



Project 3

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1 Hydro-thermal scheduling

Find the optimal operating schedule for a set of three power generating units (thermal power plants) and three hydro power plants. The operating costs for the thermal power plants depending on the generated power are given as follows.

$$B_1(P_1) = 0.005P_1^2 + 11P_1 + 200 \quad (1)$$

$$B_2(P_2) = 0.009P_2^2 + 10P_2 + 180 \quad (2)$$

$$B_3(P_3) = 0.007P_3^2 + 10P_3 + 230 \quad (3)$$

For the generating units the following minimum and maximum power constraints have to be fulfilled.

$$50MW \leq P_1 \leq 200MW \quad (4)$$

$$37MW \leq P_2 \leq 150MW \quad (5)$$

$$45MW \leq P_3 \leq 180MW \quad (6)$$

The thermal power plants are supplying a load, where the normalized load schedule p_i is given in Tab. 1. The nominal load is $P_{load,0} = 530MW$. Solve the hydro-thermal scheduling problem for varying nominal load (minimum three different cases).

For the three hydropower plants the following flow rate-power characteristic holds.

$$q = 320 \cdot 10^3 + 6 \cdot 10^3 P_H + e^{0.035 P_H} \quad (7)$$

The power generated by the hydropower plant has to fulfill the following constraint.



Table 1: Load schedule

i	1	2	3	4	5	6	7	8	9	10	11
p_i	0.5	0.53	0.55	0.53	0.5	0.54	0.7	0.9	0.95	1.1	1.2
i	12	13	14	15	16	17	18	19	20	21	
p_i	1.4	1.7	1.65	1.5	1.3	1.0	0.9	0.8	0.5	0.54	

$$43MW \leq P_H \leq 280MW \quad (8)$$

Hydropower plant 1 is supplied from a reservoir V_1 and supplies water to a reservoir V_2 , which supplies hydropower plant 2. The water outflow of hydropower plant 2 supplies reservoir V_3 , which supplies hydropower plant 3. The water volume in each reservoir should stay in its limits.

$$7 \cdot 10^6 \leq V_i \leq 8 \cdot 10^6, \quad (9)$$

The initial volume for each reservoir is $7.3 \cdot 10^6$. The flow to the first reservoir is $1.5 \cdot 10^6$. Write a small report (max. 10 pages) containing the results, their discussion and the commented code.