FACULTY OF MANAGEMENT STUDIES
UNIVERSITY OF DELHI
MBA FT - November, 2018
Paper 6102: Quantitative Methods for Management

Time: 3 hours

Max. Marks: 50

Answer any *FIVE* questions selecting at-least TWO questions from each group

Section A

1. (a) The manager of an inspection department has been asked to help reduce a backlog of safety devices that must be inspected. There are two types of safety devices: one for construction workers and one for window washers. The manager will be permitted to select any combination of items because new testing equipment will soon be available that will handle the remaining items. However, in short run, the manager has been asked to help generate revenue. The revenue for each construction device is $60 and the same for each window-washing device is $40. The manager has obtained data on the necessary inspection operations, which are as follows:

Operation	Time per unit (minutes)		Total time available (minutes)
	Construction	Window-washing	
Test #1	¾	1/3	75
Test #2	¼	½	50
Test #3	½	¼	40

   (i)   Formulate the above as a linear programming problem.
   (ii)   Determine the optimal values of the decision variablesand the revenue that will result.
   (iii) Which testing operations will have slack time? How much?
   (iv)   Is any constraint redundant? Which one? Why?

   (b) What do you understand by 100% rule? For what purposes this rule is utilized?

   $(8+2 = 10)$

2. (a) A small trucking company is determining the composition of its next trucking job. The load master has his choice of seven different types of cargo, which may be loaded in full or in part. The specifications of the cargo types are shown in the following table. The goal is to maximize the amount of freight in terms of dollars for the trip. The truck can hold up to 900 pounds of cargo in a 2500 cubic foot space.

Cargo type	Freight per pound	Volume per pound (cu.ft.)	Pounds available
A	$8.00	3.0	210
B	$6.00	2.7·	150
C	$3.50	6.3	90
D	$5.75	8.4	120
E	$9.50	5.5	130
F	$5.25	4.9	340
G	$8.60	3.1	250

Formulate the above problem as a linear programming problem. You are not required to find out solution to the above problem.

(b) A farm consists of 600 acres of land, of which 500 acres will be planted with corn, soybeans and wheat according to the following conditions:

(i) At least half of the planted acreage should be in corn.
(ii) No more than 200 acres should be soybeans.
(iii)The ratio of corn to wheat planted should be 2:1.

It costs $20 an acre to plant corn, $15 an acre to plant soybeans and $12 an acre to plant wheat. Formulate the above as a linear programming problem that will minimize planting cost while achieving the specified conditions.

$$(6+4 = 10)$$

3. An insurance company has three secretaries, A, B, and C that each is capable of processing four different types of insurance claims. The amount of time required by each secretary to process a particular type of a claim is summarized in the following table.

Processing Time in Hours

Claim Type

		1	2	3	4
	A	2	3	2	4
Secretary	B	4	5	3	1
	C	3	2	1	5

On a typical week, the insurance firm has 5 type 1 claims, 4 type 2 claims, 2 type 3 claims, and 3 type 4 claims. Each secretary works a maximum of 40 hours per week. The office manager wants to know how many of each type of an insurance claim should be processed by each secretary to minimize the total processing time.

Sensitivity Report

Adjustable Cells

Cell	Name	Final Value	Reduced Cost	Objective Coefficient	Allowable Increase	Allowable Decrease
C13	A1	5	0	2	1	1E+30
D13	A2	0	1	3	1E+30	1
E13	A3	0	1	2	1E+30	1
F13	A4	0	3	4	1E+30	3
C14	B1	0	2	4	1E+30	2
D14	B2	0	3	5	1E+30	3
E14	B3	0	2	3	1E+30	2
F14	B4	3	0	1	3	1E+30
C15	C1	0	1	3	1E+30	1
D15	C2	4	0	2	1	1E+30
E15	C3	2	0	1	1	1E+30
F15	C4	0	4	5	1E+30	4

Constraints

Cell	Name	Final Value	Shadow Price	Constraint R.H. Side	Allowable Increase	Allowable Decrease
G13	A constraint	10	0	40	1E+30	30
G14	B constraint	3	0	40	1E+30	37
G15	C constraint	10	0	40	1E+30	30
C16	Claim Type 1	5	2	5	15	5
D16	Claim Type 2	4	2	4	15	4
E16	Claim Type 3	2	1	2	30	2
F16	Claim Type 4	3	1	3	37	3

Use the Sensitivity Report to answer the following questions:

(i) What is the total minimal processing time in hours?

(ii) Suppose that secretary A can process a type 2 claim in two hours rather than three hours. How would this impact the current optimal solution?

(iii) Assume that secretary C can process a type 4 claim in 6 hours rather than 5 hours. How would this impact the current optimal solution?

(iv) Currently, secretary C is not processing any type 4 claims. Suppose that we force secretary four to process one type 4 claim. What impact would this have on the optimal solution?

(v) Suppose that the number of type 4 claims increases to 4? What impact would this have on the current optimal solution?

(10)

4. (a) Write the dual of the following primal problem.

Maximize $Z = 66X1 - 22X2$

Subject to

$$-X1 + X2 \leq -2$$
$$2X1 + 3X2 \leq 5$$
$$X1, X2 \geq 0$$

(b) Laurence County has six communities that need to be served by fire stations. The number of minutes it takes to travel between the communities is shown in the following table. The county would like to establish the minimum number of fire stations so that each community can get a response in five minutes or less. How many stations will be needed, and what communities will each station serve?

	A	B	C	D	E	F
A	-	4	6	3	5	8
B		-	4	10	6	5
C			-	9	3	5
D				-	6	3
E					-	10

Formulate the above problem as an integer linear programming problem. You are not required to find out the solution to the above problem.

(5+5 = 10)

Section B

5. (a) Research by a central bank has indicated that only 1% of credit card transactions are fraudulent. Suppose that 0.03% of fraudulent credit card transactions are associated with internet casinos, but that only 0.0007% of non-fraudulent credit card transactions are associated with internet casinos. If a given credit card transaction involves an internet casino, what is the probability it is fraudulent?

(b) The weight of individual passengers on a given flight can be characterized using the normal distribution with a mean of 160 pounds and a standard deviation of 20 pounds.

(i) Assume the flight carries 50 passengers and will be overweight if total passenger weight exceeds 8,200 pounds. If the airline doesn't screen passenger weights before the flight, what is the probability that the flight will be overweight?

(ii) Assume the flight carries 50 passengers and will be underweight if total passenger weight is less than 7,850 pounds and overweight if total passenger weight is in excess of 8,200 pounds. If the airline doesn't screen passenger weights before the flight, what is the probability the flight will be either underweight or overweight?

(5+5 = 10)

6. (a) The Good Food chain has a contract to receive eggs from a large egg producer. The eggs come in lots of 4,000 dozen each week. The contract specifies that the rate of broken or defective eggs should not exceed 8 percent. Each time a load comes in, Good Food warehouse employees select a random sample of $n = 100$ eggs and check to see if they are broken or defective. If Good Food wants no more than a 0.05 chance of rejecting the shipment, what should the cut-off be in terms of proportion of broken or defective eggs so that if the proportion is that value or more, the shipment will be rejected?

(b) A real estate broker is interested in determining whether there is a difference in the mean number of days a home stays on the market before selling based on which area of the city it is located in. However, she is also concerned that the price of the house may be an issue in determining how long it takes to sell a house, so she wants to control for this. To carry out the test, she plans to randomly select one house from each part of the city in each price range. The following data show the number of days for the sample of houses selected.

	East	West	North	South
under Rs.70,00,000	42	60	29	50
70,00,000 < 90,00,000	40	70	40	37
90,00,000 < 120,00,000	50	80	60	30
120,00,000 < 180,00,000	30	40	56	40
Rs.180,00,000 and over	56	33	40	20

Using a significance level equal to 0.05, determine whether the broker was justified in controlling for house prices. Be sure to indicate what type of statistical test should be used and why.

(5+5 = 10)

7. Director's insurance is a means by which corporate firms protect members of their boards of directors from financial liability in lawsuits from disgruntled investors. It has been suggested that more experienced boards tend to be sued less and when they are sued the losses tend to be lower. Data on collective experience and cumulative legal losses were gathered on eight boards randomly selected for study. The data are as follows:

Collective experience (years)	Legal loss (Lakhs of Rupees)
120.06	-286.06
76.31	-135.28
85.76	-145.62
99.27	-140.98
99.26	-144.42
75.98	-122.63
97.89	-93.70
122.26	-246.17

Based on this sample information,
- (i)   Formulate the least squares regression model.
- (ii) Provide a 90% interval for the average losses expected when the board has a collective experience of 95 years.