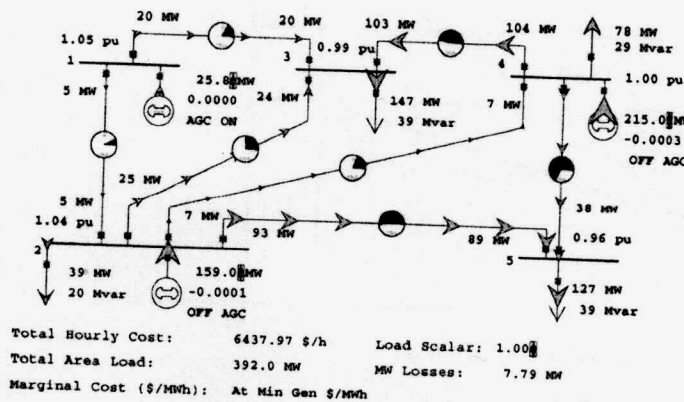
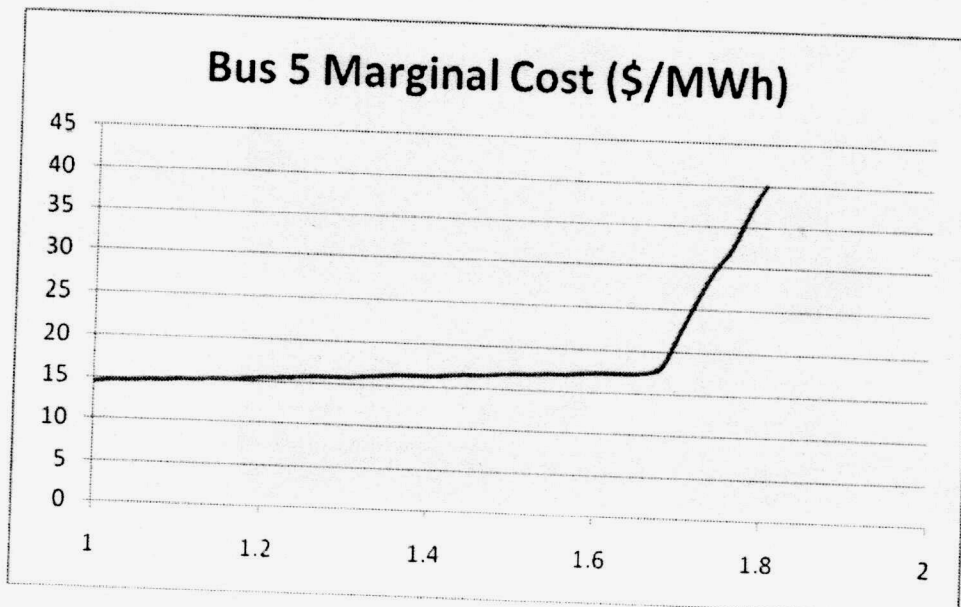


Homework 7 Solutions

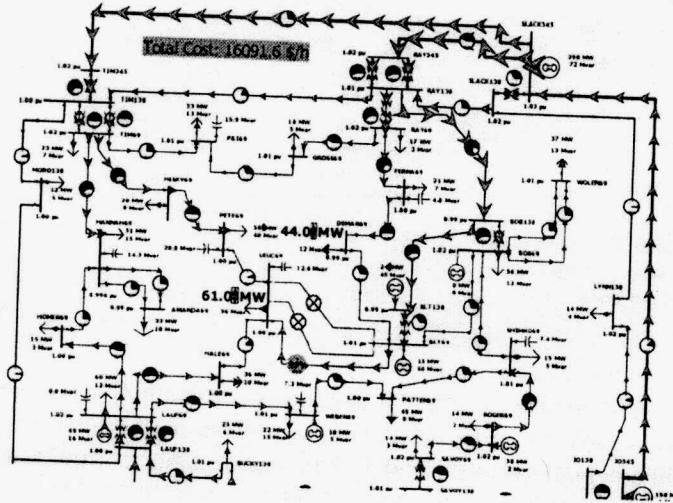
- 12.26** To achieve loss sensitivity values that are equal the generation at bus 2 should be about 159 MW and the generation at bus 4 should be about 215 MW. Minimum losses are 7.79 MW. The operating cost in Example 12.10 is lower than that found in this problem indicating that minimizing losses does not usually result in a minimum cost dispatch. The minimum loss one-line is given below.



- 12.28** The line between buses 2 and 5 reaches 100% at a load scalar of about 1.68; above this value the flow on this line is constrained to 100%, causing the additional load into bus 5 to increase the flow on the line between buses 4 and 5. This line reaches its limit at a load scalar of 1.81. Since both lines into bus 5 are loaded at 100%, no additional load can be brought into the bus without causing at least one of these lines to be overloaded. The plot of the bus 5 MW marginal cost is given below.



- 12.29 The OPF solution for this case is given below, with an operating cost of 16,091.6 \$/hr. The marginal cost at bus UIUC69 is 41.82 \$/hr. Increasing the UIUC69 MW load from 61 to 62 MW increases the operating cost to \$16,132.80, an increase of \$41.2, verifying the marginal cost. Similarly at the DEMAR69 bus the marginal cost is 17.74 \$/hr; increasing the load from 44 to 45 MW increases the operating cost by \$17.8. Note, because of convergence tolerances the manually calculated changes may differ slightly from the marginal cost values.



7.1 (a) $\bar{Z} = R + j\omega L = 0.4 + j(2\pi \cdot 60)2 \times 10^{-3} = 0.4 + j0.754$
 $= 0.8535 \angle 62.05^\circ \Omega$

$Z = 0.8535 \Omega$ and $\theta = 62.05^\circ$

$I_{ac} = \frac{V}{Z} = \frac{277}{0.8535} = 324.5 \text{ A}$

(b) $I_{rms}(0) = I_{ac} k(0) = 324.5 \sqrt{3} = 562.1 \text{ A}$

(c) Using Eq. (7.1.12), with $\frac{X}{R} = \frac{0.754}{0.4} = 1.885$

$k(\tau = 5 \text{ cycles}) = \sqrt{1 - 2e^{-4\pi(5)/1.885}} \approx 1.0$

$I_{rms}(\tau = 5 \text{ cycles}) = I_{ac} k(5 \text{ cycles}) = 324.5 \text{ A}$

(d) From Eq. (7.1.1)

$V(0) = \sqrt{2} V \sin \alpha = 300; \quad \alpha = \sin^{-1} \left(\frac{300}{\sqrt{2} V} \right) = \sin^{-1} \left(\frac{300}{\sqrt{2} 277} \right) = 49.98^\circ$

From Eq. (7.1.4)

$$\begin{aligned} i_{dc}(t) &= -\frac{\sqrt{2}V}{Z} \sin(\alpha - \theta) e^{-t/T} \\ &= -\frac{\sqrt{2}(277)}{0.8535} \sin(49.98^\circ - 62.05^\circ) e^{-t/T} \\ &= 95.98 e^{-t/T} \end{aligned}$$

where $T = \frac{L}{R} = \frac{2 \times 10^{-3}}{0.4} = 5 \times 10^{-3} \text{ s}$

$i_{dc}(t) = 95.98 e^{-t/(5 \times 10^{-3})} \text{ A}$