DEPARTMENT OF STATISTICS AND DEMOGRAPHY

SUPPLEMENTARY EXAMINATION, 2018/19

COURSE TITLE:	OPERATIONS RESEARCH I
COURSE CODE:	STA 307 / ST 307
TIME ALLOWED:	THREE (2) HOURS
INSTRUCTION:	ANSWER QUESTION ONE AND CHOOSE THREE QUESTIONS FROM THE REMAINING QUESTIONS. EACH QUESTION IS WORTH 25 MARKS.
SPECIAL REQUIREMENTS:	SCIENTIFIC CALCULATORS AND GRAPH PAPER

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Question 1

a. A confectionery company produces two sizes of its popular dark chocolate bars: a 3.5 grams size and a 6-grams size. The 3.5-grams bars cost E0.22 to make and sells for E0.35, whereas the 6-grams bars costs E0.40 to make and sell for E0.55. The company has 15,000 grams of chocolate in stock, and the manager wants to use it all on the next production run. In addition, the manager has specified that a minimum of 1,000 of the 3.5-gram bars and 1,200 of the 6-gram bars should be made.

i. Formulate the linear programming model that will enable the manager to determine how many of each kind of bar to produce in order to satisfy the conditions specified with maximum profit.

ii. Determine the optimal solution and value of the objective function using the graphical method. **(15 marks)**

b. A company has three plants producing a certain product that is to be shipped to four distribution centres. Plant 1, 2 and 3 produce 12, 17 and 11 shipments per month, respectively. Each distribution centre needs to receive 10 shipments per month. The distance from each plant to the respective distribution centres is given below in kilometres:

	Distribution Centre			
Plant	1	2	3	4
1	800	1,300	400	700
2	1,100	1,400	600	1,000
3	600	1,200	800	900

The freight cost for each shipment is E100 plus 50 cents per kilometre.
The company wishes to determine how much should be shipped from each plant to each of the distribution centres to minimise total shipping costs.
Use the North West Corner Rule method to obtain an initial feasible solution **(10 marks).**

Question 2

Consider the following problem:
Minimize $Z = 2x_1 + 15x_2 + 5x_3 + 6x_4$

Subject to
$$x_1 + 6x_2 + 3x_3 + x_4 \geq 2$$
$$-2x_1 + 5x_2 - x_3 + 3x_4 \leq -3$$
$$x_1, x_2, x_3, x_4, \geq 0.$$

(i) Give the dual linear problem. **(5 marks)**

(ii) Solve the dual problem by simplex method. **(15 marks)**

(iii) Utilise the information of the dual linear problem and the duality theorem to give a solution for the primal problem. **(5 marks)**

Question 3

Consider the transportation problem of the Calakabusha Laundry Machine Maker:

From \ To	Store 1	Store 2	Store 3	Supply
Warehouse A	12	20	15	50
Warehouse B	9	11	4	15
Warehouse C	20	14	8	55
Demand	25	50	45	120

a. Develop an initial feasible solution using the Vogel's Approximation method. Compute the total cost for this solution.
b. Evaluate the solution using the stepping-stone method. Is the solution optimal? Explain.
c. Repeat the evaluation using MODI and compare your cell evaluation to those obtained using the stepping-stone method.
d. What is the total cost for your optimal solution? **(25 marks)**

Question 4

Re-solve Question 3, assuming that the supply of laundry machine from Warehouse B increased from 15 to 40. **(25 marks)**

Question 5

The foreman of a machine shop wants to determine a minimum-cost matching for operators and machines. The foreman has determined the hourly cost for each of the four operators for the four machines, as shown in the following cost table.

	Machine			
Operator	**A**	**B**	**C**	**D**
1	70	80	75	64
2	55	52	58	54
3	58	56	64	68
4	62	60	67	70

a. Determine the minimum-cost assignment for this problem.
b. What is the total cost for the optimal assignment?
c. Is there an alternative optimal assignment? If so, what is it? Calculate the total cost for the alternative optimal solution. **(25 marks)**

Question 6

Consider the following LP model:

Min $Z = 7x_1 + 5x_2 + x_3$

Subject to

$x_1 - 3x_2 \leq 3$

$5x_1 - 3x_3 \geq 7$

$2x_2 - 5x_3 \geq 4$

$x_1, x_2, x_3 \geq 0$

The Optimal Tableau is as follows:

	Cj	7	5	1	0	0	M	0	M	
BASIS		X1	X2	X3	S1	S2	A2	S3	A3	Bj
S1	0	0	0	-6.9	1	0.2	-0.2	-1.5	1.5	7.6
X1	7	1	0	-0.6	0	-0.2	0.2	0	0	1.4
X2	5	0	1	-2.5	0	0	0	-0.5	0.5	2.0
	Zj	7	5	-16.7	0	-1.4	1.4	-2.5	2.5	19.8
	Cj-Zj	0	0	17.7	0	1.4	M-1.4	2.5	M-2.5	

(a) Perform sensitivity analysis for each of the objective function coefficients.
(b) Perform sensitivity analysis for each of the RHS values. **(25 marks)**

END OF EXAM!!