A Production Planning Problem

A rice producing firm is planning the production for the next 4 months. A warehouse is available to stock rice each month. The maximum storage capacity of the warehouse is 100 tons of rice. Each ton of rice in stock at the end of any month costs $5. On month i, it is possible to produce at most p_i tons of rice at cost c_i per ton. On month i, an extra production of q_i tons of rice is possible at extra cost: Each ton of rice produced in excess of p_i in month i has an additional cost of e_i. The firm has contracted to provide d_i tons of rice on each month i. The warehouse is empty at the beginning of the first month, and must be empty at the end of the last month. The regular (non-extra) production in each month must be at last 10% of the total production of the first three months (balanced production). Table 1 provides the production data for the 4 months.

Table 1: Production data

Month (i)	Production Cost (c_i)	Demand (d_i)	Max production (p_i)	Max extra production (q_i)	Extra production Cost (e_i)
1	440	120	140	50	260
2	440	160	150	75	260
3	440	300	140	70	260
4	440	200	160	80	260

Your task is to

(i)   provide mathematical formulation for the production/stock policy problem with the goal of minimizing the total cost,

(ii)   code the problem using Python and Gurobi and include the code in your answer, and

(iii)   solve the problem that you have coded and report (a) the optimal monthly production amounts and (b) the total cost.