UNIVERSITY OF WESTMINSTER

SCHOOL OF COMPUTER SCIENCE & ENGINEERING

Module Title: **Business Analytics**

Module Code: **5BUIS002W / 5BUIS006C**

Exam Period: **May 2020**

Time allowed: **xxxxx**

INSTRUCTIONS FOR CANDIDATES

YOU ARE ADVISED (BUT NOT REQUIRED) TO SPEND THE FIRST TEN MINUTES OF THE EXAMINATION READING THE QUESTIONS AND PLANNING HOW YOU WILL ANSWER THOSE YOU HAVE SELECTED.

CALCULATORS MAY BE USED PROVIDED THEY ARE SILENT, CORDLESS, NOT PRE-PROGRAMMED BY THE CANDIDATE AND CANNOT RECEIVE OR TRANSMIT DATA REMOTELY.

ANSWER ALL FOUR QUESTIONS. ALL QUESTIONS CARRY EQUAL MARKS.

THIS PAPER MUST NOT BE TAKEN OUT OF THE EXAMINATION ROOM

DO NOT TURN OVER THIS PAGE UNTIL THE INVIGILATOR INSTRUCTS YOU TO DO SO

Question 1 [25 Marks]

The Bag for Healthy Back Company produces two different models—the Explorer Bag and the City Bag. Both are made from the same rip-resistant nylon fabric.

The company has a long-term contract with a supplier of the nylon fabric and receives a 1000 square-meter shipment of the material each week. Each Explorer Bag requires 2 square meter while each City Bag requires 1 square meter.

The sales forecasts indicate that at most 500 Explorer Bags and 600 City Bags can be sold per week.

Each Explorer Bag requires 45 minutes of labour to produce and generates a unit profit of £32. Each City Bag requires 40 minutes of labour and generates a unit profit of £24. The Bag for Healthy Back Company has 10 labourers that each provides 40 hours of labour per week.

a. Formulate a Linear Programming (LP) model that can be used to determine how many Explorer and City Bags the company should produce per week in order to maximise profit. Precisely define each variable used and explain the purpose of each constraint. **[14 Marks]**
b. Write the LP problem in a standard form. **[6 Marks]**
c. Suppose the managers specify that at least 10% of the total production must be Explorer Bags. How should the problem be formulated? **[5 Marks]**

Question 2 [25 Marks]

A new chain of fast-food restaurants is planning to expand to locations in two different cities: city 1 and city 2.

The company has £2 million available for the expansion. Each city 1 restaurant requires a £100,000 investment, and each city 2 restaurant a £500,000 investment. It is projected that, after expenses, the net weekly profit generated by city 1 restaurants will average £1200. Whereas, projections indicate that net weekly profits generated by the city 2 restaurants will average £2000.

The company wishes to open at least two city 2 restaurants.

The company currently employs 18 managers to run the restaurants. Each city 1 restaurant will require 3 managers, whereas the company feels it can get by with just one manager for each city 2 restaurant.

The company would like to determine how many restaurants it should open in city 1 and city 2 locations in order to maximise its total net weekly profit.

The complete linear programming model for this problem can be summarized as follows:

Max $1200X_1 + 2000X_2$

s.t.

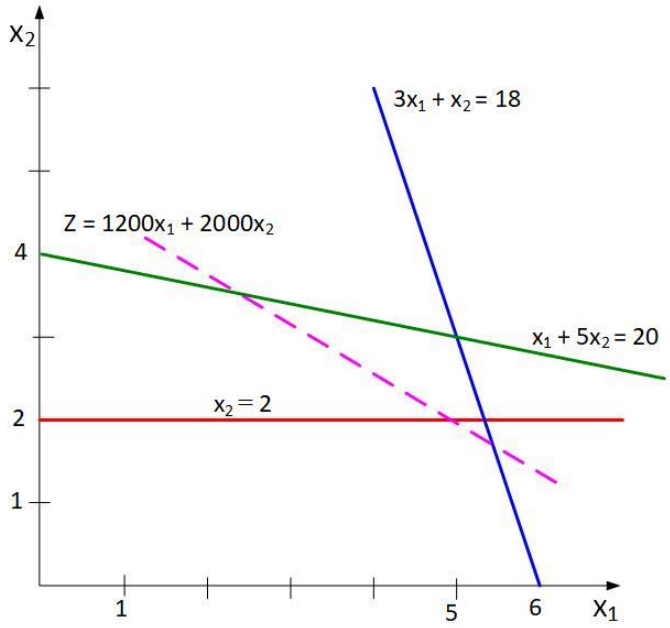
$X_1 + 5X_2 \leq 20$

$X_2 \geq 2$

$3X_1 + X_2 \leq 18$

$X_1, X_2 \geq 0$

The corresponding **Graph** is shown below:



a. Using the graph provided, find the optimal solution:
   i. Determine the optimal solution. How many city 1 and city 2 restaurants should the company open? **[4 Marks]**
   ii. What is the projected total net weekly profit? **[2 Marks]**

b. Identify the binding constraints. **[4 Marks]**

c. Is there any slack or surplus variable? If so, what is its value and how do you interpret it? If not, why? **[7 Marks]**

d. If the objective function is changed to **Max $3000x_1 + 1000x_2$**, will the optimal solution change?
   i. Determine the new optimal solution. **[6 Marks]**
   ii. Determine the value of the objective function. **[2 Marks]**

Question 3 [25 Marks]

Consider the following linear programme:

Max 10X + 6Y

s.t.

$5X + 7Y \leq 70$ (Constraint 1)

$2X + 5Y \leq 35$ (Constraint 2)

$X \geq 5$ (Constraint 3)

$Y \geq 2$ (Constraint 4)

$X, Y \geq 0$

Solve the linear programming model by using Excel Solver. Append a screenshot of the appropriate table from the Excel Solver report(s) to support each answer to the following questions:

a. What is the optimal solution? **[4 Marks]**
b. Identify the range of feasibility for the right-hand side values. **[10 Marks]**
c. Suppose that the right-hand side value of constraint 1 increases to 73 and the right-hand side value of constraint 4 decreases to 1. Would the dual prices change? Use the 100 per cent rule and discuss. **[11 Marks]**

Question 4 [25 Marks]

An inventor develops a new product. Having made the product he has three choices of what to do with it:

- Manufacture the product himself
- Allow someone else to make it and be paid on a royalty basis
- Sell the rights for a lump sum.

The profit which can be expected depends on the level of sales and is shown in the following table (in £000s):

	High sales	Medium sales	Low sales
Manufacture	80	40	-20
Royalties	50	30	10
Sell	20	20	20

a. If the inventor knows nothing about the probabilities of the three states of nature (three levels of sales), what is the recommended decision using the optimistic approach and the conservative approach? **[14 Marks]**
b. The probabilities associated with the level of sales are 0.2, 0.5 and 0.3 for high, medium and low sales respectively. Use the expected value approach to determine an optimal decision. **[11 Marks]**

END