

**FACULTY OF MANAGEMENT STUDIES**  
**UNIVERSITY OF DELHI**  
**MBA FT - November, 2016**  
**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) An electronics manufacturer has an option to produce six styles of cell phones. Each of these devices requires time, in minutes, on three types of electronic testing equipment as shown in the following table. The first two test devices are each available for 120 hours per week. Test device 3 requires more preventive maintenance and may be used only for 100 hours each week. The market for all six cell phones is vast, so the manufacturer believes that it can sell as many cell phones as it can manufacture. The table also summarizes the revenues and material costs for each type of phone. In addition, variable labour costs are \$15 per hour for test device 1, \$12 per hour for test device 2 and \$18 per hour for test device 3. Formulate the above problem as linear programming problem.

Particulars	Smartphone	Blueberry	Mophone	Boldphone	Luxphone	Tap3G
Test device 1	7	3	12	6	18	17
Test device 2	2	5	3	2	15	17
Test device 3	5	1	3	2	9	2
Revenue per Unit	\$200	\$120	\$180	\$200	\$430	\$260
Material cost Per unit	\$35	\$25	\$40	\$45	\$170	\$60

- (b) Under what condition is it possible for an LP problem to have more than one optimal solution? Further under what condition is it possible for an LP problem to have an unbounded solution?

(10)

2. (a) The manager of a food processing unit that specializes in potato chips has developed an LP model to reflect processing times.

1/6

$X_1$  = boxes of regular chips

$X_2$  = boxes of crinkle out chips

Max  $Z = 0.4X_1 + 0.3X_2$  (Profit)

Subject to

Cutting  $3.6X_1 + 0.8X_2 \leq 144$  minutes

Frying  $3.2X_1 + 1.6X_2 \leq 160$  minutes

Crinkle  $X_2 \leq 80$  boxes

Crinkle  $X_2 \geq 20$  boxes

$X_1, X_2 \geq 0$

- (i) With the help of graphical method, determine the combination of boxes of the two types of chips that will maximize profits.
- (ii) Is any constraint redundant? Explain briefly.

(b) What are the assumptions of linear programming problems? (10)

3. (a) An investment company currently has \$1 million available for investment in five different stocks. The company wants to maximize the interest earned over the next year. The five investment possibilities along with the expected interest earned are shown below. To manage risk, the investment firm wishes to have at least 35% of the investment in stocks A and B. Furthermore, no more than 15% of the investment may be in stock E.

<u>Investment</u>	<u>Expected Interest Earned (%)</u>
Stock A	7
Stock B	9
Stock C	8
Stock D	10
Stock E	11

2/6

## Sensitivity Report

## Adjustable Cells

Cell	Name	Final Value	Reduced Cost	Objective Coefficient	Allowable Increase	Allowable Decrease
\$B\$4	Stock A	0	-0.02	0.07	0.02	1E+30
\$C\$4	Stock B	350000	0	0.09	0.01	0.02
\$D\$4	Stock C	0	-0.02	0.08	0.02	1E+30
\$E\$4	Stock D	500000	0	0.1	0.01	0.01
\$F\$4	Stock E	150000	0	0.11	1E+30	0.01

## Constraints

Cell	Name	Final Value	Shadow Price	Constraint R.H. Side	Allowable Increase	Allowable Decrease
\$G\$7	Constraint 1	1000000	0.1	1000000	1E+30	500000
\$G\$8	Constraint 2	350000	-0.01	350000	500000	350000
\$G\$9	Constraint 3	150000	0.01	150000	500000	150000

Answer the following questions:

- What is the optimal total expected interest earned for next year?
  - Which constraints are binding? Which constraints are not binding?
  - What would be the impact on the optimal allocation if the expected interest earned on stock A decreases to 6%?
  - What would be the impact on the optimal allocation if the expected interest earned on stock A increases to 10%?
  - What would be the impact on the optimal allocation and the objective function value if the expected interest earned on stock B decreases by 1%?
  - Suppose that total investment in stocks A and B must be at least 40% of the total amount available for investment (i.e., \$400,000). What impact would this have on the current optimal objective function value?
- (b) What do you understand by reduced cost as provided in excel solver output? What is the significance of negative reduced cost?

(10)

4. (a) Write the dual associated with the following primal problem:

$$\text{Maximize } Z = -2X_1 + 3X_2$$

Subject to

$$X_1 + 2X_2 \leq 12$$

$$4X_1 - 2X_2 \geq 3$$

$$6X_1 - X_2 = 10$$

$$X_1, X_2 \geq 0$$

3/6

(b)XYZ Construction Company has an opportunity to build five shopping malls during the next year. The expected net profit and expected cost for each of the shopping malls are shown in the following table:

**Expected net profit and expected net cost**

Shopping mall	Expected net profit (Rs. '000)	Expected cost (Rs. '000)
1	200	150
2	150	90
3	140	50
4	125	80
5	180	100

The Company has budgeted Rs. 300,000 for the construction of shopping malls during the next year. Also due to various legal restrictions and marketing considerations, the following relationships among the projects must be met:

Exactly one of the shopping malls 1, 2 and 5 must be constructed.

At most only one of the two shopping malls 1 and 4 may be constructed.

If shopping mall 4 is constructed, then shopping mall 5 must also be constructed.

Formulate the above problem as an integer programming problem.

(10)

**Section B**

5. (a) Auditors have observed that a particular accounting error tends to be associated with attempts to misstate (inaccurately stated) financial positions. Approximately 85% of firms attempting to misstate their earnings will commit this accounting error; for a firm *not* trying to misstate its earnings, the likelihood of making this error is approximately 5%. It has been estimated that the percentage of firms attempting to misstate earnings at any given time is only 5%. Suppose that in an audit of QRS Airlines, an auditor discovers this particular accounting error. What is the probability that this is *not* an honest mistake (i.e., QRS has actually been attempting to misstate its earnings)?

- (b) A stock portfolio contains 20 stocks. Of these stocks, 10 are considered "large-cap" stocks, 5

4/6

are "mid-cap," and 5 are "small cap." The portfolio manager has been asked by his client to develop a report that highlights 7 randomly selected stocks. When she presents her report to the client, all 7 of the stocks are large-cap stocks. The client is very suspicious that the manager has not randomly selected the stocks. She believes that the chances of all 7 of the stocks being large cap must be very low. Compute the probability of all 7 being large cap.

6. (a) The manager of a computer help desk operation has collected enough data to conclude that the distribution of time per call is normally distributed with a mean equal to 8.21 minutes and a standard deviation of 2.14 minutes. The manager has decided to have a signal system attached to the phone so that after a certain period of time, a sound will occur on her employees' phone if she exceeds the time limit. The manager wants to set the time limit at a level such that it will sound on only 8 percent of all calls.
  - (i) What should be the time limit?
  - (ii) What is the probability that three randomly monitored calls will each be completed in 4 minutes or less?

(b) 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?

7. (a) To increase productivity, workers went through a training program. The management wanted to know the effectiveness of the program. A sample of seven workers was taken and their daily production rates before and after the training are shown below.

Worker	Before	After
1	18	22
2	23	25
3	25	27
4	22	25
5	20	24
6	21	19
7	19	20

Based on the data, can you conclude that the training program is effective? Set up and conduct appropriate hypothesis test at 0.05 level of significance.

(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.

8. A company which specializes in college job placements, is interested in developing a model that might be used to explain the variation in starting salaries for college graduates based on the college GPA. The following data were collected through a random sample of the clients with which this company has been associated.

GPA	Starting Salary
3.20	Rs.35,00,000
3.40	Rs.29,50,000
2.90	Rs.30,00,000
3.60	Rs.36,40,000
2.80	Rs.31,50,000
2.50	Rs.29,00,000
3.00	Rs.33,20,000
3.60	Rs.37,60,000
2.90	Rs.32,00,000
3.50	Rs.36,00,000

Based on this sample information,

- Determine the least squares regression model,
- Determine what percent of the variation in starting salaries is explained by GPA, and test to determine whether the regression model is statistically significant at the 0.05 level of significance.
- Develop a scatter plot of the data and locate the regression line on the scatter plot.

6/6