Linear Programming Optimization in Python

Problem 1

A company can produce 4 types of products H1, H2, H3, and H4 using 2 types of raw materials N1, and N2. The maximum amount of raw materials that the company can mobilize is 600kg and 800kg, respectively. The consumption rate of each type of raw material for each type of product and the profit earned for each unit of product are given in the table below:

Consumption / Raw material \ Product	H_1	H_2	H_3	H_4
N_1: 600kg	0.5	0.2	0.3	0.6
N_2: 800kg	0.1	0.4	0.2	0.5
Profit (thousand USD)	0.8	0.3	0.38	0.4

a. Find the optimal production plan for the company to achieve the maximum profit.
b. Additional constraints that the solution must satisfy:
    − The total number of products H1 and H2 is not less than 1000.
    − The profit for one unit of product H3 is 0.5.
    − With the requirement in a) find the optimal production plan for the company.

Problem 2

Considering a 1-year period, Fund A has $USD 500 million and plans to invest in 4 types of investments I1, I2, I3, and I4 to diversify and reduce the level of risk. Each type of investment corresponds to an interest rate (%) and the maximum amount of investment for each type is as follows:

Investment Type	Interest Rate (%)	Maximum Investment ($USD million)
I_1	7	100
I_2	8	100
I_3	10	150
I_4	11	150

Fund A also has the following limitations: the total investment amount for I2 and I3 must be at least 50% of the available fund, and the investment amount for I1 must be at least 10% of the available fund.

You need to formulate an optimization problem to determine the allocation of investment capital for each type of investment to maximize the total interest earned over the year.

Problem 3

A real estate company plans to build 50 houses in a new residential area. The company plans to build 4 types of houses: single-story, 2-story, 3-story, and villa. According to the company, each type of house must build at least 5 units to be profitable. The completion time for the project is 4 years, otherwise, there will be unpredictable market fluctuations and high bank interest rates. The construction time for building 1 house (in days) and the profit earned per house (in USD) for each type are shown in the table:

House Type / Task	Single-Story	2-Story	3-Story	Villa
Construction	5	10	15	25
Decoration	4	15	20	18
Profit	1000	1500	2500	3000

You need to formulate an optimization model for this problem.

Problem 4

A mechanical company has 32 male workers and 20 female workers. The company has two types of machines: cutting and milling. The average productivity of each worker when working (operating) at each type of machine is given in the table below. A plan is needed to assign workers to operate the machines so that the average number of products produced is maximized, with the condition that cutting and milling need to be done within the day.

Worker Productivity / Machine	Male	Female
Cut	30 parts/hr	28 parts/hr
Mill	25 parts/hr	20 parts/hr

Problem 5

A wooden furniture company produces 4 types of tables: A, B, C, and D. The company has 2 workshops: a carpentry workshop specialized in making tables and a decoration workshop (polishing, painting, applying mica, carving). The number of working hours that can be mobilized for the two workshops respectively is 1000 and 2500. The amount of precious wood that can be purchased is 350m3. The wood and labor consumption rate to produce each type of table and each type of work with a profit of 1 table per type is given in the table below:

Task \ Table	A	B	C	D
Carpentry	4 hours 0.08 m^3	9 hours 0.12 m^3	7 hours 0.3 m^3	12 hours 0.21 m^3
Decoration	1 hour	1 hour	3 hour	40 hours
Profit	250,000	350,000	380,000	850,000

Formulate the problem to find the production plan for the company to achieve the highest profit.

Problem 6

To prepare goods for Christmas, a transport team must transport goods from 4 factories to 5 stores. The number of goods at the factories and the number of goods needed at the stores, and the distance between the factories and the stores (km) are given in the table below. The team wants to have a transportation plan so that the total weight*distance is minimized.

Store / Factory	C_1 10	C_2 10	C_3 10	C_4 20	C_5 20
A:5	5	1	4	6	7
B:15	3	4	2	7	8
C:20	4	3	1	7	9
D:30	6	5	4	9	11

a. Solve the optimization problem.
b. Solve the problem when the requirement for stores C3 and C5 are both 15 tons.

Problem 7

A production workshop has 2 female workers and 3 male workers. The workshop has 1 type I milling machine, 2 type II milling machines, and 3 type III milling machines. Each worker produces at a certain rate (parts/day) on a machine, as shown in the table below:

Machine / Worker	I 1	II 2	III 3
Female: 2	10	8	7
Male: 3	8	9	11

a. Develop a plan to allocate workers to the machines to maximize the total number of parts produced per day.
b. Solve the optimization problem.

Problem 8

Company A need to plant 30 hectares of IR8 rice, 20 hectares of CBC rice, and 40 hectares of IR132 rice. The rice field include types I, II, and III with the corresponding area of 25, 25, and 40 hectares, respectively. The yield of each type of rice field per hectare (in tons/ha) is given in the table below:

Field Rice type	I 25	II 25	III 40
IR8: 30	4	8	6
CBC: 20	6	9	7
IR132: 40	5	4	6

We want to create a distribution plan for planting these types of rice to maximize the total harvest.

a. Formulate and solve the optimization problem.
b. Formulate and solve the problem in the case where IR8 rice cannot be grown on the type I field.