Assignment #3

Transportation /Assignment, Binary/Integer Programming (BIP) and Goal Programming

85 points

ADM2302 students are reminded that submitted assignments must be typed (i.e. **can NOT be hand written**), neat, readable, and well-organized. Assignment marks will be adjusted for sloppiness, poor grammar and spelling.

The assignment is to be submitted electronically as a **single PDF file** via Brightspace by Friday November 23rd prior to 23:59.

Front page of the document has to include title of the assignment, course code and section, student name and student number. Second page is the individual statement of integrity that must be signed.

Note: Each student must provide an individual original submission of completed Assignment #3.

Questions related to the assignment should be sent to the Teaching Assistant.

Problem 1: Transportation/Assignment **(19 points)**

Ottawa Art Gallery (OAG) has four valuable paintings that are up for sale to raise funds for the future building expansion. Four customers are bidding for the paintings. Customer 1 is willing to buy two paintings, but each other customer is willing to purchase at most one painting. The prices (in thousands) that each customer is willing to pay are given in the table below.

	Bid for ($)			
Customers	**Painting 1**	**Painting 2**	**Painting 3**	**Painting 4**
Customer 1	8	11	-	-
Customer 2	9	13	12	7
Customer 3	9	-	11	-
Customer 4	-	-	12	9

Note: " - " indicates that customer has not placed a bid for a painting

OAG is interested in maximizing total revenue received from the sale of the paintings.

1. Formulate this problem as an assignment problem.
2. Use Excel Solver to solve the resulting LP (Include both formulation and answer report)
3. Describe clearly the optimal solution to this problem using a managerial statement to make a recommendation to the leadership of the OAG.

Problem 2: Integer/Binary Programming **(22 points)**

Company ABC is considering opening warehouses in four cities in Canada: Ottawa, Toronto, Calgary and Winnipeg. Each warehouse can ship 100 units per day. The daily fixed cost of keeping each warehouse open is $400 for Ottawa, $500 for Toronto, $300 for Calgary and $350 for Winnipeg. Region 1 of the country requires 80 units per day, region 2 requires 70 units per day and region 3 requires 40 per day. The costs (including production and shipping costs) of sending one unit from plant to a region are shown below in the table. The company wants to meet daily demands at a minimum cost subject to the preceding information and following restrictions:

	To ($)		
From	Region 1	Region 2	Region 3
Ottawa	20	40	50
Toronto	48	15	26
Calgary	26	35	18
Winnipeg	24	50	35

a) If Ottawa warehouse is opened, then Calgary warehouse must be opened.
b) At most two warehouses can be opened
c) Either Winnipeg or Calgary warehouse must be opened.

The company wants to minimize the daily cost of meeting demand.

1. Formulate algebraically a Binary/Integer Programming (BIP) model for this problem.
2. Use Excel Solver to solve the resulting BIP. (Include both formulation and answer report)
3. Describe clearly the optimal solution to this problem using a managerial statement to make a recommendation to the leadership of company ABC.

Problem 3: Integer/Binary Programming **(22 points)**

Suppose that Freedom Mobile needs to build a set of cell towers to provide signal for residents of the Northern and Eastern Ontario. A number of potential locations for building the towers have been determined. The choice of these locations is based on several factors, including how well the tower blends in to the surrounding environment and the height of the terrain. The towers have a fixed range, and due to budget constraints only a limited number of them can be built. Given these restrictions, the company wishes to provide coverage to as large a fraction of the population as possible. To simplify the problem, the company has split the area it wishes into a set of regions, each of which has a known population. The goal is then to choose at which of the potential sites the company should build cell towers to provide coverage to as many people as possible. Assume that a total budget of 2 million dollars is available.

Region	Population (thousands)
1	523
2	690
3	420
4	1010
5	1200
6	850
7	400
8	1008
9	950

Tower	Cost (hundred thousand)	Regions Covered by Each Tower
1	4.2	1,2,6
2	6.1	1,8,9
3	5.2	3,4,5,6
4	5.5	3,6,7
5	4.8	1,3,7,8,9
6	9.2	4,5,9

1. Formulate algebraically a Binary/Integer Programming (BIP) model for this problem.
2. Use Excel Solver to solve the resulting BIP. (Include both formulation and answer report)
3. Describe clearly the optimal solution to this problem using a managerial statement to make a recommendation to the leadership of Freedom Mobile.

Problem 4: Goal Programming **(22 points)**

A Company produces two products. Relevant information for each product is shown in the Table below. The company has a goal of $48 in profits and incurs $1 penalty for each dollar it falls short of this goal. A total of 32 hours of labor are available. A $2 penalty is incurred for each hour of overtime (labor over 32 hours) used, and $1 penalty is incurred for each hour of available labor that is unused. Marketing considerations require at least 5 units of product 1 and 10 units of product 2 be produced. For each unit of either product by which production falls short of demand, a penalty of $5 is assessed.

	Product 1	Product 2
Labor Required	4 hours	2 hours
Contribution to profit	$4	$2

1. Formulate a weighted goal programming that can be used to minimize the penalty incurred by the company. Do NOT solve, just formulate.

2. Suppose that company sets (in order of importance) the following goals:

    a. Goal 1: Avoid underutilization of labor
    b. Goal 2: Meet demand for product 1
    c. Goal 3: Meet demand for product 2
    d. Goal 4: Do not use overtime

    Formulate and solve the preemptive goal programming model for this situation using Excel solver. Describe clearly the optimal solution to this problem using a managerial statement.