.0007786 | 'NS' |
| 82 | 92 | 117 | 1.0062163 | -2.16E-04 | 'AS' | 0.9498241 | -8.24E-04 | 'NS' |
| 80 | 90 | 115 | 1.0063489 | -0.00035 | 'AS' | 0.9504111 | -0.001411 | 'NS' |
| **Load at Bus 5** | **Load at Bus 7** | **Load at Bus 9** | **| V8 | (P.U.)** | **Errors between ANN and NR** | **Statuses of the Buses** | **| V9 | (P.U.)** | **Errors between ANN and NR** | **Statuses of the Buses** |
| 100 | 110 | 135 | 0.9779124 | 8.76E-05 | 'NS' | 0.9472697 | 2.73E-03 | 'NS' |
| 98 | 108 | 133 | 0.9780211 | -2.11E-05 | 'NS' | 0.9492537 | 7.46E-04 | 'NS' |
| 96 | 106 | 131 | 0.9781346 | 0.0008654 | 'NS' | 0.9502541 | 0.0007459 | 'NS' |
| 94 | 104 | 129 | 0.9783252 | 0.0006748 | 'NS' | 0.9513487 | -3.49E-04 | 'NS' |
| 92 | 102 | 127 | 0.9784928 | 0.0005072 | 'NS' | 0.9518709 | -0.0008709 | 'NS' |
| 90 | 100 | 125 | 0.9787168 | 1.28E-03 | 'NS' | 0.9523406 | -0.0013406 | 'NS' |
| 88 | 98 | 123 | 0.9790051 | 0.0009949 | 'NS' | 0.9527515 | -0.0007515 | 'NS' |
| 86 | 96 | 121 | 0.9792238 | 0.0007762 | 'NS' | 0.9528656 | -0.0008656 | 'NS' |
| 84 | 94 | 119 | 0.9794052 | 0.0015948 | 'NS' | 0.952512 | -5.12E-04 | 'NS' |
| 82 | 92 | 117 | 0.9795173 | 0.0014827 | 'NS' | 0.9519097 | 9.03E-05 | 'NS' |
| 80 | 90 | 115 | 0.9793844 | 0.0016156 | 'NS' | 0.9520878 | -8.78E-05 | 'NS' |

Classification accuracy for case6 at training stage (%) = (162 /165) \* 100 = 98.8181 %.

Table B.7.1: Values of the thermal lines, statuses and errors between ANN and NR method (results of the training for case7 (outage the line (7-8)))

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Load at Bus 5** | **Load at Bus 7** | **Load at Bus 9** | **Thermal line (1- 4)** | **Errors between ANN and NR** | **Statuses of the Lines** | **Thermal line (2- 8)** | **Errors between ANN and NR** | **Statuses of the Lines** |
| 100 | 110 | 135 | 0.4021832 | 7.82E-03 | 'NS' | 0.5462893 | 3.71E-03 | 'NS' |
| 98 | 108 | 133 | 0.3889382 | 0.0010618 | 'NS' | 0.5490289 | 0.0009711 | 'NS' |
| 96 | 106 | 131 | 0.3723078 | -2.31E-03 | 'NS' | 0.5516084 | -1.61E-03 | 'NS' |
| 94 | 104 | 129 | 0.3517077 | -1.71E-03 | 'NS' | 0.5509773 | -9.77E-04 | 'NS' |
| 92 | 102 | 127 | 0.3304021 | -4.02E-04 | 'NS' | 0.550247 | -0.000247 | 'NS' |
| 90 | 100 | 125 | 0.3085061 | 0.0014939 | 'NS' | 0.5492884 | 7.12E-04 | 'NS' |
| 88 | 98 | 123 | 0.2874434 | 0.0025566 | 'NS' | 5.49E-01 | 1.05E-03 | 'NS' |
| 86 | 96 | 121 | 0.2671857 | 0.0028143 | 'NS' | 0.5487642 | 1.24E-03 | 'NS' |
| 84 | 94 | 119 | 0.2483681 | 0.0016319 | 'NS' | 0.5486941 | 1.31E-03 | 'NS' |
| 82 | 92 | 117 | 0.2302162 | -0.0002162 | 'NS' | 0.5495323 | 0.0004677 | 'NS' |
| 80 | 90 | 115 | 0.2130163 | -0.0030163 | 'NS' | 0.5508359 | -8.36E-04 | 'NS' |
| **Load at Bus 5** | **Load at Bus 7** | **Load at Bus 9** | **Thermal line (3- 6)** | **Errors between ANN and NR** | **Statuses of the Lines** | **Thermal line (4- 5)** | **Errors between ANN and NR** | **Statuses of the Lines** |
| 100 | 110 | 135 | 0.3141566 | -0.0041566 | 'NS' | 0.8976283 | 0.0023717 | 'AS' |
| 98 | 108 | 133 | 3.12E-01 | -2.03E-03 | 'NS' | 0.8711689 | -0.0011689 | 'AS' |
| 96 | 106 | 131 | 0.3096134 | 0.0003866 | 'NS' | 0.8420463 | -0.0020463 | 'AS' |
| 94 | 104 | 129 | 0.3075555 | 0.0024445 | 'NS' | 0.8025902 | 0.0074098 | 'AS' |
| 92 | 102 | 127 | 0.3057286 | 0.0042714 | 'NS' | 0.7653718 | -5.37E-03 | 'NS' |
| 90 | 100 | 125 | 0.304056 | -0.004056 | 'NS' | 0.7291651 | 0.0008349 | 'NS' |
| 88 | 98 | 123 | 0.3027752 | -2.78E-03 | 'NS' | 0.6969612 | 3.04E-03 | 'NS' |
| 86 | 96 | 121 | 0.3015029 | -0.0015029 | 'NS' | 0.6675803 | 1.24E-02 | 'NS' |
| 84 | 94 | 119 | 0.3009212 | -0.0009212 | 'NS' | 0.6418023 | 0.0081977 | 'NS' |
| 82 | 92 | 117 | 0.3003947 | -3.95E-04 | 'NS' | 0.6191231 | 8.77E-04 | 'NS' |
| 80 | 90 | 115 | 0.3003312 | -0.0003312 | 'NS' | 0.5997382 | -0.0097382 | 'NS' |
| **Load at Bus 5** | **Load at Bus 7** | **Load at Bus 9** | **Thermal line (5- 6)** | **Errors between ANN and NR** | **Statuses of the Lines** | **Thermal line (6- 7)** | **Errors between ANN and NR** | **Statuses of the Lines** |
| 100 | 110 | 135 | 0.2984668 | 0.0015332 | 'NS' | 0.7816371 | 1.84E-02 | 'NS' |
| 98 | 108 | 133 | 0.290229 | -0.000229 | 'NS' | 0.7696441 | 3.56E-04 | 'NS' |
| 96 | 106 | 131 | 0.2786948 | 0.0013052 | 'NS' | 0.7544957 | -0.0044957 | 'NS' |
| 94 | 104 | 129 | 0.2707252 | -0.0007252 | 'NS' | 0.7388602 | 1.14E-03 | 'NS' |
| 92 | 102 | 127 | 0.2607217 | -0.0007217 | 'NS' | 0.7234249 | -0.0034249 | 'NS' |
| 90 | 100 | 125 | 0.249983 | 1.70E-05 | 'NS' | 0.708195 | 0.001805 | 'NS' |
| 88 | 98 | 123 | 0.2390164 | 0.0009836 | 'NS' | 0.6944302 | -0.0044302 | 'NS' |
| 86 | 96 | 121 | 0.2289997 | 0.0010003 | 'NS' | 0.6813795 | -0.0013795 | 'NS' |
| 84 | 94 | 119 | 0.2189948 | 0.0010052 | 'NS' | 0.6703202 | -3.20E-04 | 'NS' |
| 82 | 92 | 117 | 0.2105137 | -0.0005137 | 'NS' | 0.659967 | 3.30E-05 | 'NS' |
| 80 | 90 | 115 | 0.2034198 | 0.0065802 | 'NS' | 0.6513558 | -1.14E-02 | 'NS' |
| **Load at Bus 5** | **Load at Bus 7** | **Load at Bus 9** | **Thermal line (7- 8)** | **Errors between ANN and NR** | **Statuses of the Lines** | **Thermal line (8- 9)** | **Errors between ANN and NR** | **Statuses of the Lines** |
| 100 | 110 | 135 | 1.35E-05 | -1.35E-05 | 'NS' | 1.1028275 | -0.002827 | 'ES' |
| 98 | 108 | 133 | -0.0006257 | 0.0006257 | 'NS' | 1.1014478 | -0.0014478 | 'ES' |
| 96 | 106 | 131 | 0.0011715 | -0.0011715 | 'NS' | 1.0969321 | 0.0030679 | 'ES' |
| 94 | 104 | 129 | -5.20E-05 | 5.20E-05 | 'NS' | 1.0993266 | 0.0006734 | 'ES' |
| 92 | 102 | 127 | -0.0008276 | 0.0008276 | 'NS' | 1.1003585 | -0.0003585 | 'ES' |
| 90 | 100 | 125 | -0.0016842 | 0.0016842 | 'NS' | 1.1017848 | -0.0017848 | 'ES' |
| 88 | 98 | 123 | -0.0022812 | 0.0022812 | 'NS' | 1.1024188 | -0.0024188 | 'ES' |
| 86 | 96 | 121 | -0.0014436 | 0.0014436 | 'NS' | 1.1021798 | -0.0021798 | 'ES' |
| 84 | 94 | 119 | 0.0012467 | 0.0012467 | 'NS' | 1.101948 | -1.95E-03 | 'ES' |
| 82 | 92 | 117 | -0.0001821 | 0.0001821 | 'NS' | 1.1006097 | -0.0006097 | 'ES' |
| 80 | 90 | 115 | 0.0004264 | -0.0004264 | 'NS' | 1.0989717 | 0.0010283 | 'ES' |
| **Load at Bus 5** | **Load at Bus 7** | **Load at Bus 9** | **Thermal line (4- 9)** | **Errors between ANN and NR** | **Statuses of the Lines** |
| 100 | 110 | 135 | 0.3936462 | 0.0063538 | 'NS' |
| 98 | 108 | 133 | 0.4004733 | -0.0004733 | 'NS' |
| 96 | 106 | 131 | 0.4093383 | 0.0006617 | 'NS' |
| 94 | 104 | 129 | 0.4154915 | 0.0045085 | 'NS' |
| 92 | 102 | 127 | 0.4228803 | -0.0028803 | 'NS' |
| 90 | 100 | 125 | 0.4300088 | -8.85E-06 | 'NS' |
| 88 | 98 | 123 | 0.4368215 | 0.0031785 | 'NS' |
| 86 | 96 | 121 | 0.4448843 | -0.0048843 | 'NS' |
| 84 | 94 | 119 | 0.4523201 | -0.0023201 | 'NS' |
| 82 | 92 | 117 | 0.4591196 | 0.0008804 | 'NS' |
| 80 | 90 | 115 | 0.4657734 | 0.0042266 | 'NS' |

Table B.7.2: Voltage Magnitudes per unit, statuses and errors between ANN and NR method (results of the training for case7 (outage the line (7-8)))

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Load at Bus 5** | **Load at Bus 7** | **Load at Bus 9** | **| V4 | (P.U.)** | **Errors between ANN and NR** | **Statuses of the Buses** | **| V5 | (P.U.)** | **Errors between ANN and NR** | **Statuses of the Buses** |
| 100 | 110 | 135 | 0.9728791 | 1.12E-03 | 'NS' | 0.9522965 | 1.70E-03 | 'NS' |
| 98 | 108 | 133 | 0.9732728 | 0.0007272 | 'NS' | 0.9545176 | 0.0014824 | 'NS' |
| 96 | 106 | 131 | 0.9737397 | 1.26E-03 | 'NS' | 0.9567446 | 2.55E-04 | 'NS' |
| 94 | 104 | 129 | 0.9743211 | 6.79E-04 | 'NS' | 0.9586794 | -6.79E-04 | 'NS' |
| 92 | 102 | 127 | 0.9748973 | 1.10E-03 | 'NS' | 0.9602781 | -0.0012781 | 'NS' |
| 90 | 100 | 125 | 0.975508 | 0.000492 | 'NS' | 0.9615238 | -1.52E-03 | 'NS' |
| 88 | 98 | 123 | 0.9760797 | -7.97E-05 | 'NS' | 9.62E-01 | -1.32E-03 | 'NS' |
| 86 | 96 | 121 | 0.9766483 | -0.0006483 | 'NS' | 0.9626829 | -6.83E-04 | 'NS' |
| 84 | 94 | 119 | 0.9771188 | -0.0001188 | 'NS' | 0.9626876 | 3.12E-04 | 'NS' |
| 82 | 92 | 117 | 0.9775575 | -0.0005575 | 'NS' | 0.9623365 | 0.0016635 | 'NS' |
| 80 | 90 | 115 | 0.9779029 | -0.0009029 | 'NS' | 0.9616186 | 3.38E-03 | 'NS' |
| **Load at Bus 5** | **Load at Bus 7** | **Load at Bus 9** | **| V6 | (P.U.)** | **Errors between ANN and NR** | **Statuses of the Buses** | **| V7 | (P.U.)** | **Errors between ANN and NR** | **Statuses of the Buses** |
| 100 | 110 | 135 | 0.984162 | -0.006162 | 'NS' | 0.9184357 | -0.0004357 | 'NS' |
| 98 | 108 | 133 | 9.84E-01 | -4.81E-03 | 'NS' | 0.9199603 | 3.97E-05 | 'NS' |
| 96 | 106 | 131 | 0.9834768 | 0.0044768 | 'NS' | 0.9219152 | 8.48E-05 | 'NS' |
| 94 | 104 | 129 | 0.9833778 | -0.0033778 | 'NS' | 0.9236981 | -0.0006981 | 'NS' |
| 92 | 102 | 127 | 0.9833248 | -0.0023248 | 'NS' | 0.9255649 | -5.65E-04 | 'NS' |
| 90 | 100 | 125 | 0.9833143 | -0.0013143 | 'NS' | 0.9274804 | -0.0004804 | 'NS' |
| 88 | 98 | 123 | 0.9833196 | -3.20E-04 | 'NS' | 0.9293622 | -1.36E-03 | 'NS' |
| 86 | 96 | 121 | 0.9833407 | -0.0003407 | 'NS' | 0.9311999 | -1.20E-03 | 'NS' |
| 84 | 94 | 119 | 0.9833915 | 0.0006085 | 'NS' | 0.9329749 | -0.0019749 | 'NS' |
| 82 | 92 | 117 | 0.983431 | 1.57E-03 | 'NS' | 0.9347857 | -1.79E-03 | 'NS' |
| 80 | 90 | 115 | 0.9834764 | 0.0025236 | 'NS' | 0.9366006 | -0.0026006 | 'NS' |
| **Load at Bus 5** | **Load at Bus 7** | **Load at Bus 9** | **| V8 | (P.U.)** | **Errors between ANN and NR** | **Statuses of the Buses** | **| V9 | (P.U.)** | **Errors between ANN and NR** | **Statuses of the Buses** |
| 100 | 110 | 135 | 0.9894985 | -0.0014985 | 'NS' | 0.9284587 | 2.54E-03 | 'NS' |
| 98 | 108 | 133 | 0.9892677 | -0.0012677 | 'NS' | 0.9310833 | 9.17E-04 | 'NS' |
| 96 | 106 | 131 | 0.9889364 | 6.36E-05 | 'NS' | 0.9333074 | -0.0013074 | 'NS' |
| 94 | 104 | 129 | 0.9887332 | 0.0002668 | 'NS' | 0.9331306 | -1.13E-03 | 'NS' |
| 92 | 102 | 127 | 0.9884882 | 0.0005118 | 'NS' | 0.9329863 | 1.37E-05 | 'NS' |
| 90 | 100 | 125 | 0.9882191 | 7.81E-04 | 'NS' | 0.9327506 | 0.0002494 | 'NS' |
| 88 | 98 | 123 | 0.987947 | 0.001053 | 'NS' | 0.9327183 | 0.0012817 | 'NS' |
| 86 | 96 | 121 | 0.9877657 | 0.0012343 | 'NS' | 0.9328926 | 0.0011074 | 'NS' |
| 84 | 94 | 119 | 0.9876055 | 0.0013945 | 'NS' | 0.9332741 | 7.26E-04 | 'NS' |
| 82 | 92 | 117 | 0.9875237 | 0.0014763 | 'NS' | 0.9341358 | -1.36E-04 | 'NS' |
| 80 | 90 | 115 | 0.9875107 | 0.0014893 | 'NS' | 0.9355227 | -5.23E-04 | 'NS' |

Classification accuracy for case7 at training stage (%) = (162 / 165) \* 100 = 98.8181 %.

Table B.8.1: Values of the thermal lines, statuses and errors between ANN and NR method (results of the training for case8 (outage the line (8-9)))

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Load at Bus 5** | **Load at Bus 7** | **Load at Bus 9** | **Thermal line (1- 4)** | **Errors between ANN and NR** | **Statuses of the Lines** | **Thermal line (2- 8)** | **Errors between ANN and NR** | **Statuses of the Lines** |
| 100 | 110 | 135 | 0.4601921 | -1.92E-04 | 'NS' | 0.5505705 | -5.70E-04 | 'NS' |
| 98 | 108 | 133 | 0.448698 | 0.001302 | 'NS' | 0.5486713 | 0.0013287 | 'NS' |
| 96 | 106 | 131 | 0.4320222 | -2.02E-03 | 'NS' | 0.5495519 | 4.48E-04 | 'NS' |
| 94 | 104 | 129 | 0.4168749 | 3.13E-03 | 'NS' | 0.55042 | -4.20E-04 | 'NS' |
| 92 | 102 | 127 | 0.4030811 | -3.08E-03 | 'NS' | 0.5502646 | -0.0002646 | 'NS' |
| 90 | 100 | 125 | 0.3905076 | -0.0005076 | 'NS' | 0.550378 | -3.78E-04 | 'NS' |
| 88 | 98 | 123 | 0.3789385 | 0.0010615 | 'NS' | 5.50E-01 | 3.60E-04 | 'NS' |
| 86 | 96 | 121 | 0.3680366 | 0.0019634 | 'NS' | 0.5498501 | 1.50E-04 | 'NS' |
| 84 | 94 | 119 | 0.3589658 | 0.0010342 | 'NS' | 0.5492989 | 7.01E-04 | 'NS' |
| 82 | 92 | 117 | 0.3505405 | -0.0005405 | 'NS' | 0.549484 | 0.000516 | 'NS' |
| 80 | 90 | 115 | 0.3433647 | -0.0033647 | 'NS' | 0.5506812 | -6.81E-04 | 'NS' |
| **Load at Bus 5** | **Load at Bus 7** | **Load at Bus 9** | **Thermal line (3- 6)** | **Errors between ANN and NR** | **Statuses of the Lines** | **Thermal line (4- 5)** | **Errors between ANN and NR** | **Statuses of the Lines** |
| 100 | 110 | 135 | 0.2915653 | -0.0015653 | 'NS' | 0.2702437 | -0.0002437 | 'NS' |
| 98 | 108 | 133 | 2.89E-01 | 6.80E-04 | 'NS' | 0.2897024 | 0.0002976 | 'NS' |
| 96 | 106 | 131 | 0.2889885 | 0.0010115 | 'NS' | 0.3117103 | -0.0017103 | 'NS' |
| 94 | 104 | 129 | 0.2893043 | 0.0006957 | 'NS' | 0.335383 | 0.004617 | 'NS' |
| 92 | 102 | 127 | 0.2895299 | 0.0004701 | 'NS' | 0.3585326 | 1.47E-03 | 'NS' |
| 90 | 100 | 125 | 0.2904719 | -0.0004719 | 'NS' | 0.3822842 | -0.0022842 | 'NS' |
| 88 | 98 | 123 | 0.2917734 | -1.77E-03 | 'NS' | 0.405167 | 4.83E-03 | 'NS' |
| 86 | 96 | 121 | 0.2931617 | -0.0031617 | 'NS' | 0.4308186 | -8.19E-04 | 'NS' |
| 84 | 94 | 119 | 0.2954513 | -0.0054513 | 'NS' | 0.4538867 | -0.0038867 | 'NS' |
| 82 | 92 | 117 | 0.2982083 | 1.79E-03 | 'NS' | 0.4787862 | 1.21E-03 | 'NS' |
| 80 | 90 | 115 | 0.3012126 | -0.0012126 | 'NS' | 0.504728 | -0.004728 | 'NS' |
| **Load at Bus 5** | **Load at Bus 7** | **Load at Bus 9** | **Thermal line (5- 6)** | **Errors between ANN and NR** | **Statuses of the Lines** | **Thermal line (6- 7)** | **Errors between ANN and NR** | **Statuses of the Lines** |
| 100 | 110 | 135 | 0.910567 | -0.000567 | 'AS' | 0.4105002 | -5.00E-04 | 'NS' |
| 98 | 108 | 133 | 0.9246071 | -0.0046071 | 'AS' | 0.4201066 | -1.07E-04 | 'NS' |
| 96 | 106 | 131 | 0.9358948 | 0.0041052 | 'AS' | 0.4287283 | 0.0012717 | 'NS' |
| 94 | 104 | 129 | 0.9477791 | 0.0022209 | 'AS' | 0.4394208 | 5.79E-04 | 'NS' |
| 92 | 102 | 127 | 0.9610457 | -0.0010457 | 'AS' | 0.4506249 | -0.0006249 | 'NS' |
| 90 | 100 | 125 | 0.9737827 | -3.78E-03 | 'AS' | 0.4624358 | -0.0024358 | 'NS' |
| 88 | 98 | 123 | 0.9882001 | 0.0017999 | 'AS' | 0.4743409 | -0.0043409 | 'NS' |
| 86 | 96 | 121 | 1.0009931 | -0.0009931 | 'ES' | 0.4872156 | 0.0027844 | 'NS' |
| 84 | 94 | 119 | 1.0158805 | -0.0058805 | 'ES' | 0.4989127 | 1.09E-03 | 'NS' |
| 82 | 92 | 117 | 1.0291674 | 0.0008326 | 'ES' | 0.5112271 | -1.23E-03 | 'NS' |
| 80 | 90 | 115 | 1.0418432 | -0.0018432 | 'ES' | 0.523227 | -3.23E-03 | 'NS' |
| **Load at Bus 5** | **Load at Bus 7** | **Load at Bus 9** | **Thermal line (7- 8)** | **Errors between ANN and NR** | **Statuses of the Lines** | **Thermal line (8- 9)** | **Errors between ANN and NR** | **Statuses of the Lines** |
| 100 | 110 | 135 | 1.0981064 | 0.0018936 | 'ES' | 0.0017103 | -0.0017103 | 'NS' |
| 98 | 108 | 133 | 1.1013405 | -0.0013405 | 'ES' | -0.0017206 | 0.0017206 | 'NS' |
| 96 | 106 | 131 | 1.0999254 | 7.46E-05 | 'ES' | -0.0004265 | 0.0004265 | 'NS' |
| 94 | 104 | 129 | 1.0986293 | 0.0013707 | 'ES' | 0.0010624 | -0.0010624 | 'NS' |
| 92 | 102 | 127 | 1.0990243 | 0.0009757 | 'ES' | 0.0007469 | -0.0007469 | 'NS' |
| 90 | 100 | 125 | 1.0994752 | 0.0005248 | 'ES' | 0.0001094 | -0.0001094 | 'NS' |
| 88 | 98 | 123 | 1.1011225 | -0.0011225 | 'ES' | 0.0001448 | -0.0001448 | 'NS' |
| 86 | 96 | 121 | 1.1000927 | -9.27E-05 | 'ES' | 0.0005583 | -0.0005583 | 'NS' |
| 84 | 94 | 119 | 1.1004135 | -0.0004135 | 'ES' | -0.000602 | 6.02E-04 | 'NS' |
| 82 | 92 | 117 | 1.0990015 | 0.0009985 | 'ES' | -0.0002364 | 0.0002364 | 'NS' |
| 80 | 90 | 115 | 1.0953161 | 0.0046839 | 'ES' | 0.0002947 | -0.0002947 | 'NS' |
| **Load at Bus 5** | **Load at Bus 7** | **Load at Bus 9** | **Thermal line (4- 9)** | **Errors between ANN and NR** | **Statuses of the Lines** |
| 100 | 110 | 135 | 1.0385112 | 0.0014888 | 'ES' |
| 98 | 108 | 133 | 1.0293412 | 0.0006588 | 'ES' |
| 96 | 106 | 131 | 1.0135673 | -0.0035673 | 'ES' |
| 94 | 104 | 129 | 0.9976112 | 0.0023888 | 'ES' |
| 92 | 102 | 127 | 0.9826898 | -0.0026898 | 'AS' |
| 90 | 100 | 125 | 0.9676671 | 0.0023329 | 'AS' |
| 88 | 98 | 123 | 0.9530337 | -0.0030337 | 'AS' |
| 86 | 96 | 121 | 0.9388156 | 0.0011844 | 'AS' |
| 84 | 94 | 119 | 0.925279 | -0.005279 | 'AS' |
| 82 | 92 | 117 | 0.9106478 | -0.0006478 | 'AS' |
| 80 | 90 | 115 | 0.8958996 | 0.0041004 | 'AS' |

Table B.8.2: Voltage Magnitudes per unit, statuses and errors between ANN and NR method (results of the training for case8 (outage the line (8-9)))

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Load at Bus 5** | **Load at Bus 7** | **Load at Bus 9** | **| V4 | (P.U.)** | **Errors between ANN and NR** | **Statuses of the Buses** | **| V5 | (P.U.)** | **Errors between ANN and NR** | **Statuses of the Buses** |
| 100 | 110 | 135 | 0.9520616 | 9.38E-04 | 'NS' | 0.934428 | 5.72E-04 | 'NS' |
| 98 | 108 | 133 | 0.9520428 | 0.0009572 | 'NS' | 0.934525 | 0.000475 | 'NS' |
| 96 | 106 | 131 | 0.952178 | 8.22E-04 | 'NS' | 0.9345222 | -5.22E-04 | 'NS' |
| 94 | 104 | 129 | 0.9523718 | 6.28E-04 | 'NS' | 0.9343429 | -3.43E-04 | 'NS' |
| 92 | 102 | 127 | 0.9525417 | 4.58E-04 | 'NS' | 0.9339071 | -0.0009071 | 'NS' |
| 90 | 100 | 125 | 0.9527051 | -0.0007051 | 'NS' | 0.9333175 | -3.18E-04 | 'NS' |
| 88 | 98 | 123 | 0.9528898 | -0.0008898 | 'NS' | 9.32E-01 | -4.67E-04 | 'NS' |
| 86 | 96 | 121 | 0.9530945 | -0.0010945 | 'NS' | 0.931426 | -4.26E-04 | 'NS' |
| 84 | 94 | 119 | 0.9532791 | -0.0022791 | 'NS' | 0.9300216 | 9.78E-04 | 'NS' |
| 82 | 92 | 117 | 0.9535495 | -0.0025495 | 'NS' | 0.9284777 | 0.0015223 | 'NS' |
| 80 | 90 | 115 | 0.9538583 | -0.0028583 | 'NS' | 0.9265925 | 2.41E-03 | 'NS' |
| **Load at Bus 5** | **Load at Bus 7** | **Load at Bus 9** | **| V6 | (P.U.)** | **Errors between ANN and NR** | **Statuses of the Buses** | **| V7 | (P.U.)** | **Errors between ANN and NR** | **Statuses of the Buses** |
| 100 | 110 | 135 | 0.9887596 | 0.0002404 | 'NS' | 0.9734383 | -0.0004383 | 'NS' |
| 98 | 108 | 133 | 9.89E-01 | 3.93E-04 | 'NS' | 0.9734863 | -0.0004863 | 'NS' |
| 96 | 106 | 131 | 0.9883569 | 0.0006431 | 'NS' | 0.973628 | 0.000372 | 'NS' |
| 94 | 104 | 129 | 0.9880968 | 0.0009032 | 'NS' | 0.9737383 | 0.0002617 | 'NS' |
| 92 | 102 | 127 | 0.9878701 | 0.0001299 | 'NS' | 0.9737489 | 2.51E-04 | 'NS' |
| 90 | 100 | 125 | 0.9876468 | 0.0003532 | 'NS' | 0.9736996 | -0.0006996 | 'NS' |
| 88 | 98 | 123 | 0.9874543 | 5.46E-04 | 'NS' | 0.9735377 | -5.38E-04 | 'NS' |
| 86 | 96 | 121 | 0.9872565 | -0.0002565 | 'NS' | 0.97333 | -3.30E-04 | 'NS' |
| 84 | 94 | 119 | 0.9870831 | -8.31E-05 | 'NS' | 0.9729606 | 3.94E-05 | 'NS' |
| 82 | 92 | 117 | 0.9869106 | 8.94E-05 | 'NS' | 0.9724876 | 5.12E-04 | 'NS' |
| 80 | 90 | 115 | 0.986754 | -0.000754 | 'NS' | 0.971901 | 0.001099 | 'NS' |
| **Load at Bus 5** | **Load at Bus 7** | **Load at Bus 9** | **| V8 | (P.U.)** | **Errors between ANN and NR** | **Statuses of the Buses** | **| V9 | (P.U.)** | **Errors between ANN and NR** | **Statuses of the Buses** |
| 100 | 110 | 135 | 0.9915245 | -0.0015245 | 'NS' | 0.8890602 | -6.02E-05 | 'AS' |
| 98 | 108 | 133 | 0.9911691 | -0.0001691 | 'NS' | 0.8889117 | 8.83E-05 | 'AS' |
| 96 | 106 | 131 | 0.9908367 | 0.0001633 | 'NS' | 0.8895472 | -0.0005472 | 'AS' |
| 94 | 104 | 129 | 0.9905405 | 0.0004595 | 'NS' | 0.8900415 | -4.15E-05 | 'AS' |
| 92 | 102 | 127 | 0.990291 | 0.000709 | 'NS' | 0.890322 | -0.000322 | 'AS' |
| 90 | 100 | 125 | 0.9901019 | 8.98E-04 | 'NS' | 0.8905086 | -0.0005086 | 'AS' |
| 88 | 98 | 123 | 0.9899695 | 0.0010305 | 'NS' | 0.8902993 | 0.0007007 | 'AS' |
| 86 | 96 | 121 | 0.9899296 | 7.04E-05 | 'NS' | 0.8905637 | 0.0004363 | 'AS' |
| 84 | 94 | 119 | 0.9899842 | 1.58E-05 | 'NS' | 0.8901849 | 8.15E-04 | 'AS' |
| 82 | 92 | 117 | 0.9901037 | -0.000104 | 'NS' | 0.8901492 | 8.51E-04 | 'AS' |
| 80 | 90 | 115 | 0.9903465 | -0.000346 | 'NS' | 0.8903105 | 6.89E-04 | 'AS' |

Classification accuracy for case8 at training stage (%) = (165 / 165) \* 100 = 100 %.

Table B.9.1: Values of the thermal lines, statuses and errors between ANN and NR method (results of the training for case9 (outage the line (4-9)))

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Load at Bus 5** | **Load at Bus 7** | **Load at Bus 9** | **Thermal line (1- 4)** | **Errors between ANN and NR** | **Statuses of the Lines** | **Thermal line (2- 8)** | **Errors between ANN and NR** | **Statuses of the Lines** |
| 100 | 110 | 135 | 0.3703913 | -3.91E-04 | 'NS' | 0.6612272 | -3.12E-02 | 'NS' |
| 98 | 108 | 133 | 0.3491001 | 0.0008999 | 'NS' | 0.6441735 | -0.0141735 | 'NS' |
| 96 | 106 | 131 | 0.3331196 | -3.12E-03 | 'NS' | 0.6258888 | -5.89E-03 | 'NS' |
| 94 | 104 | 129 | 0.3092375 | 7.62E-04 | 'NS' | 0.6189061 | 1.09E-03 | 'NS' |
| 92 | 102 | 127 | 0.2848001 | -4.80E-03 | 'NS' | 0.6140217 | -0.0040217 | 'NS' |
| 90 | 100 | 125 | 0.2621071 | -0.0021071 | 'NS' | 0.6091084 | 8.92E-04 | 'NS' |
| 88 | 98 | 123 | 0.2406066 | -0.0006066 | 'NS' | 6.04E-01 | -4.14E-03 | 'NS' |
| 86 | 96 | 121 | 0.219215 | 0.000785 | 'NS' | 0.5994894 | 5.11E-04 | 'NS' |
| 84 | 94 | 119 | 0.1962507 | 0.0037493 | 'NS' | 0.5959065 | 4.09E-03 | 'NS' |
| 82 | 92 | 117 | 0.1728154 | -0.0028154 | 'NS' | 0.5924119 | -0.0024119 | 'NS' |
| 80 | 90 | 115 | 0.1497415 | 0.0002585 | 'NS' | 0.5889475 | 1.05E-03 | 'NS' |
| **Load at Bus 5** | **Load at Bus 7** | **Load at Bus 9** | **Thermal line (3- 6)** | **Errors between ANN and NR** | **Statuses of the Lines** | **Thermal line (4- 5)** | **Errors between ANN and NR** | **Statuses of the Lines** |
| 100 | 110 | 135 | 0.2996031 | -0.0096031 | 'NS' | 0.7456332 | 0.0043668 | 'NS' |
| 98 | 108 | 133 | 2.97E-01 | -6.77E-03 | 'NS' | 0.703495 | -0.003495 | 'NS' |
| 96 | 106 | 131 | 0.2940768 | -0.0040768 | 'NS' | 0.6526994 | 0.0073006 | 'NS' |
| 94 | 104 | 129 | 0.2913523 | -0.0013523 | 'NS' | 0.609526 | 0.000474 | 'NS' |
| 92 | 102 | 127 | 0.2883404 | 0.0016596 | 'NS' | 0.5663177 | 3.68E-03 | 'NS' |
| 90 | 100 | 125 | 0.2854692 | 0.0045308 | 'NS' | 0.5209943 | -0.0009943 | 'NS' |
| 88 | 98 | 123 | 0.2828959 | -2.90E-03 | 'NS' | 0.4756938 | 4.31E-03 | 'NS' |
| 86 | 96 | 121 | 0.2812232 | -0.0012232 | 'NS' | 0.431403 | -1.40E-03 | 'NS' |
| 84 | 94 | 119 | 0.2801811 | -0.000181 | 'NS' | 0.3901553 | -0.000155 | 'NS' |
| 82 | 92 | 117 | 0.2794997 | 5.00E-04 | 'NS' | 0.3505422 | -5.42E-04 | 'NS' |
| 80 | 90 | 115 | 0.2797507 | 0.0002493 | 'NS' | 0.3184895 | 0.0015105 | 'NS' |
| **Load at Bus 5** | **Load at Bus 7** | **Load at Bus 9** | **Thermal line (5- 6)** | **Errors between ANN and NR** | **Statuses of the Lines** | **Thermal line (6- 7)** | **Errors between ANN and NR** | **Statuses of the Lines** |
| 100 | 110 | 135 | 0.1922041 | -0.0022041 | 'NS' | 0.5875454 | 6.25E-02 | 'NS' |
| 98 | 108 | 133 | 0.1769 | 0.0031 | 'NS' | 0.5911041 | 2.89E-02 | 'NS' |
| 96 | 106 | 131 | 0.1628915 | -0.0028915 | 'NS' | 0.5862071 | 0.0137929 | 'NS' |
| 94 | 104 | 129 | 0.1610572 | -0.001057 | 'NS' | 0.5690095 | 9.90E-04 | 'NS' |
| 92 | 102 | 127 | 0.1633049 | -0.0033049 | 'NS' | 0.5474972 | -0.0074972 | 'NS' |
| 90 | 100 | 125 | 0.1693104 | 6.90E-04 | 'NS' | 0.5208401 | -0.0008401 | 'NS' |
| 88 | 98 | 123 | 0.1797119 | 0.0002881 | 'NS' | 0.4938726 | -0.0038726 | 'NS' |
| 86 | 96 | 121 | 0.192051 | -0.002051 | 'NS' | 0.4661646 | 0.0038354 | 'NS' |
| 84 | 94 | 119 | 0.2094792 | 0.0005208 | 'NS' | 0.4399678 | 3.22E-05 | 'NS' |
| 82 | 92 | 117 | 0.2321712 | -0.0021712 | 'NS' | 0.4178519 | 2.15E-03 | 'NS' |
| 80 | 90 | 115 | 0.2592717 | 0.0007283 | 'NS' | 0.4022722 | -2.27E-03 | 'NS' |
| **Load at Bus 5** | **Load at Bus 7** | **Load at Bus 9** | **Thermal line (7- 8)** | **Errors between ANN and NR** | **Statuses of the Lines** | **Thermal line (8- 9)** | **Errors between ANN and NR** | **Statuses of the Lines** |
| 100 | 110 | 135 | 0.1796839 | -0.0496839 | 'NS' | 1.1158921 | 0.0641079 | 'ES' |
| 98 | 108 | 133 | 0.1614048 | -0.0214048 | 'NS' | 1.1284993 | 0.0215007 | 'ES' |
| 96 | 106 | 131 | 0.1558593 | 0.0041407 | 'NS' | 1.1188161 | 0.0111839 | 'ES' |
| 94 | 104 | 129 | 0.170133 | -0.000133 | 'NS' | 1.1012249 | -0.0012249 | 'ES' |
| 92 | 102 | 127 | 0.1886318 | 0.0013682 | 'NS' | 1.0798951 | 0.0001049 | 'ES' |
| 90 | 100 | 125 | 0.206454 | 0.003546 | 'NS' | 1.0566579 | 0.0033421 | 'ES' |
| 88 | 98 | 123 | 0.2224351 | -0.0024351 | 'NS' | 1.0335725 | -0.0035725 | 'ES' |
| 86 | 96 | 121 | 0.2369621 | 0.0030379 | 'NS' | 1.0116786 | -0.0016786 | 'ES' |
| 84 | 94 | 119 | 0.2515162 | -0.0015162 | 'NS' | 0.989815 | 1.85E-04 | 'AS' |
| 82 | 92 | 117 | 0.2675687 | 0.0024313 | 'NS' | 0.9693464 | 0.0006536 | 'AS' |
| 80 | 90 | 115 | 0.2797077 | 0.0002923 | 'NS' | 0.9508322 | -0.0008322 | 'AS' |
| **Load at Bus 5** | **Load at Bus 7** | **Load at Bus 9** | **Thermal line (4- 9)** | **Errors between ANN and NR** | **Statuses of the Lines** |
| 100 | 110 | 135 | 0.0077154 | -0.0077154 | 'NS' |
| 98 | 108 | 133 | 0.0002271 | -0.0002271 | 'NS' |
| 96 | 106 | 131 | 0.0020852 | -0.0020852 | 'NS' |
| 94 | 104 | 129 | -0.00012 | 0.00012 | 'NS' |
| 92 | 102 | 127 | -0.000722 | 0.000722 | 'NS' |
| 90 | 100 | 125 | -0.0011798 | 0.0011798 | 'NS' |
| 88 | 98 | 123 | 0.0002965 | -0.0002965 | 'NS' |
| 86 | 96 | 121 | 0.000234 | -0.000234 | 'NS' |
| 84 | 94 | 119 | -0.000744 | 0.000744 | 'NS' |
| 82 | 92 | 117 | -0.0009416 | 0.0009416 | 'NS' |
| 80 | 90 | 115 | 0.0001026 | -0.000103 | 'NS' |

Table B.9.2: Voltage Magnitudes per unit, statuses and errors between ANN and NR method (results of the training for case9 (outage the line (4-9)))

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Load at Bus 5** | **Load at Bus 7** | **Load at Bus 9** | **| V4 | (P.U.)** | **Errors between ANN and NR** | **Statuses of the Buses** | **| V5 | (P.U.)** | **Errors between ANN and NR** | **Statuses of the Buses** |
| 100 | 110 | 135 | 0.997946 | 5.40E-05 | 'NS' | 0.9746447 | 3.36E-03 | 'NS' |
| 98 | 108 | 133 | 0.9986783 | 0.0003217 | 'NS' | 0.976153 | 0.002847 | 'NS' |
| 96 | 106 | 131 | 0.9990819 | -8.19E-05 | 'NS' | 0.9780128 | 1.99E-03 | 'NS' |
| 94 | 104 | 129 | 0.9994851 | -4.85E-04 | 'NS' | 0.9803849 | 6.15E-04 | 'NS' |
| 92 | 102 | 127 | 0.9998234 | 1.77E-04 | 'NS' | 0.9825165 | -0.0005165 | 'NS' |
| 90 | 100 | 125 | 1.0000681 | -6.81E-05 | 'AS' | 0.9840817 | -1.08E-03 | 'NS' |
| 88 | 98 | 123 | 1.000261 | -0.000261 | 'AS' | 9.85E-01 | -8.89E-04 | 'NS' |
| 86 | 96 | 121 | 1.0002719 | -0.0002719 | 'AS' | 0.9850936 | -1.09E-03 | 'NS' |
| 84 | 94 | 119 | 1.0001473 | -0.0001473 | 'AS' | 0.9848863 | 1.14E-04 | 'NS' |
| 82 | 92 | 117 | 0.9999689 | 3.11E-05 | 'NS' | 0.9841834 | 0.0008166 | 'NS' |
| 80 | 90 | 115 | 0.9998932 | 0.0001068 | 'NS' | 0.9833939 | 1.61E-03 | 'NS' |
| **Load at Bus 5** | **Load at Bus 7** | **Load at Bus 9** | **| V6 | (P.U.)** | **Errors between ANN and NR** | **Statuses of the Buses** | **| V7 | (P.U.)** | **Errors between ANN and NR** | **Statuses of the Buses** |
| 100 | 110 | 135 | 0.9954012 | -0.0044012 | 'NS' | 0.9494775 | -0.0044775 | 'NS' |
| 98 | 108 | 133 | 9.95E-01 | -3.32E-03 | 'NS' | 0.9505218 | -0.0035218 | 'NS' |
| 96 | 106 | 131 | 0.9954895 | -0.002489 | 'NS' | 0.9513877 | -0.002387 | 'NS' |
| 94 | 104 | 129 | 0.9957994 | -0.0017994 | 'NS' | 0.9525093 | -0.0015093 | 'NS' |
| 92 | 102 | 127 | 0.9961333 | -0.0011333 | 'NS' | 0.9536322 | -6.32E-04 | 'NS' |
| 90 | 100 | 125 | 0.9965197 | -0.0005197 | 'NS' | 0.9548189 | 0.0001811 | 'NS' |
| 88 | 98 | 123 | 0.9968667 | -8.67E-04 | 'NS' | 0.9561012 | -1.01E-04 | 'NS' |
| 86 | 96 | 121 | 0.9972213 | -0.0002213 | 'NS' | 0.9574357 | 5.64E-04 | 'NS' |
| 84 | 94 | 119 | 0.9975779 | 0.0004221 | 'NS' | 0.9588765 | 0.0001235 | 'NS' |
| 82 | 92 | 117 | 0.9978787 | 1.21E-04 | 'NS' | 0.9604499 | 5.50E-04 | 'NS' |
| 80 | 90 | 115 | 0.9981278 | 0.0008722 | 'NS' | 0.9618677 | 0.0001323 | 'NS' |
| **Load at Bus 5** | **Load at Bus 7** | **Load at Bus 5** | **| V8 | (P.U.)** | **Errors between ANN and NR** | **Statuses of the Buses** | **| V9 | (P.U.)** | **Errors between ANN and NR** | **Statuses of the Buses** |
| 100 | 110 | 135 | 0.9509805 | -0.0059805 | 'NS' | 0.775178 | -1.12E-02 | 'EES' |
| 98 | 108 | 133 | 0.9513149 | -0.004315 | 'NS' | 0.7783251 | -8.33E-03 | 'EES' |
| 96 | 106 | 131 | 0.9518999 | -0.0029 | 'NS' | 0.7807767 | -0.004777 | 'EES' |
| 94 | 104 | 129 | 0.9526183 | -0.0016183 | 'NS' | 0.7840951 | -2.10E-03 | 'EES' |
| 92 | 102 | 127 | 0.9535533 | -0.0005533 | 'NS' | 0.7878405 | -0.0008405 | 'EES' |
| 90 | 100 | 125 | 0.9548484 | 1.52E-04 | 'NS' | 0.7917786 | 0.0002214 | 'EES' |
| 88 | 98 | 123 | 0.956338 | -0.000338 | 'NS' | 0.796108 | 0.000892 | 'EES' |
| 86 | 96 | 121 | 0.9579425 | 5.75E-05 | 'NS' | 0.8005309 | 0.0014691 | 'ES' |
| 84 | 94 | 119 | 0.9594611 | -0.0004611 | 'NS' | 0.8052623 | 7.38E-04 | 'ES' |
| 82 | 92 | 117 | 0.9608817 | 0.0001183 | 'NS' | 0.8100501 | -5.01E-05 | 'ES' |
| 80 | 90 | 115 | 0.9618604 | 0.0001396 | 'NS' | 0.815418 | -1.42E-03 | 'ES' |

Classification accuracy for case9 at training stage (%) = (154 / 165) \* 100 = 93.3333 %.

Table B.1.1.1: Values of the thermal lines, statuses and errors between ANN and NR method (results of the testing for case1).

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Load at Bus 5** | **Load at Bus 7** | **Load at Bus 9** | **Thermal line (1- 4)** | **Errors between ANN and NR** | **Statuses of the Lines** | **Thermal line (2- 8)** | **Errors between ANN and NR** | **Statuses of the Lines** |
| 97 | 107 | 132 | 0.3195191 | 4.81E-04 | 'NS' | 0.5494836 | 5.16E-04 | 'NS' |
| 93 | 103 | 128 | 0.2982165 | -0.0582165 | 'NS' | 0.5488578 | 0.0011422 | 'NS' |
| 89 | 99 | 124 | 0.2638602 | -5.39E-02 | 'NS' | 0.5414309 | 8.57E-03 | 'NS' |
| 85 | 95 | 120 | 0.2135248 | -4.35E-02 | 'NS' | 0.5446177 | 5.38E-03 | 'NS' |
| 81 | 91 | 116 | 0.1194402 | 1.61E-01 | 'NS' | 0.5326296 | 0.0173704 | 'NS' |
| **Load at Bus 5** | **Load at Bus 7** | **Load at Bus 9** | **Thermal line (3- 6)** | **Errors between ANN and NR** | **Statuses of the Lines** | **Thermal line (4- 5)** | **Errors between ANN and NR** | **Statuses of the Lines** |
| 97 | 107 | 132 | 0.2795387 | 0.0004613 | 'NS' | 2.85E-01 | -5.04E-03 | 'NS' |
| 93 | 103 | 128 | 0.3157175 | -0.0357175 | 'NS' | 0.2629413 | -4.29E-02 | 'NS' |
| 89 | 99 | 124 | 0.3119297 | -0.0319297 | 'NS' | 0.2271694 | -4.72E-02 | 'NS' |
| 85 | 95 | 120 | 0.3111504 | -0.0311504 | 'NS' | 0.1675675 | -0.0175675 | 'NS' |
| 81 | 91 | 116 | 0.2175934 | 0.0624066 | 'NS' | 0.1531675 | 9.68E-02 | 'NS' |
| **Load at Bus 5** | **Load at Bus 7** | **Load at Bus 9** | **Thermal line (5- 6)** | **Errors between ANN and NR** | **Statuses of the Lines** | **Thermal line (6- 7)** | **Errors between ANN and NR** | **Statuses of the Lines** |
| 97 | 107 | 132 | 0.3964766 | -0.0064766 | 'NS' | 0.2409887 | -0.0009887 | 'NS' |
| 93 | 103 | 128 | 3.83E-01 | 3.67E-02 | 'NS' | 0.2843162 | -0.0643162 | 'NS' |
| 89 | 99 | 124 | 0.3954494 | 0.0345506 | 'NS' | 0.2744012 | -0.0544012 | 'NS' |
| 85 | 95 | 120 | 0.4278672 | 0.0121328 | 'NS' | 0.2471949 | -0.0371949 | 'NS' |
| 81 | 91 | 116 | 0.3734362 | 0.0265638 | 'NS' | 0.1266421 | 1.03E-01 | 'NS' |
| **Load at Bus 5** | **Load at Bus 7** | **Load at Bus 9** | **Thermal line (7- 8)** | **Errors between ANN and NR** | **Statuses of the Lines** | **Thermal line (8- 9)** | **Errors between ANN and NR** | **Statuses of the Lines** |
| 97 | 107 | 132 | 0.5375157 | 2.48E-03 | 'NS' | 0.5521811 | -2.18E-03 | 'NS' |
| 93 | 103 | 128 | 0.3004405 | 0.2095595 | 'NS' | 0.546202 | 3.38E-02 | 'NS' |
| 89 | 99 | 124 | 0.2769795 | 0.2130205 | 'NS' | 0.5677526 | 0.0322474 | 'NS' |
| 85 | 95 | 120 | 0.2923999 | 1.88E-01 | 'NS' | 0.5808238 | 2.92E-02 | 'NS' |
| 81 | 91 | 116 | 1.0202622 | -0.5002622 | 'ES' | 0.6542643 | -0.0842643 | 'NS' |
| **Load at Bus 5** | **Load at Bus 7** | **Load at Bus 9** | **Thermal line (4- 9)** | **Errors between ANN and NR** | **Statuses of the Lines** |
| 97 | 107 | 132 | 0.4168324 | -0.0068324 | 'NS' |
| 93 | 103 | 128 | 0.281366 | 0.078634 | 'NS' |
| 89 | 99 | 124 | 0.2634497 | 0.0665503 | 'NS' |
| 85 | 95 | 120 | 0.2513029 | 0.0586971 | 'NS' |
| 81 | 91 | 116 | 0.6211442 | -0.2411442 | 'NS' |

Table B.1.1.2: Voltage Magnitudes per unit, statuses and errors between ANN and NR method (results of the testing for case1)

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Load at Bus 5** | **Load at Bus 7** | **Load at Bus 9** | **| V4 | (P.U.)** | **Errors between ANN and NR** | **Statuses of the Buses** | **| V5 | (P.U.)** | **Errors between ANN and NR** | **Statuses of the Buses** |
| 97 | 107 | 132 | 0.9872936 | -2.94E-04 | 'NS' | 0.9754874 | -4.87E-04 | 'NS' |
| 93 | 103 | 128 | 0.9830115 | 0.0039885 | 'NS' | 0.9725477 | 0.0024523 | 'NS' |
| 89 | 99 | 124 | 0.9837789 | 3.22E-03 | 'NS' | 0.9729905 | 3.01E-03 | 'NS' |
| 85 | 95 | 120 | 0.9837894 | 3.21E-03 | 'NS' | 0.9731857 | 2.81E-03 | 'NS' |
| 81 | 91 | 116 | 0.9924674 | -5.47E-03 | 'NS' | 0.9733304 | 0.0016696 | 'NS' |
| **Load at Bus 5** | **Load at Bus 7** | **Load at Bus 9** | **| V6 | (P.U.)** | **Errors between ANN and NR** | **Statuses of the Buses** | **| V7 | (P.U.)** | **Errors between ANN and NR** | **Statuses of the Buses** |
| 97 | 107 | 132 | 1.0017274 | 0.0012726 | 'AS' | 9.84E-01 | 1.86E-04 | 'NS' |
| 93 | 103 | 128 | 1.0019511 | 0.0020489 | 'AS' | 0.9858679 | -1.87E-03 | 'NS' |
| 89 | 99 | 124 | 1.0023692 | 0.0016308 | 'AS' | 0.9858989 | -8.99E-04 | 'NS' |
| 85 | 95 | 120 | 1.0039959 | 4.06E-06 | 'AS' | 0.9843325 | 0.0006675 | 'NS' |
| 81 | 91 | 116 | 0.9982552 | 0.0057448 | 'NS' | 0.9837489 | 2.51E-04 | 'NS' |
| **Load at Bus 5** | **Load at Bus 7** | **Load at Bus 9** | **| V8 | (P.U.)** | **Errors between ANN and NR** | **Statuses of the Buses** | **| V9 | (P.U.)** | **Errors between ANN and NR** | **Statuses of the Buses** |
| 97 | 107 | 132 | 0.9972354 | -0.0022354 | 'NS' | 0.9562469 | 0.0007531 | 'NS' |
| 93 | 103 | 128 | 9.96E-01 | -1.90E-04 | 'NS' | 0.9630469 | -0.0060469 | 'NS' |
| 89 | 99 | 124 | 0.995664 | 0.000336 | 'NS' | 0.9633897 | -0.0053897 | 'NS' |
| 85 | 95 | 120 | 0.994308 | 0.001692 | 'NS' | 0.9603014 | -0.0023014 | 'NS' |
| 81 | 91 | 116 | 0.9931952 | 0.0028048 | 'NS' | 0.9527645 | 4.24E-03 | 'NS' |

Classification accuracy for case1 at testing stage (%) = (42 / 75) \* 100 = 56 %.

Table B.3.3.1: Values of the thermal lines, statuses and errors between ANN and NR method (results of the testing for case3 (outage the line (3-6))).

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Load at Bus 5** | **Load at Bus 5** | **Load at Bus 5** | **Thermal line (1- 4)** | **Errors between ANN and NR** | **Statuses of the Lines** | **Thermal line (2- 8)** | **Errors between ANN and NR** | **Statuses of the Lines** |
| 97 | 107 | 132 | 0.5550344 | 4.50E-02 | 'NS' | 0.5769383 | -2.69E-02 | 'NS' |
| 93 | 103 | 128 | 0.5064507 | 0.0535493 | 'NS' | 0.5712214 | -0.0212214 | 'NS' |
| 89 | 99 | 124 | 0.45749 | 6.25E-02 | 'NS' | 0.5646028 | -1.46E-02 | 'NS' |
| 85 | 95 | 120 | 0.4113799 | 5.86E-02 | 'NS' | 0.5593406 | -9.34E-03 | 'NS' |
| 81 | 91 | 116 | 0.3708696 | 5.91E-02 | 'NS' | 0.5618222 | -0.0218222 | 'NS' |
| **Load at Bus 5** | **Load at Bus 5** | **Load at Bus 5** | **Thermal line (3- 6)** | **Errors between ANN and NR** | **Statuses of the Lines** | **Thermal line (4- 5)** | **Errors between ANN and NR** | **Statuses of the Lines** |
| 97 | 107 | 132 | 0.0034446 | 0.0034446 | 'NS' | 5.60E-01 | 6.03E-02 | 'NS' |
| 93 | 103 | 128 | -0.0066561 | 0.0066561 | 'NS' | 0.5421591 | 3.78E-02 | 'NS' |
| 89 | 99 | 124 | -0.0109299 | 0.0109299 | 'NS' | 0.5200635 | 1.99E-02 | 'NS' |
| 85 | 95 | 120 | -0.0155327 | 0.0155327 | 'NS' | 0.5003023 | 0.0096977 | 'NS' |
| 81 | 91 | 116 | -0.0180936 | 0.0180936 | 'NS' | 0.5016319 | -3.16E-02 | 'NS' |
| **Load at Bus 5** | **Load at Bus 5** | **Load at Bus 5** | **Thermal line (5- 6)** | **Errors between ANN and NR** | **Statuses of the Lines** | **Thermal line (6- 7)** | **Errors between ANN and NR** | **Statuses of the Lines** |
| 97 | 107 | 132 | 0.2416611 | -0.051661 | 'NS' | 0.1783164 | 0.0016836 | 'NS' |
| 93 | 103 | 128 | 2.32E-01 | -4.19E-02 | 'NS' | 0.1842488 | -0.0042488 | 'NS' |
| 89 | 99 | 124 | 0.2286693 | -0.0386693 | 'NS' | 0.1936588 | -0.0036588 | 'NS' |
| 85 | 95 | 120 | 0.2274369 | -0.0374369 | 'NS' | 0.2072563 | -0.0072563 | 'NS' |
| 81 | 91 | 116 | 0.2056501 | -0.0156501 | 'NS' | 0.2250997 | -1.51E-02 | 'NS' |
| **Load at Bus 5** | **Load at Bus 5** | **Load at Bus 5** | **Thermal line (7- 8)** | **Errors between ANN and NR** | **Statuses of the Lines** | **Thermal line (8- 9)** | **Errors between ANN and NR** | **Statuses of the Lines** |
| 97 | 107 | 132 | 0.953596 | -1.94E-01 | 'AS' | 0.3813418 | -2.13E-02 | 'NS' |
| 93 | 103 | 128 | 0.9491573 | -0.2091573 | 'AS' | 0.4040419 | -3.40E-02 | 'NS' |
| 89 | 99 | 124 | 0.9244066 | -0.1944066 | 'AS' | 0.4280338 | -0.0480338 | 'NS' |
| 85 | 95 | 120 | 0.8808452 | -1.71E-01 | 'AS' | 0.4525323 | -6.25E-02 | 'NS' |
| 81 | 91 | 116 | 0.824305 | -0.124305 | 'AS' | 0.4707905 | -0.0707905 | 'NS' |
| **Load at Bus 5** | **Load at Bus 5** | **Load at Bus 5** | **Thermal line (4- 9)** | **Errors between ANN and NR** | **Statuses of the Lines** |
| 97 | 107 | 132 | 0.5313769 | 0.0486231 | 'NS' |
| 93 | 103 | 128 | 0.5243086 | 0.0256914 | 'NS' |
| 89 | 99 | 124 | 0.5202178 | -0.0102178 | 'NS' |
| 85 | 95 | 120 | 0.5197341 | -0.0497341 | 'NS' |
| 81 | 91 | 116 | 0.5140916 | -0.0740916 | 'NS' |

Table B.3.3.2: Voltage Magnitudes per unit, statuses and errors between ANN and NR method (results of the training for case3 (outage the line (3-6)))

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Load at Bus 5** | **Load at Bus 7** | **Load at Bus 9** | **| V4 | (P.U.)** | **Errors between ANN and NR** | **Statuses of the Buses** | **| V5 | (P.U.)** | **Errors between ANN and NR** | **Statuses of the Buses** |
| 97 | 107 | 132 | 0.9962073 | -8.21E-03 | 'NS' | 0.9947224 | -2.17E-02 | 'NS' |
| 93 | 103 | 128 | 0.9956177 | -0.0066177 | 'NS' | 0.9957799 | -0.0207799 | 'NS' |
| 89 | 99 | 124 | 0.9946365 | -4.64E-03 | 'NS' | 0.9951823 | -1.72E-02 | 'NS' |
| 85 | 95 | 120 | 0.9929231 | -1.92E-03 | 'NS' | 0.9924528 | -1.25E-02 | 'NS' |
| 81 | 91 | 116 | 0.99036 | 1.64E-03 | 'NS' | 0.9873447 | -0.0063447 | 'NS' |
| **Load at Bus 5** | **Load at Bus 7** | **Load at Bus 9** | **| V6 | (P.U.)** | **Errors between ANN and NR** | **Statuses of the Buses** | **| V7 | (P.U.)** | **Errors between ANN and NR** | **Statuses of the Buses** |
| 97 | 107 | 132 | 0.9991133 | -0.0041133 | 'NS' | 9.73E-01 | 6.02E-03 | 'NS' |
| 93 | 103 | 128 | 0.999237 | -0.002237 | 'NS' | 0.9751998 | 5.80E-03 | 'NS' |
| 89 | 99 | 124 | 0.9994063 | -0.0004063 | 'NS' | 0.9777078 | 5.29E-03 | 'NS' |
| 85 | 95 | 120 | 0.9995447 | 0.0014553 | 'NS' | 0.9803126 | 0.0046874 | 'NS' |
| 81 | 91 | 116 | 0.999314 | 0.002686 | 'NS' | 0.9826924 | 3.31E-03 | 'NS' |
| **Load at Bus 5** | **Load at Bus 7** | **Load at Bus 9** | **| V8 | (P.U.)** | **Errors between ANN and NR** | **Statuses of the Buses** | **| V9 | (P.U.)** | **Errors between ANN and NR** | **Statuses of the Buses** |
| 97 | 107 | 132 | 0.9895358 | 0.0044642 | 'NS' | 0.9663693 | -0.0063693 | 'NS' |
| 93 | 103 | 128 | 9.90E-01 | 4.92E-03 | 'NS' | 0.9689925 | -0.0079925 | 'NS' |
| 89 | 99 | 124 | 0.9909129 | 0.0050871 | 'NS' | 0.9706799 | -0.0086799 | 'NS' |
| 85 | 95 | 120 | 0.9923057 | 0.0046943 | 'NS' | 0.9713882 | -0.0073882 | 'NS' |
| 81 | 91 | 116 | 0.99433 | 0.00267 | 'NS' | 0.9725932 | -7.59E-03 | 'NS' |

Classification accuracy for case3 at testing stage (%) = (36 / 75) \* 100 = 48 %.

Table B.4.4.1: Values of the thermal lines, statuses and errors between ANN and NR method (results of the testing for case4 (outage the line (4-5)))

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Load at Bus 5** | **Load at Bus 7** | **Load at Bus 9** | **Thermal line (1- 4)** | **Errors between ANN and NR** | **Statuses of the Lines** | **Thermal line (2- 8)** | **Errors between ANN and NR** | **Statuses of the Lines** |
| 97 | 107 | 132 | 0.3311228 | -1.12E-03 | 'NS' | 0.5512541 | -1.25E-03 | 'NS' |
| 93 | 103 | 128 | 0.2903975 | -0.0003975 | 'NS' | 0.5504487 | -0.0004487 | 'NS' |
| 89 | 99 | 124 | 0.248844 | 1.16E-03 | 'NS' | 0.5483473 | 1.65E-03 | 'NS' |
| 85 | 95 | 120 | 0.210108 | -1.08E-04 | 'NS' | 0.5502769 | -2.77E-04 | 'NS' |
| 81 | 91 | 116 | 0.1722164 | -2.22E-03 | 'NS' | 0.5606283 | -0.0106283 | 'NS' |
| **Load at Bus 5** | **Load at Bus 7** | **Load at Bus 9** | **Thermal line (3- 6)** | **Errors between ANN and NR** | **Statuses of the Lines** | **Thermal line (4- 5)** | **Errors between ANN and NR** | **Statuses of the Lines** |
| 97 | 107 | 132 | 0.2984876 | 0.0015124 | 'NS' | 8.03E-05 | -8.03E-05 | 'NS' |
| 93 | 103 | 128 | 0.2950114 | 0.0049886 | 'NS' | -0.000581 | 5.81E-04 | 'NS' |
| 89 | 99 | 124 | 0.2915552 | -0.0015552 | 'NS' | -0.0016384 | 1.64E-03 | 'NS' |
| 85 | 95 | 120 | 0.289344 | 0.000656 | 'NS' | -0.000147 | 0.000147 | 'NS' |
| 81 | 91 | 116 | 0.290441 | -0.000441 | 'NS' | 0.0113752 | -1.14E-02 | 'NS' |
| **Load at Bus 5** | **Load at Bus 7** | **Load at Bus 9** | **Thermal line (5- 6)** | **Errors between ANN and NR** | **Statuses of the Lines** | **Thermal line (6- 7)** | **Errors between ANN and NR** | **Statuses of the Lines** |
| 97 | 107 | 132 | 0.6908624 | -0.0008624 | 'NS' | 0.1946333 | 0.0053667 | 'NS' |
| 93 | 103 | 128 | 6.61E-01 | -8.23E-04 | 'NS' | 0.1754633 | 0.0045367 | 'NS' |
| 89 | 99 | 124 | 0.6302199 | -0.0002199 | 'NS' | 0.1600278 | -2.78E-05 | 'NS' |
| 85 | 95 | 120 | 0.5994735 | 0.0005265 | 'NS' | 0.1504593 | -0.0004593 | 'NS' |
| 81 | 91 | 116 | 0.5603582 | 0.0196418 | 'NS' | 0.149539 | -9.54E-03 | 'NS' |
| **Load at Bus 5** | **Load at Bus 7** | **Load at Bus 9** | **Thermal line (7- 8)** | **Errors between ANN and NR** | **Statuses of the Lines** | **Thermal line (8- 9)** | **Errors between ANN and NR** | **Statuses of the Lines** |
| 97 | 107 | 132 | 0.8383439 | 1.66E-03 | 'AS' | 0.3010103 | -1.01E-03 | 'NS' |
| 93 | 103 | 128 | 0.7763716 | 0.0036284 | 'NS' | 0.3414238 | -1.42E-03 | 'NS' |
| 89 | 99 | 124 | 0.7209235 | -0.0009235 | 'NS' | 0.385363 | 0.004637 | 'NS' |
| 85 | 95 | 120 | 0.6650707 | -5.07E-03 | 'NS' | 0.4312654 | -1.27E-03 | 'NS' |
| 81 | 91 | 116 | 0.5989367 | 0.0110633 | 'NS' | 0.4741391 | 0.0058609 | 'NS' |
| **Load at Bus 5** | **Load at Bus 7** | **Load at Bus 9** | **Thermal line (4- 9)** | **Errors between ANN and NR** | **Statuses of the Lines** |
| 97 | 107 | 132 | 0.6521256 | -0.0021256 | 'NS' |
| 93 | 103 | 128 | 0.5791152 | 0.0008848 | 'NS' |
| 89 | 99 | 124 | 0.5087977 | 0.0012023 | 'NS' |
| 85 | 95 | 120 | 0.4384504 | 0.0015496 | 'NS' |
| 81 | 91 | 116 | 0.3638466 | 0.0161534 | 'NS' |

Table B.4.4.2: Voltage Magnitudes per unit, statuses and errors between ANN and NR method (results of the testing for case4 (outage the line (4-5)))

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Load at Bus 5** | **Load at Bus 7** | **Load at Bus 9** | **| V4 | (P.U.)** | **Errors between ANN and NR** | **Statuses of the Buses** | **| V5 | (P.U.)** | **Errors between ANN and NR** | **Statuses of the Buses** |
| 97 | 107 | 132 | 0.9878884 | 1.12E-04 | 'NS' | 0.8970459 | -4.59E-05 | 'AS' |
| 93 | 103 | 128 | 0.9888464 | 0.0001536 | 'NS' | 0.9013103 | 0.0016897 | 'AS' |
| 89 | 99 | 124 | 0.9894924 | -4.92E-04 | 'NS' | 0.9073741 | 1.63E-03 | 'AS' |
| 85 | 95 | 120 | 0.9898573 | -8.57E-04 | 'NS' | 0.9149208 | -9.21E-04 | 'NS' |
| 81 | 91 | 116 | 0.9896434 | -1.64E-03 | 'NS' | 0.9231372 | -0.0041372 | 'NS' |
| **Load at Bus 5** | **Load at Bus 7** | **Load at Bus 9** | **| V6 | (P.U.)** | **Errors between ANN and NR** | **Statuses of the Buses** | **| V7 | (P.U.)** | **Errors between ANN and NR** | **Statuses of the Buses** |
| 97 | 107 | 132 | 0.986074 | -0.001074 | 'NS' | 9.71E-01 | 1.95E-03 | 'NS' |
| 93 | 103 | 128 | 0.9867671 | 0.0002329 | 'NS' | 0.9747647 | 2.35E-04 | 'NS' |
| 89 | 99 | 124 | 0.9879587 | 4.13E-05 | 'NS' | 0.9783981 | -1.40E-03 | 'NS' |
| 85 | 95 | 120 | 0.9896621 | 0.0003379 | 'NS' | 0.9814401 | -0.0034401 | 'NS' |
| 81 | 91 | 116 | 0.9916145 | 0.0003855 | 'NS' | 0.983737 | -3.74E-03 | 'NS' |
| **Load at Bus 5** | **Load at Bus 7** | **Load at Bus 9** | **| V8 | (P.U.)** | **Errors between ANN and NR** | **Statuses of the Buses** | **| V9 | (P.U.)** | **Errors between ANN and NR** | **Statuses of the Buses** |
| 97 | 107 | 132 | 0.9904595 | 0.0005405 | 'NS' | 0.9600122 | -0.0010122 | 'NS' |
| 93 | 103 | 128 | 9.93E-01 | -5.95E-04 | 'NS' | 0.9608479 | -0.0008479 | 'NS' |
| 89 | 99 | 124 | 0.9939653 | -0.0009653 | 'NS' | 0.9606457 | 0.0003543 | 'NS' |
| 85 | 95 | 120 | 0.994506 | -0.000506 | 'NS' | 0.9610367 | -3.67E-05 | 'NS' |
| 81 | 91 | 116 | 0.994491 | -0.000491 | 'NS' | 0.9635612 | -3.56E-03 | 'NS' |

Classification accuracy for case4 at testing stage (%) = (70 / 75) \* 100 = 93.3333 %.

Table B.5.5.1: Values of the thermal lines, statuses and errors between ANN and NR method (results of the testing for case5 (outage the line (5-6)))

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Load at Bus 5** | **Load at Bus 7** | **Load at Bus 9** | **Thermal line (1- 4)** | **Errors between ANN and NR** | **Statuses of the Lines** | **Thermal line (2- 8)** | **Errors between ANN and NR** | **Statuses of the Lines** |
| 97 | 107 | 132 | 0.3986733 | 1.33E-03 | 'NS' | 0.5512231 | -1.22E-03 | 'NS' |
| 93 | 103 | 128 | 0.3643896 | -0.0043896 | 'NS' | 0.5529346 | -0.0029346 | 'NS' |
| 89 | 99 | 124 | 0.335432 | -5.43E-03 | 'NS' | 0.5546358 | 5.36E-03 | 'NS' |
| 85 | 95 | 120 | 0.3090737 | 9.26E-04 | 'NS' | 0.5572856 | 2.71E-03 | 'NS' |
| 81 | 91 | 116 | 0.2833524 | -3.35E-03 | 'NS' | 0.5615458 | -0.0015458 | 'NS' |
| **Load at Bus 5** | **Load at Bus 5** | **Load at Bus 5** | **Thermal line (3- 6)** | **Errors between ANN and NR** | **Statuses of the Lines** | **Thermal line (4- 5)** | **Errors between ANN and NR** | **Statuses of the Lines** |
| 97 | 107 | 132 | 0.2835727 | -0.0035727 | 'NS' | 6.82E-01 | -1.71E-03 | 'NS' |
| 93 | 103 | 128 | 0.2804199 | -0.0004199 | 'NS' | 0.6549094 | 5.09E-03 | 'NS' |
| 89 | 99 | 124 | 0.2792476 | 0.0007524 | 'NS' | 0.6246611 | 5.34E-03 | 'NS' |
| 85 | 95 | 120 | 0.2795411 | 0.0004589 | 'NS' | 0.597631 | 0.002369 | 'NS' |
| 81 | 91 | 116 | 0.2803887 | -0.0003887 | 'NS' | 0.5752842 | 4.72E-03 | 'NS' |
| **Load at Bus 5** | **Load at Bus 7** | **Load at Bus 9** | **Thermal line (5- 6)** | **Errors between ANN and NR** | **Statuses of the Lines** | **Thermal line (6- 7)** | **Errors between ANN and NR** | **Statuses of the Lines** |
| 97 | 107 | 132 | 0.0002826 | -0.0002826 | 'NS' | 0.5708766 | -0.0008766 | 'NS' |
| 93 | 103 | 128 | 3.90E-07 | -3.90E-07 | 'NS' | 0.5701082 | -0.0001082 | 'NS' |
| 89 | 99 | 124 | 0.0007713 | -0.0007713 | 'NS' | 0.5703817 | -0.0003817 | 'NS' |
| 85 | 95 | 120 | 0.0004776 | -0.0004776 | 'NS' | 0.5700401 | -4.01E-05 | 'NS' |
| 81 | 91 | 116 | -0.0003217 | 0.0003217 | 'NS' | 0.5693268 | 6.73E-04 | 'NS' |
| **Load at Bus 5** | **Load at Bus 7** | **Load at Bus 9** | **Thermal line (7- 8)** | **Errors between ANN and NR** | **Statuses of the Lines** | **Thermal line (8- 9)** | **Errors between ANN and NR** | **Statuses of the Lines** |
| 97 | 107 | 132 | 0.1881774 | 2.18E-02 | 'NS' | 0.9472319 | 2.77E-03 | 'AS' |
| 93 | 103 | 128 | 0.1847979 | 0.0052021 | 'NS' | 0.9754939 | -5.49E-03 | 'AS' |
| 89 | 99 | 124 | 0.1723244 | -0.0023244 | 'NS' | 1.0049908 | -0.0049908 | 'ES' |
| 85 | 95 | 120 | 0.1568918 | 3.11E-03 | 'NS' | 1.0324999 | -2.50E-03 | 'ES' |
| 81 | 91 | 116 | 0.1430617 | 0.0069383 | 'NS' | 1.0561109 | 0.0038891 | 'ES' |
| **Load at Bus 5** | **Load at Bus 7** | **Load at Bus 9** | **Thermal line (4- 9)** | **Errors between ANN and NR** | **Statuses of the Lines** |
| 97 | 107 | 132 | 0.3093172 | 0.0006828 | 'NS' |
| 93 | 103 | 128 | 0.3235555 | -0.0035555 | 'NS' |
| 89 | 99 | 124 | 0.3459365 | 0.0040635 | 'NS' |
| 85 | 95 | 120 | 0.3726959 | -0.0026959 | 'NS' |
| 81 | 91 | 116 | 0.4030501 | 0.0069499 | 'NS' |

Table B.5.5.2: Voltage Magnitudes per unit, statuses and errors between ANN and NR method (results of the testing for case5 (outage the line (5-6)))

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Load at Bus 5** | **Load at Bus 7** | **Load at Bus 9** | **| V4 | (P.U.)** | **Errors between ANN and NR** | **Statuses of the Buses** | **| V5 | (P.U.)** | **Errors between ANN and NR** | **Statuses of the Buses** |
| 97 | 107 | 132 | 0.9592976 | 3.70E-03 | 'NS' | 0.9181388 | -1.14E-03 | 'NS' |
| 93 | 103 | 128 | 0.9604925 | 0.0025075 | 'NS' | 0.9181092 | -0.0001092 | 'NS' |
| 89 | 99 | 124 | 0.9617317 | 1.27E-03 | 'NS' | 0.9181285 | 8.72E-04 | 'NS' |
| 85 | 95 | 120 | 0.96313 | -1.13E-03 | 'NS' | 0.9187696 | 1.23E-03 | 'NS' |
| 81 | 91 | 116 | 0.9647507 | -2.75E-03 | 'NS' | 0.9198978 | 0.0001022 | 'NS' |
| **Load at Bus 5** | **Load at Bus 7** | **Load at Bus 9** | **| V6 | (P.U.)** | **Errors between ANN and NR** | **Statuses of the Buses** | **| V7 | (P.U.)** | **Errors between ANN and NR** | **Statuses of the Buses** |
| 97 | 107 | 132 | 0.9985906 | -0.0005906 | 'NS' | 9.74E-01 | -2.25E-03 | 'NS' |
| 93 | 103 | 128 | 0.9978847 | 0.0001153 | 'NS' | 0.973717 | -7.17E-04 | 'NS' |
| 89 | 99 | 124 | 0.9971562 | 0.0008438 | 'NS' | 0.9728217 | 1.78E-04 | 'NS' |
| 85 | 95 | 120 | 0.9964582 | 0.0015418 | 'NS' | 0.9718009 | 0.0011991 | 'NS' |
| 81 | 91 | 116 | 0.9958326 | 0.0021674 | 'NS' | 0.9705444 | 1.46E-03 | 'NS' |
| **Load at Bus 5** | **Load at Bus 7** | **Load at Bus 9** | **| V8 | (P.U.)** | **Errors between ANN and NR** | **Statuses of the Buses** | **| V9 | (P.U.)** | **Errors between ANN and NR** | **Statuses of the Buses** |
| 97 | 107 | 132 | 0.9866827 | -0.0016827 | 'NS' | 0.9277047 | -0.0007047 | 'NS' |
| 93 | 103 | 128 | 9.85E-01 | -1.42E-03 | 'NS' | 0.9273251 | -0.0003251 | 'NS' |
| 89 | 99 | 124 | 0.984178 | -0.000178 | 'NS' | 0.925913 | 8.70E-05 | 'NS' |
| 85 | 95 | 120 | 0.9828422 | 0.0011578 | 'NS' | 0.9240158 | 0.0009842 | 'NS' |
| 81 | 91 | 116 | 0.9814614 | 0.0015386 | 'NS' | 0.922731 | 2.69E-04 | 'NS' |

Classification accuracy for case5 at testing stage (%) = (74 / 75) \* 100 = 98.667 %.

Table B.6.6.1: Values of the thermal lines, statuses and errors between ANN and NR method (results of the testing for case6 (outage the line (6-7))).

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Load at Bus 5** | **Load at Bus 7** | **Load at Bus 9** | **Thermal line (1- 4)** | **Errors between ANN and NR** | **Statuses of the Lines** | **Thermal line (2- 8)** | **Errors between ANN and NR** | **Statuses of the Lines** |
| 97 | 107 | 132 | 0.3296712 | 3.29E-04 | 'NS' | 0.5600024 | -2.43E-06 | 'NS' |
| 93 | 103 | 128 | 0.2901185 | -0.0001185 | 'NS' | 0.5591533 | 0.0008467 | 'NS' |
| 89 | 99 | 124 | 0.2541805 | -4.18E-03 | 'NS' | 0.5593748 | 6.25E-04 | 'NS' |
| 85 | 95 | 120 | 0.2197559 | 2.44E-04 | 'NS' | 0.5593797 | 6.20E-04 | 'NS' |
| 81 | 91 | 116 | 0.1862802 | -6.28E-03 | 'NS' | 0.5621544 | -0.0021544 | 'NS' |
| **Load at Bus 5** | **Load at Bus 7** | **Load at Bus 9** | **Thermal line (3- 6)** | **Errors between ANN and NR** | **Statuses of the Lines** | **Thermal line (4- 5)** | **Errors between ANN and NR** | **Statuses of the Lines** |
| 97 | 107 | 132 | 0.2896342 | 0.0003658 | 'NS' | 1.54E-01 | 6.39E-03 | 'NS' |
| 93 | 103 | 128 | 0.2902879 | -0.0002879 | 'NS' | 0.1426911 | -2.69E-03 | 'NS' |
| 89 | 99 | 124 | 0.2902823 | -0.0002823 | 'NS' | 0.1364742 | -6.47E-03 | 'NS' |
| 85 | 95 | 120 | 0.2898993 | 0.0001007 | 'NS' | 0.1306452 | -0.000645 | 'NS' |
| 81 | 91 | 116 | 0.2907017 | -0.0007017 | 'NS' | 0.1328261 | -2.83E-03 | 'NS' |
| **Load at Bus 5** | **Load at Bus 7** | **Load at Bus 9** | **Thermal line (5- 6)** | **Errors between ANN and NR** | **Statuses of the Lines** | **Thermal line (6- 7)** | **Errors between ANN and NR** | **Statuses of the Lines** |
| 97 | 107 | 132 | 0.5705955 | -0.0005955 | 'NS' | 0.0006516 | -0.0006516 | 'NS' |
| 93 | 103 | 128 | 5.71E-01 | -1.25E-03 | 'NS' | -0.0028327 | 0.0028327 | 'NS' |
| 89 | 99 | 124 | 0.5691563 | 0.0008437 | 'NS' | -0.0027643 | 0.0027643 | 'NS' |
| 85 | 95 | 120 | 0.5693863 | 0.0006137 | 'NS' | 3.88E-05 | -3.88E-05 | 'NS' |
| 81 | 91 | 116 | 0.5637179 | 0.0062821 | 'NS' | 0.0058867 | -5.89E-03 | 'NS' |
| **Load at Bus 5** | **Load at Bus 7** | **Load at Bus 9** | **Thermal line (7- 8)** | **Errors between ANN and NR** | **Statuses of the Lines** | **Thermal line (8- 9)** | **Errors between ANN and NR** | **Statuses of the Lines** |
| 97 | 107 | 132 | 0.7506291 | -6.29E-04 | 'NS' | 0.3754641 | 4.54E-03 | 'NS' |
| 93 | 103 | 128 | 0.7240656 | 0.0059344 | 'NS' | 0.4038907 | -3.89E-03 | 'NS' |
| 89 | 99 | 124 | 0.699376 | 0.000624 | 'NS' | 0.4312875 | -0.0112875 | 'NS' |
| 85 | 95 | 120 | 0.6763047 | -6.30E-03 | 'NS' | 0.4555012 | -5.50E-03 | 'NS' |
| 81 | 91 | 116 | 0.6501731 | -0.0001731 | 'NS' | 0.4667817 | 0.0132183 | 'NS' |
| **Load at Bus 5** | **Load at Bus 7** | **Load at Bus 9** | **Thermal line (4- 9)** | **Errors between ANN and NR** | **Statuses of the Lines** |
| 97 | 107 | 132 | 0.5655972 | 0.0044028 | 'NS' |
| 93 | 103 | 128 | 0.5190558 | 0.0009442 | 'NS' |
| 89 | 99 | 124 | 0.4757842 | 0.0042158 | 'NS' |
| 85 | 95 | 120 | 0.4390388 | -0.0090388 | 'NS' |
| 81 | 91 | 116 | 0.4035492 | -0.0035492 | 'NS' |

Table B.6.6.2: Voltage Magnitudes per unit, statuses and errors between ANN and NR method (results of the testing for case6 (outage the line (6-7)))

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Load at Bus 5** | **Load at Bus 7** | **Load at Bus 9** | **| V4 | (P.U.)** | **Errors between ANN and NR** | **Statuses of the Buses** | **| V5 | (P.U.)** | **Errors between ANN and NR** | **Statuses of the Buses** |
| 97 | 107 | 132 | 0.983347 | -3.47E-04 | 'NS' | 0.9692529 | 7.47E-04 | 'NS' |
| 93 | 103 | 128 | 0.9826246 | 0.0003754 | 'NS' | 0.9708079 | 0.0001921 | 'NS' |
| 89 | 99 | 124 | 0.9820303 | 1.97E-03 | 'NS' | 0.9725556 | -5.56E-04 | 'NS' |
| 85 | 95 | 120 | 0.9815801 | 2.42E-03 | 'NS' | 0.9740941 | -2.09E-03 | 'NS' |
| 81 | 91 | 116 | 0.9806965 | 3.30E-03 | 'NS' | 0.9756797 | -0.0026797 | 'NS' |
| **Load at Bus 5** | **Load at Bus 7** | **Load at Bus 9** | **| V6 | (P.U.)** | **Errors between ANN and NR** | **Statuses of the Buses** | **| V7 | (P.U.)** | **Errors between ANN and NR** | **Statuses of the Buses** |
| 97 | 107 | 132 | 1.0048685 | 0.0001315 | 'AS' | 9.45E-01 | -5.28E-04 | 'NS' |
| 93 | 103 | 128 | 1.0052879 | -0.0002879 | 'AS' | 0.9450773 | 9.23E-04 | 'NS' |
| 89 | 99 | 124 | 1.0056287 | -0.0006287 | 'AS' | 0.9463747 | 6.25E-04 | 'NS' |
| 85 | 95 | 120 | 1.0059302 | 6.98E-05 | 'AS' | 0.9482338 | -0.0002338 | 'NS' |
| 81 | 91 | 116 | 1.0062527 | -0.0002527 | 'AS' | 0.950075 | -1.07E-03 | 'NS' |
| **Load at Bus 5** | **Load at Bus 7** | **Load at Bus 9** | **| V8 | (P.U.)** | **Errors between ANN and NR** | **Statuses of the Buses** | **| V9 | (P.U.)** | **Errors between ANN and NR** | **Statuses of the Buses** |
| 97 | 107 | 132 | 0.9780746 | 0.0009254 | 'NS' | 0.9497541 | 0.0012459 | 'NS' |
| 93 | 103 | 128 | 9.78E-01 | 6.12E-04 | 'NS' | 0.9515698 | -0.0005698 | 'NS' |
| 89 | 99 | 124 | 0.9788662 | 0.0011338 | 'NS' | 0.9526745 | -0.0006745 | 'NS' |
| 85 | 95 | 120 | 0.9793325 | 0.0016675 | 'NS' | 0.9525947 | -0.0005947 | 'NS' |
| 81 | 91 | 116 | 0.9794713 | 0.0015287 | 'NS' | 0.9517856 | 2.14E-04 | 'NS' |

Classification accuracy for case6 at testing stage (%) = (73 / 75) \* 100 = 97.3333 %.

Table B.7.7.1: Values of the thermal lines, statuses and errors between ANN and NR method (results of the testing for case7 (outage the line (7-8)))

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Load at Bus 5** | **Load at Bus 7** | **Load at Bus 9** | **Thermal line (1- 4)** | **Errors between ANN and NR** | **Statuses of the Lines** | **Thermal line (2- 8)** | **Errors between ANN and NR** | **Statuses of the Lines** |
| 97 | 107 | 132 | 0.3809256 | -9.26E-04 | 'NS' | 0.550702 | -7.02E-04 | 'NS' |
| 93 | 103 | 128 | 0.3409752 | -0.0009752 | 'NS' | 0.5501492 | -0.0001492 | 'NS' |
| 89 | 99 | 124 | 0.2976874 | 2.31E-03 | 'NS' | 0.5485558 | 1.44E-03 | 'NS' |
| 85 | 95 | 120 | 0.257195 | 2.81E-03 | 'NS' | 0.5487836 | 1.22E-03 | 'NS' |
| 81 | 91 | 116 | 0.2214536 | -1.45E-03 | 'NS' | 0.5506147 | -0.0006147 | 'NS' |
| **Load at Bus 5** | **Load at Bus 7** | **Load at Bus 9** | **Thermal line (3- 6)** | **Errors between ANN and NR** | **Statuses of the Lines** | **Thermal line (4- 5)** | **Errors between ANN and NR** | **Statuses of the Lines** |
| 97 | 107 | 132 | 0.3107894 | -0.000789 | 'NS' | 8.57E-01 | 3.18E-03 | 'AS' |
| 93 | 103 | 128 | 0.3066649 | 0.0033351 | 'NS' | 0.7821837 | -2.18E-03 | 'NS' |
| 89 | 99 | 124 | 0.303566 | -0.003566 | 'NS' | 0.7111183 | 8.88E-03 | 'NS' |
| 85 | 95 | 120 | 0.3012178 | 0.0012178 | 'NS' | 0.6527307 | 0.0072693 | 'NS' |
| 81 | 91 | 116 | 0.2998094 | 0.0001906 | 'NS' | 0.6104874 | -4.87E-04 | 'NS' |
| **Load at Bus 5** | **Load at Bus 7** | **Load at Bus 9** | **Thermal line (5- 6)** | **Errors between ANN and NR** | **Statuses of the Lines** | **Thermal line (6- 7)** | **Errors between ANN and NR** | **Statuses of the Lines** |
| 97 | 107 | 132 | 0.2849352 | -0.0049352 | 'NS' | 0.7619739 | -0.0019739 | 'NS' |
| 93 | 103 | 128 | 2.67E-01 | -6.77E-03 | 'NS' | 0.7309382 | -0.0009382 | 'NS' |
| 89 | 99 | 124 | 0.2446075 | -0.0046075 | 'NS' | 0.7010868 | -0.0010868 | 'NS' |
| 85 | 95 | 120 | 0.2249757 | -0.0049757 | 'NS' | 0.6751729 | -0.0051729 | 'NS' |
| 81 | 91 | 116 | 0.206788 | 0.003212 | 'NS' | 0.654974 | -4.97E-03 | 'NS' |
| **Load at Bus 5** | **Load at Bus 7** | **Load at Bus 9** | **Thermal line (7- 8)** | **Errors between ANN and NR** | **Statuses of the Lines** | **Thermal line (8- 9)** | **Errors between ANN and NR** | **Statuses of the Lines** |
| 97 | 107 | 132 | 0.0001723 | -1.72E-04 | 'NS' | 1.099112 | 8.88E-04 | 'ES' |
| 93 | 103 | 128 | -0.0009783 | 0.0009783 | 'NS' | 1.1009782 | -9.78E-04 | 'ES' |
| 89 | 99 | 124 | -0.0027076 | 0.0027076 | 'NS' | 1.1032249 | -0.0032249 | 'ES' |
| 85 | 95 | 120 | -0.0017157 | 1.72E-03 | 'NS' | 1.1025626 | -2.56E-03 | 'ES' |
| 81 | 91 | 116 | 0.0021654 | -0.0021654 | 'NS' | 1.0977804 | 0.0022196 | 'ES' |
| **Load at Bus 5** | **Load at Bus 7** | **Load at Bus 9** | **Thermal line (4- 9)** | **Errors between ANN and NR** | **Statuses of the Lines** |
| 97 | 107 | 132 | 0.4044037 | 0.0055963 | 'NS' |
| 93 | 103 | 128 | 0.4186701 | 0.0013299 | 'NS' |
| 89 | 99 | 124 | 0.4337269 | -0.0037269 | 'NS' |
| 85 | 95 | 120 | 0.4478412 | 0.0021588 | 'NS' |
| 81 | 91 | 116 | 0.4638064 | -0.0038064 | 'NS' |

Table B.7.7.2: Voltage Magnitudes per unit, statuses and errors between ANN and NR method (results of the testing for case7 (outage the line (7-8)))

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Load at Bus 5** | **Load at Bus 7** | **Load at Bus 9** | **| V4 | (P.U.)** | **Errors between ANN and NR** | **Statuses of the Buses** | **| V5 | (P.U.)** | **Errors between ANN and NR** | **Statuses of the Buses** |
| 97 | 107 | 132 | 0.9734956 | 1.50E-03 | 'NS' | 0.9556555 | 3.44E-04 | 'NS' |
| 93 | 103 | 128 | 0.9746107 | 0.0003893 | 'NS' | 0.959551 | -0.000551 | 'NS' |
| 89 | 99 | 124 | 0.9757829 | 2.17E-04 | 'NS' | 0.9619652 | -9.65E-04 | 'NS' |
| 85 | 95 | 120 | 0.9768869 | 1.13E-04 | 'NS' | 0.9627156 | 2.84E-04 | 'NS' |
| 81 | 91 | 116 | 0.9777833 | -7.83E-04 | 'NS' | 0.9620234 | 0.0019766 | 'NS' |
| **Load at Bus 5** | **Load at Bus 7** | **Load at Bus 9** | **| V6 | (P.U.)** | **Errors between ANN and NR** | **Statuses of the Buses** | **| V7 | (P.U.)** | **Errors between ANN and NR** | **Statuses of the Buses** |
| 97 | 107 | 132 | 0.9836305 | -0.0046305 | 'NS' | 9.21E-01 | 7.06E-05 | 'NS' |
| 93 | 103 | 128 | 0.9833743 | -0.0023743 | 'NS' | 0.9245823 | -5.82E-04 | 'NS' |
| 89 | 99 | 124 | 0.9833253 | -0.0013253 | 'NS' | 0.928452 | -4.52E-04 | 'NS' |
| 85 | 95 | 120 | 0.9833826 | 0.0006174 | 'NS' | 0.9320767 | -0.0010767 | 'NS' |
| 81 | 91 | 116 | 0.9834255 | 0.0015745 | 'NS' | 0.9357133 | -2.71E-03 | 'NS' |
| **Load at Bus 5** | **Load at Bus 7** | **Load at Bus 9** | **| V8 | (P.U.)** | **Errors between ANN and NR** | **Statuses of the Buses** | **| V9 | (P.U.)** | **Errors between ANN and NR** | **Statuses of the Buses** |
| 97 | 107 | 132 | 0.989104 | -0.000104 | 'NS' | 0.9323641 | -0.0003641 | 'NS' |
| 93 | 103 | 128 | 9.89E-01 | 3.58E-04 | 'NS' | 0.9328423 | 0.0001577 | 'NS' |
| 89 | 99 | 124 | 0.988072 | 0.000928 | 'NS' | 0.9326607 | 0.0003393 | 'NS' |
| 85 | 95 | 120 | 0.987702 | 0.001298 | 'NS' | 0.9329204 | 0.0010796 | 'NS' |
| 81 | 91 | 116 | 0.987552 | 0.001448 | 'NS' | 0.9349124 | 8.76E-05 | 'NS' |

Classification accuracy for case7 at testing stage (%) = (75 / 75) \* 100 = 100 %.

Table B.8.8.1: Values of the thermal lines, statuses and errors between ANN and NR method (results of the testing for case8 (outage the line (8-9)))

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Load at Bus 5** | **Load at Bus 5** | **Load at Bus 5** | **Thermal line (1- 4)** | **Errors between ANN and NR** | **Statuses of the Lines** | **Thermal line (2- 8)** | **Errors between ANN and NR** | **Statuses of the Lines** |
| 97 | 107 | 132 | 0.4408637 | -8.64E-04 | 'NS' | 0.548648 | 1.35E-03 | 'NS' |
| 93 | 103 | 128 | 0.4094583 | 0.0005417 | 'NS' | 0.5501799 | -0.0001799 | 'NS' |
| 89 | 99 | 124 | 0.3843839 | 5.62E-03 | 'NS' | 0.5499621 | 3.79E-05 | 'NS' |
| 85 | 95 | 120 | 0.36319 | -3.19E-03 | 'NS' | 0.5491861 | 8.14E-04 | 'NS' |
| 81 | 91 | 116 | 0.3469644 | -6.96E-03 | 'NS' | 0.550365 | -0.000365 | 'NS' |
| **Load at Bus 5** | **Load at Bus 5** | **Load at Bus 5** | **Thermal line (3- 6)** | **Errors between ANN and NR** | **Statuses of the Lines** | **Thermal line (4- 5)** | **Errors between ANN and NR** | **Statuses of the Lines** |
| 97 | 107 | 132 | 0.2894298 | 0.0005702 | 'NS' | 3.00E-01 | 7.37E-05 | 'NS' |
| 93 | 103 | 128 | 0.28944 | 0.00056 | 'NS' | 0.346531 | 3.47E-03 | 'NS' |
| 89 | 99 | 124 | 0.2910677 | -0.0010677 | 'NS' | 0.39375 | -3.75E-03 | 'NS' |
| 85 | 95 | 120 | 0.2942412 | 0.0042412 | 'NS' | 0.4413793 | 0.0013793 | 'NS' |
| 81 | 91 | 116 | 0.2997218 | 0.0002782 | 'NS' | 0.4915659 | -1.57E-03 | 'NS' |
| **Load at Bus 5** | **Load at Bus 5** | **Load at Bus 5** | **Thermal line (5- 6)** | **Errors between ANN and NR** | **Statuses of the Lines** | **Thermal line (6- 7)** | **Errors between ANN and NR** | **Statuses of the Lines** |
| 97 | 107 | 132 | 0.9311835 | -0.0011835 | 'AS' | 0.4243829 | -0.0043829 | 'NS' |
| 93 | 103 | 128 | 9.55E-01 | 5.42E-03 | 'AS' | 0.444652 | 0.005348 | 'NS' |
| 89 | 99 | 124 | 0.9811323 | -0.0011323 | 'AS' | 0.4683713 | 0.0016287 | 'NS' |
| 85 | 95 | 120 | 1.0090623 | 0.0009377 | 'ES' | 0.4927884 | -0.0027884 | 'NS' |
| 81 | 91 | 116 | 1.035155 | -0.005155 | 'ES' | 0.5172829 | 2.72E-03 | 'NS' |
| **Load at Bus 5** | **Load at Bus 5** | **Load at Bus 5** | **Thermal line (7- 8)** | **Errors between ANN and NR** | **Statuses of the Lines** | **Thermal line (8- 9)** | **Errors between ANN and NR** | **Statuses of the Lines** |
| 97 | 107 | 132 | 1.1011661 | -1.17E-03 | 'ES' | -0.0010257 | 1.03E-03 | 'NS' |
| 93 | 103 | 128 | 1.0996193 | 0.0003807 | 'ES' | 0.0014982 | -1.50E-03 | 'NS' |
| 89 | 99 | 124 | 1.100281 | -0.000281 | 'ES' | 0.0003745 | -0.0003745 | 'NS' |
| 85 | 95 | 120 | 1.1006235 | -6.24E-04 | 'ES' | -0.0005191 | 5.19E-04 | 'NS' |
| 81 | 91 | 116 | 1.0974916 | 0.0025084 | 'ES' | -0.0002595 | 0.0002595 | 'NS' |
| **Load at Bus 5** | **Load at Bus 5** | **Load at Bus 5** | **Thermal line (4- 9)** | **Errors between ANN and NR** | **Statuses of the Lines** |
| 97 | 107 | 132 | 1.0216272 | -0.0016272 | 'ES' |
| 93 | 103 | 128 | 0.9894248 | 0.0005752 | 'AS' |
| 89 | 99 | 124 | 0.9601849 | -0.0001849 | 'AS' |
| 85 | 95 | 120 | 0.9320892 | -0.0020892 | 'AS' |
| 81 | 91 | 116 | 0.9031357 | -0.0031357 | 'AS' |

Table B.8.8.2: Voltage Magnitudes per unit, statuses and errors between ANN and NR method (results of the testing for case8 (outage the line (8-9)))

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Load at Bus 5** | **Load at Bus 7** | **Load at Bus 9** | **| V4 | (P.U.)** | **Errors between ANN and NR** | **Statuses of the Buses** | **| V5 | (P.U.)** | **Errors between ANN and NR** | **Statuses of the Buses** |
| 97 | 107 | 132 | 0.9521224 | 8.78E-04 | 'NS' | 0.9345222 | 4.78E-04 | 'NS' |
| 93 | 103 | 128 | 0.952462 | 0.000538 | 'NS' | 0.9341889 | 0.0001889 | 'NS' |
| 89 | 99 | 124 | 0.952799 | -7.99E-04 | 'NS' | 0.9329262 | -9.26E-04 | 'NS' |
| 85 | 95 | 120 | 0.9531527 | -1.15E-03 | 'NS' | 0.9307224 | 2.78E-04 | 'NS' |
| 81 | 91 | 116 | 0.9536892 | -2.69E-03 | 'NS' | 0.9275689 | 0.0024311 | 'NS' |
| **Load at Bus 5** | **Load at Bus 7** | **Load at Bus 9** | **| V6 | (P.U.)** | **Errors between ANN and NR** | **Statuses of the Buses** | **| V7 | (P.U.)** | **Errors between ANN and NR** | **Statuses of the Buses** |
| 97 | 107 | 132 | 0.9884782 | 0.0005218 | 'NS' | 9.74E-01 | -5.49E-04 | 'NS' |
| 93 | 103 | 128 | 0.9879889 | 1.11E-05 | 'NS' | 0.9737347 | 2.65E-04 | 'NS' |
| 89 | 99 | 124 | 0.9875505 | 0.0004495 | 'NS' | 0.9736301 | -6.30E-04 | 'NS' |
| 85 | 95 | 120 | 0.9871766 | -0.0001766 | 'NS' | 0.9731506 | -0.0001506 | 'NS' |
| 81 | 91 | 116 | 0.986833 | -0.000833 | 'NS' | 0.9722092 | 7.91E-04 | 'NS' |
| **Load at Bus 5** | **Load at Bus 7** | **Load at Bus 9** | **| V8 | (P.U.)** | **Errors between ANN and NR** | **Statuses of the Buses** | **| V9 | (P.U.)** | **Errors between ANN and NR** | **Statuses of the Buses** |
| 97 | 107 | 132 | 0.9909938 | 6.21E-06 | 'NS' | 0.8889665 | 3.35E-05 | 'AS' |
| 93 | 103 | 128 | 9.90E-01 | 6.03E-04 | 'NS' | 0.8901123 | -0.0001123 | 'AS' |
| 89 | 99 | 124 | 0.9900247 | 0.0009753 | 'NS' | 0.8904187 | -0.0004187 | 'AS' |
| 85 | 95 | 120 | 0.9899457 | 5.43E-05 | 'NS' | 0.8903058 | 0.0006942 | 'AS' |
| 81 | 91 | 116 | 0.9902124 | -0.0002124 | 'NS' | 0.8902254 | 7.75E-04 | 'AS' |

Classification accuracy for case8 at testing stage (%) = (75 / 75) \* 100 = 100 %.

**APPENDIX C**

**MATLAB SOURSE CODE**

The neural network part of the used program:

clc

clear;

target\_tr=[];

target\_test=[];

input\_tr=[];

input\_tr\_re=[];

input\_test=[];

input\_test\_re=[];

for n=1:9

t=strcat(['a',num2str(n)]);

load(t);clear('t');

t\_tr=[v\_out\_tr' ; ther\_out\_tr'./100];

t\_test=[v\_out\_test' ; ther\_out\_test'./100];

input\_tr=[input\_tr in\_tr'];

input\_tr\_re=[input\_tr\_re in\_tr\_re'];

input\_test=[input\_test in\_test'];

input\_test\_re=[input\_test\_re in\_test\_re'];

target\_tr=[target\_tr t\_tr]; target\_test=[target\_test t\_test];

clear('t\_tr','t\_test');

end

clear('n');

input\_tr\_final=[input\_tr;input\_tr\_re];

input\_test\_final=[input\_test;input\_test\_re];

net=newff((input\_tr\_final),target\_tr,[30 100 30 50],{'tansig','tansig','logsig','logsig'},'traingdx');

net.trainparam.epochs=20000;

net.trainparam.goal=0.000001;

net.trainparam.lr=0.04;

net.trainparam.mc=0.3;

[net\_s,tr]=train(net,input\_tr\_final,target\_tr);

result;

a=sim(net\_s,input\_tr\_final);

b=sim(net\_s,input\_test\_final);

test\_error=target\_test-b; save('test\_error','test\_error');

train\_error=target\_tr-a; save('train\_error','train\_error');

mse\_test=test\_error.^2; save('mse\_test','mse\_test');

affiche;

classify;

affiche\_d\_erreur;