K. J. Somaiya Institute of Management Studies and Research

Program: PGDM-RM Trimester III 2017-19

Subject: Operations Research
(End Term Examination)

Maximum marks: 50 Date: 4th April, 2018
Duration: 3 hours

Notes:

1. **You have to attempt 4 questions in all. Question 1 is compulsory and carries 20 marks. Do any 3 questions out of remaining 6.**
2. **Make suitable assumptions if required and state them.**
3. **Write all relevant answers in your answer sheet, with sufficient detail to enable a fast evaluation of your answers.**
4. **Use Excel as required and keep saving the file on the desktop every ten minutes or so.**
5. **Make only 1 Excel file with different worksheets pertaining to each question.**
6. **Name the file with your division and roll number only (no names). Finally, before handling over the answer sheet, transfer the file to an exam folder, as per on-the-spot instructions given to you.**

1. Andrew–Carter, Inc. (A–C), is a major Canadian producer and distributor of outdoor lighting fixtures. Its fixture is distributed throughout North America and has been in high demand for several years. The company operates three plants that manufacture the fixture and distribute it to five distribution centers (warehouses). During the present recession, A–C has seen a major drop in demand for its fixture as the housing market has declined. Based on the forecast of interest rates, the head of operations feels that demand for housing and thus for its product will remain depressed for the foreseeable future. A–C is considering closing one of its plants, as it is now operating with a forecasted excess capacity of 34,000 units per week. The forecasted weekly demands for the coming year are:

Warehouse 1	9,000 units
Warehouse 2	13,000 units
Warehouse 3	11,000 units
Warehouse 4	15,000 units
Warehouse 5	8,000 units

The plant capacities in units per week are:

Plant 1	34,000 units
Plant 2	25,000 units
Plant 3	31,000 units

If A–C shuts down any plants, its weekly costs will change, as fixed costs are lower for a non-operating plant. The following table shows fixed costs incurred when a particular plant is operating and shut down.

	Fixed Costs per Week (in $)	
Plant	**Operating**	**Not Operating**
Plant 1	14000	6000
Plant 2	12000	5000
Plant 3	15000	7500

The following table shows distribution costs (in $) from each plant to each warehouse (distribution center).

	To Distribution Center				
From Plant	Warehouse 1	Warehouse 2	Warehouse 3	Warehouse 4	Warehouse 5
1	0.50	0.44	0.49	0.46	0.56
2	0.40	0.52	0.50	0.56	0.57
3	0.56	0.53	0.51	0.54	0.35

a. Evaluate the various configurations of operating and closed plants that will meet weekly demand. Determine which configuration minimizes total costs.

b. Discuss the implications of closing a plant.

2. **10 Marks**

a. Economic Electronics is a new specialty store that sells laptops, mobiles, video games and other related products. A new Chinese manufactured video game costs Economic Electronics $500 per unit. Economic Electronics annual holding cost rate is 20%. Ordering costs are estimated to be $50 per order.

   i. If the demand of the new video game is expected to be constant with a rate of 10 units per month, what is the recommended order for the video game?

   ii. What are the estimated annual inventory holding and ordering costs associated with this product?

iii. How many orders will be placed per year?

iv. With 200 working days per year, what is the cycle time for this product?

b. The Greene Daisy Company offers a spring tune up-service for power lawn mowers at a price of Rs. 24.95. Labor and supplies cost an average of Rs. 10 per tune-up, and overhead charged to the operation is Rs. 5,000 per month.

i. Write the expression for total cost.

ii. Write the expression for total revenue.

iii. Write an expression for total profit.

iv. What profit or loss would result if from 375 tune-ups are performed per month?

v. What is the monthly volume needed to break-even?

3. **10 Marks**

a. Solve the following LPP **using Excel Solver as well as using graph**.

$$\begin{aligned} \text{Max} \quad & 25x_1 + 40x_2 \\ \text{s.t.} \quad & 2x_1 + x_2 \leq 60 \\ & 4x_1 - x_2 \leq 20 \\ & x_1 \geq 80 \\ & x_1, x_2 \geq 0 \end{aligned}$$

b. A manager has prepared the following information on a transshipment problem. Locations 1 and 2 are sources, locations 3 and 4 are transshipment points (warehouses), and locations 5 and 6 are destinations.

Units Shipping Costs from Source to Transshipment Points

To / From	5	6
3	8	4
4	6	7

Units Shipping Costs from Transshipment Points to Destinations

To / From	3	4
1	9	11
2	10	12

The source supplies and destination demands are shown in the following tables.

Source	Supply
1	200
2	300

Destination	Demand
5	250
6	250

Draw a network diagram and formulate this as an LPP. **DO NOT SOLVE.**

4. Solve the following LPP **using Excel Solver and give the complete optimal solution**. Also determine binding and non binding constraints. Generate the sensitivity report and **answer any 4 parts:**

$$\text{Max} \quad x_1 + 1.25x_2$$

$$\text{s.t.} \quad 5x_1 + 7x_2 \leq 4480$$

$$3x_1 + x_2 \leq 2080$$

$$2x_1 + 2x_2 \leq 1600$$

$$x_1, x_2 \geq 0$$

a) Determine the range of optimality for objective function coefficients of x_1 and x_2.

b) If the objective function coefficient of x_1 is increased to 1.2 from 1, what will be the new optimal solution?

c) If the objective function coefficient of x_2 is decreased to 0.5 from 1.25, what will be the new optimal solution?

d) Suppose the objective function coefficient of x1 is increased to 3 and the objective function coefficient of x2 is decreased to 1. Find the new optimal solution.

e) Interpret the dual prices of 1st and 2nd constraints.

f) If the RHS of 1st constraint is decreased to 4400 and RHS of 3rd constraint is decreased to 1500, will the optimal solution change?

g) What is the range of feasibility of 3rd constraint? Interpret. **10 Marks**

5. **10 Marks**

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

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

Suppose that operator 1 could not be assigned to machine B because of technical problems. Determine the minimum-cost assignment for this problem. What is the total cost for the optimal assignment?

b. The manager of Home Office Supplies, Gigi Staples, has just received demand forecasts and capacity (supply) figures for next month. These are summarized along with unit transportation costs (in $) in the following transportation table:

To From	D1	D2	D3	D4	D5	**Supply**
O1	8	4	12	11	9	**220**
O2	7	6	10	5	6	**260**
O3	12	13	9	16	9	**200**
Demand	**140**	**180**	**150**	**140**	**195**	

Determine the minimum-cost shipping schedule. What is the total shipping cost?

6. **10 Marks**

A cereal manufacturer is investigating the possibility of introducing a new cereal. A 12-Ounce box would be composed of wheat, rice, and corn flakes. The cost per ounce and dietary requirements are shown in the table below:

	Wheat	**Rice**	**Corn**	**Requirements per 12-Ounce Box**
Protein (grams per ounce)	4	2	2	At least 27 grams
Carbohydrates (grams per ounce)	20	25	21	At least 240 grams
Calories per ounce	90	110	100	No more than 1,260 calories
Cost per ounce	Rs. 0.03	Rs. 0.05	Rs. 0.02	

Formulate and solve an LP model for this problem that will determine the optimal quantities of wheat, rice, and corn per box that will achieve the requirements at minimum cost.

7. **10 Marks**

a. A bakery keeps stock of a popular brand of cake. Previous experience shows the demand pattern for the item with associated probabilities, as given below:

Daily Demand	0	10	20	30	40	50
Probability	0.1	0.02	0.3	0.4	0.12	0.06

Use the following sequence of random numbers to simulate the demand for next 10 days.

Random numbers: 25, 39, 65, 76, 12, 05, 73, 89, 19, 49.

Estimate the daily average demand for the cakes on the basis of simulated data.

Also find out the stock situation if the owner of the bakery decides to make 20 cakes everyday.

b. The enrollment data (figures in thousands) for a state college for the past six years are shown:

Year	1	2	3	4	5	6
Enrollment	20.5	20.2	19.5	19.0	19.1	18.8

i. Graph the time series. Does a linear trend appear?

ii. Develop the equation for the linear trend component for this time series.

iii. Use the trend equation to estimate the number of enrollments in 7^{th} year.

iv. Comment on what is happening to the enrollment at this institution.

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