Lab 4

Calculations:

"Cost equations"

$C_1 = 10P_1 + 0.016P_1^2$ Rs/hr $(100MW < P_1 < 400MW)$

$C_2 = 8P_2 + 0.018P_2^2$ — $(150MW < P_2 < 500MW)$

$C_3 = 12P_3 + 0.018P_3^2$ — $(50MW < P_3 < 300MW)$

a) Load 1160 MW:

$$\lambda = \frac{P_D + \sum_1^n \frac{\beta_i}{2\gamma_i}}{\sum_1^n \frac{1}{2\gamma_i}}$$

$$\lambda = 1160 + \left[\frac{10}{2(0.016)} + \frac{8}{2(0.018)} + \frac{12}{2(0.018)}\right] = \frac{2026.232}{87.8056}$$

$$\left(\frac{1}{2(0.016)} + \frac{1}{2(0.018)} + \frac{1}{2(0.018)}\right)$$

$$\boxed{\lambda = 23.36} \Leftarrow \frac{2026.055}{86.80}$$

Let $\lambda' = 23$; $P_i = \frac{\lambda - \beta_i}{2\gamma_i}$

$P_1' = \frac{23-10}{2(0.016)} = 406.25$

$P_2' = \frac{23-8}{2(0.018)} = 416.667$

$P_3' = \frac{23-12}{2(0.018)} = 305.556$

$\Sigma P_i = (406.25 + 416.667 + 305.5$

$\Sigma P_i = 1128.47$ MW

$\Delta P' = P_D - \Sigma P_i$

$\Delta P' = 1160 - (1128.47)$

$\Delta P' = 31.527$ MW

$$\Delta\lambda' = \frac{\Delta P'}{\Sigma \frac{1}{2\gamma_i}} = \frac{31.5}{\frac{1}{2(0.016)} + \frac{1}{2(0.018)} + \frac{1}{2(0.018)}}$$

$\Delta\lambda' = 0.3629$

$\lambda^2 = \lambda' + \Delta\lambda' = 23 + 0.3625 = 23.3625$

$\lambda_2 = 23.3629$

$P_1^2 = \frac{23.3629 - 10}{2(0.016)} = 417.59$ | $\Sigma P_i = 1159.7$

$P_2^2 = \frac{23.3629 - 8}{2(0.018)} = 426.747$ | $\Delta P^2 = 1160 - 1159.7$

$P_3^2 = \frac{23.3629 - 12}{2(0.018)} = 315.636$ | $\Delta P^2 = 0.29989$

$\Delta\lambda^2 = \frac{\Delta P^2}{\frac{1}{2(0.016)} + \frac{1}{2(0.018)} + \frac{1}{2(0.018)}} = \frac{0.29989}{86.80} = 0.0034544$

$\lambda_3 = \lambda_2 + \Delta\lambda^2 = 23.3629 + 0.0034544 = 23.36635$

$\lambda_3 = 23.36635$

$P_1^3 = \frac{23.36549 - 10}{2(0.016)} = 417.6671$ | $\Sigma P_i = 1160.18$

$P_2^3 = \frac{23.36549 - 8}{2(0.018)} = 426.8152$ | $\Delta P = 1160 - 1160.18$

$P_3^3 = \frac{23.36549 - 12}{2(0.018)} = 315.704$ | $= -0.18$

Now keep the values of P_i in limits.

$P_1 = 400$ | $\Sigma P_i = 1126.8125$

$P_2 = 426.8125$ | $\Delta P = 1160 - 1126.8125$

$P_3 = 300$ | $= 33.1875$

$\Delta\lambda_4 = \frac{\Delta P}{\Sigma \frac{1}{2r_i}} = \frac{33.1875}{86.8} = 1.19475$

$\lambda_4 = \lambda_3 + \Delta\lambda_4 = 23.36635 + 1.19475$

$\lambda_4 = 24.5611$

$\lambda_4 = 23.7458$

$\Sigma P_i = 1137.38$

$P_1 = 400$

$P_2 = 437.38$

$P_3 = 300$

$\lambda_4 = 24.5611$

$P_1 = 400$, $P_2 = \frac{24.5611 - 8}{2(0.018)} = 460.09$

$P_3 = 300$

$\Sigma P_i = 1160.09$

$\Delta P = 1160 - 1160$

$\Delta P = 0$

b) $P_D = 654 MW$

$$\lambda_1 = 654 + \left[\frac{10}{2(0.016)} + \frac{8}{2(0.018)} + \frac{12}{2(0.018)}\right] = 17.535$$

$\Sigma \frac{1}{2\gamma_i}$

$P_1' = \frac{17.535 - 10}{2(0.016)} = 235.48$

$P_2' = \frac{17.535 - 8}{2(0.018)} = 264.86$

$P_3 = \frac{17.535 - 12}{2(0.018)} = 153.75$

$\Sigma P_i = 654.09$

$\Delta P = 654 - 654.09$

$= -0.09$

$\Delta \lambda = \frac{-0.09}{86.8} = -0.001$

$\lambda_2 = 17.535 - 0.001 = 17.534$

$P_1 = 235.43$

$P_2 = 264.833$

$P_3 = 153.722$

a) cost equation : $P_1 = 400$, $P_2 = 460$, $P_3 = 300$

$C_1 = 10(400) + 0.016(400)^2 = 6560$

$C_2 = 8(460) + 0.018(460)^2 = 7488.8$

$C_3 = 12(300) + 0.018(300)^2 = 5220$

Total cost = 19268 Rs/hr

b) cost $P_1 = 235.48$ $P_2 = 264.833$, $P_3 = 153.722$

$C_1 = 10(235.48) + 0.016(835.48)^2 = 3242.013$

$C_2 = 8(264.86) + 0.018(264.86)^2 = 3381.59$

$C_3 = 12(153.75) + 0.018(153.75)^2 = 2270.50$

Total cost = 8894.106

c) $P_D = 300$

at $\lambda = 13.45686 \Rightarrow$

$P_1 = 108.0268$

$P_2 = 151.579$

$P_3 = 40.468$

$\Sigma P_i = 300.074$

$\Delta P = 300 - 300.074$

$\Delta P = -0.074$

$C_1 = 10(108.0268) + 0.016(108.0268)^2$

$C_2 = 8(151.579) + 0.018(151.579)^2$

$C_3 = 12(40.468) + 0.018(40.468)^2$

$C_T = (1266.32) + (1626.2) + (515.89)$

$C_T = 3408.22$