1 Problem 1

A company produces two products A, B, which are sold at 30 and 10 Euro. The production of each unit of A requires 2 units of raw material M and 6 units of suproduct P. Each unit of B requires 2 units of M and 3 of P. 4000 units of M and 10000 of P are available.

10% of the packages of product A and 20% of those of product B contain a free bonus item. The number of such items added to the packages must be non smaller than 400. Fractional solutions are accepted.

Give a mathematical programming formulation for the problem of maximizing the revenue.

2 Problem 2

A computer service shop has to repair 16 printers, 7 personal computers, and 27 scanners. The owner decides to hire two technicias A, B, Technician A can repair, in a work day, 3 printers, 1 personal computer, and 3 scanners, while technician B can repair 2 printers, 1 personal computer, and 5 scanners. The hiring cost, per day, is of 75 Euro for technician A and 60 for technician B.

Give a linear programming formulation for the problem of minimizing the hiring costs.

3 Problem 3

A companing is planning the launch of a new product. A market analysis is on the way. To be statistically meaningful, it is estimated that the sample must be composed as follows

	married women	non married women	married men	non marrier men
number	≥ 150	≥ 110	≥ 120	≥ 100

The sample is contacted by telephone, either in the morning (at a cost of 1 Euro for each phone call) or in the evening (at the cost of 1.6 Euro per phone call).

The estimated amount of people, of each category, that can be reached either in the morning of in the evening is

	married women	non married women	married men	non marrier men	nobody
morning	30%	10%	10%	10%	40%
evening	30%	20%	30%	15%	5%

Give a mathematical programming formulation for the problem of minimizing the total phone call, so as to contact a meaningful sample of people.

4 Problem 4

A company produces two models of vehicles A, B, which yield a profit, per unit, of 6000 and 13000 Euro. The production of a vehicle of type A involves 40 hours of work, while that of a

vehicle of type B involves 60 hours. We are to plan the production for 3 months, using no more than 40000 hours of work. The demand, per month, is

month	1	2	3
A	450	500	600
B	200	150	180

A box of a size of 4000 m^2 cam ne used to store the cars which are not yet sold. Each vehicle of type A uses 7 m^2, while each vehicle of type B used 10 m^2.

Give an integer linear programming formulation for the problem of planning the production so as to maximize the profit.

5 Problem 5

A depuration plan for the waters of the Como Lake is to be scheduled. At least 50 tons of pollution agent 1 and 50 of pollution agent 2 must be removed. Four sites, A, B, C, D, are identified as candidate locations where to build the depuration plants. The costs for building, depuration of a ton of water, and depuration power per ton are given in the following table

location	building cost	depuration cost	depuration power, agent 1	depuration power, agent 2
1	100000	20	0.40%	0.35%
2	70000	30	0.25%	0.25%
3	80000	30	0.30%	0.20%
4	40000	35	0.15%	0.22%

Due to geographical reasons, of a plant is built both on site 1 and 3, no plant must be build on site 2.

Give a mathematical programming formulation for the problem of minimizing the total installation and depuration costs.

6 Problem 6

A refinery mixes 4 types of raw oil in different proportions, to produce 3 types of gasoline: A, B, C. The available amount of each component of raw oil per type of gasoline and its cost is

component	availability (barrels)	cost (Euro per barrel)
1	5000	9
2	2400	7
3	4000	12
4	1500	6

The requirements of each type of gasoline are

type	amounts of types of raw oil	price (Euro per barrel)
A	$\geq 20\%$ of 2	12
A	$\leq 30\%$ of 3	
B	$\geq 40\%$ of 4	18
C	$\geq 50\%$ of 2	10

Give a mathematical programming formulation for the problem of maximizing the total revenue.

6.1 Problem 7

A company is to plan the set of projects to start. 6 projects are available, each of which having a cost of 0.5 billions of Euro, 2 billions of Euro, 1 billion of Euro, 1.5 billions of euro, 0.8 billions of Euro, and 3 billions of euro. The available budget is of 5 billions of Euro. Each projects requires the following out of people

Projects	1	2	3	4	5	6
Technicians	5	15	10	8	10	12
Managers	1	3	2	1	2	5
Accounters	1	2	1	1	1	2

At most, the company can use 30 technicians, 7 mangers, and 3 accounters. Projects 1, 4, and 5 are related to the Environment Area, projects 2, 3, and 5 are related to the Computer Science Area, and projects 4 and 6 are related to the Financial Area. At most two project, from the same area, can be chosen.

Fo each project, the company estimates a profit of 0.2, 0.5, 0.6, 0.8, 0.3, and 1 billions of Euro.

Given a mathematical program for the problem of maximizing the average revenue.