EXAMINATION QUESTION PAPER - Written examination

GRA 62272
Business Optimisation

Department of Accounting, Auditing and Business Analytics

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Answer sheets:	Lines
Examination support materials permitted:	All printed and handwritten support materials BI-approved exam calculator Simple calculator Bilingual dictionary

Problem 1 (20 %)

A manufacturing company produces three products A, B, and C, which are processed on three machines.

For machine 1, there are 400 hours available. For machine 2, there are 300 hours available. For machine 3, there are 500 hours available.

For each product and each machine, the following table shows how many hours are required to produce one unit and the profit per unit of the products:

	Machine 1	Machine 2	Machine 3	Profit
A	4	3	4	65
B	7	3	5	80
C	2	6	5	70

a) Use the given data and formulate a model to maximize total profit, subject to the capacity constraints. (You can choose either a LINGO model or a mathematical model.)

b) Extend the model to take into account the following additional information:
Because of market constraints, the company needs to choose two out of the three products.

Problem 2 (35%)

Below is a LINGO model for facility location.

```
MODEL:
SETS:
    Node: LOCATE, population;
    Matrix (Node, Node): ASSIGN, distance;
ENDSETS

MIN = TOTAL_DISTANCE;
TOTAL_DISTANCE =
    @SUM(Matrix(I,J): population(I)*distance(I,J)*ASSIGN(I,J));

@SUM(Node(J): LOCATE(J)) = P;
@FOR(Node(I): @SUM(Node(J): ASSIGN(I,J)) = 1);
@FOR(Node(I): @FOR(Node(J): ASSIGN(I,J) - LOCATE(J) <= 0 ));
@FOR(Node(I): @BIN(LOCATE(I)));
@FOR(Node(I): @FOR(Node(J): @BIN(ASSIGN(I,J))));

DATA:
    P = 20;
    Node = C1..C100;
    distance = @file('C:\Users\LINGO data\distance_matrix.txt');
    population = @file('C:\Users\LINGO data\population.txt');
ENDDATA
```

Consultants are trying to use this model to support the decisions on where to locate fire stations in a region.

a) In such a setting, give a possible explanation for each constraint and the objective function of the above model.

b) Suggest how the model can be modified to take into account an upper limit on the number of nodes that can be covered by each fire station.

c) Suggest how the model can be modified to take into account an upper limit on the area (in terms of population) that can be covered by each fire station.

d) Suggest how the model can be modified to minimize the maximum distance from a fire station to the population.

Problem 3 (35%)

The following shows a formulation for a production planning problem known as the Capacitated Lot Sizing Problem for one product:

Min z = $\sum_t h_t \cdot I_t + \sum_t v_t \cdot X_t + \sum_t s_t \cdot Y_t$ (1)

Subject to

$I_t = I_{t-1} + X_t - d_t$ for all t (2)

$X_t \leq K_t \cdot Y_t$ for all t (3)

$Y_t \in \{0,1\}$ for all t (4)

$X_t \geq 0$ for all t (5)

$I_t \geq 0$ for all t (6)

h_t is inventory holding cost per unit on inventory per period.

v_t is variable production cost per unit produced.

s_t is setup cost per setup.

d_t is demand per period.

K_t is production capacity per period.

a) Build a LINGO model that represents the above problem.

b) Extend the LINGO model to include multiple products, which use the same production capacity.

c) For the multi-product model, extend the LINGO model to include a setup time that consumes production capacity each time a product is produced.

d) The model in c) is a starting point for a company that wants to optimise its *campaign planning*. A campaign means that the company reduces the price of a product in a given period. The price reduction will then lead to increased demand for the given product in the given period.
Imagine that a campaign implies a price reduction of 15%, and that the corresponding demand then increases by 40%. For simplicity, assume that demand for other periods and other products is not affected.
Assume that the company has decided to run a total of 5 campaigns during the planning horizon (but that it has not been decided for which products and which periods the campaigns will be run).
Extend the above model so that it will simultaneously suggest a production plan and the products and periods for which the campaigns should be run, so that total profit is maximized.

Problem 4 (10%)

Give an example of a successful "real-life" optimization project and summarize briefly:

- The motivation behind the project.
- The proposed solution.
- How it is being used in the organization.
- The impact of the project.