FACULTY OF MANAGEMENT STUDIES
UNIVERSITY OF DELHI
MBA FT - November, 2017
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 airline with operations in San Diego, California must staff its ticket counters inside the airport. Ticket attendants work 6-hour shifts at the counter. There are two types of agents: those who speak English as a first language and those who are fully bilingual (English and Spanish). The requirements for the number of agents depend on the number of people expected to pass through the airline's ticket counters during various hours. The airline believes that the need for agents between the hours of 6 am and 9 pm are as follows:

	6 to 9 am	9 to 12 noon	12 noon to 3 pm	3 to 6 pm	6 to 9 pm
Agents needed	12	20	16	24	12

Agents begin work either at 6 am, 9 am, 12 noon or 3 pm. The shifts are designated as shifts A, B, C and D respectively. It is the policy of the airline that at least half of the agents needed in any time period will speak English as the first language. Further, at least one quarter of the agents needed in any time should be fully bilingual. How many and what type of agents should be hired for each shift to meet the language and staffing requirements for the airline so that the total number of agents is minimized? Formulate the above problem as a linear programming problem. You are not required to find out solution to the above problem.

(b) Under what circumstances, the solution to a linear programming problem becomes degenerate? Elucidate with the help of an example.

(10)

2. (a) A manager of an automobile dealership must decide how many cars to order for the end of the year. Midsize cars yield an average profit of $500 each and compact cars yield an average of $400 each. Either type of car will cost the dealership $8000 each. No more than $720,000 can be invested. The manager wants at least 10 of each type of car but no more than 50 of the midsized cars and no more than 60 of the compact cars.

(i) Formulate the linear programming model of this problem.

(ii) Find out the optimal quantities of each type of car and the optimal value of the objecti function.

(b) Define the following terms as obtained from the Excel solver output

(i) Binding constraint
(ii) Non-binding constraint
(iii) Shadow price and
(iv) Reduced cost

(10)

3. Consider the following LP problem, in which X and Y denote the number of units of products X and Y to produce respectively.

Max profit = $4X + $5Y

Subject to

X + 2Y <= 10 (available labour in hours)
6X + 6Y <= 36 (available material in pounds)
8X + 4Y <= 40 (storage available in square feet)
X, Y >= 0

Sensitivity report of the problem is shown in the following screenshot.

Variable Cells

Cell	Name	Final Value	Reduced Cost	Objective Coefficient	Allowable Increase	Allowable Decrease
B4	Solution value X	2.00	0.00	4.00	1.00	1.50
C4	Solution value Y	4.00	0.00	5.00	3.00	1.00

Constraints

Cell	Name	Final Value	Shadow Price	Constraint R.H. Side	Allowable Increase	Allowable Decrease
D7	Labor	10.00	1.00	10.00	2.00	2.00
D8	Material	36.00	0.50	36.00	4.00	6.00
D9	Storage	32.00	0.00	40.00	1E+30	8.00

Calculate and explain what happens to the optimal solution for each of the following situations.

(i) You acquire 2 additional pounds of material.
(ii) You acquire 1.5 additional hours of labour.
(iii) You give up 1 hour of labour and get 1.5 pounds of material simultaneously.
(iv) The profit contributions of both products X and Y are changed to \$4.75 each.
(v) You decide to introduce a new product that has a profit contribution of \$2. Each unit of this product will use 1 hour of labour, 1 pound of material and 2 square feet of storage space.

(10)

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

Max Z = - 2X1 + 3X2

Subject to

$$X1 + 2X2 <= 12$$
$$4X1 - 2X2 >= 3$$
$$6X1 - X2 = 10$$
$$X1, X2 >= 0$$

(b) The Houston-based investment firm of Simkin and Steinberg specializes in recommending oil stock portfolios for wealthy clients. One such client has up to \$3 million available for investments and insists on purchasing large blocks of shares of each company in which he invests. The following table describes various companies that are under consideration.

Company name	Expected annual return ('000)	Cost for block of shares ('000)
Trans – Texas (Texas)	\$50	\$480
British Petro (Foreign)	\$80	\$540
Dutch Shell (Foreign)	\$90	\$680
Houston Drilling (Texas)	\$120	\$1000
Lone Star Petro (Texas)	\$110	\$700
San Diego Oil (California)	\$40	\$510
California Petro (California)	\$75	\$900

The objective is to maximize annual return on investment subject to the following specifications made by the client:

- At least two Texas companies must be in the Portfolio.
- No more than one investment can be made in foreign companies.
- Exactly one of the two California companies must be included.
- If British Petro stock is included in the portfolio, then Trans – Texas oil stock must also be included.

Formulate the above problem as an integer linear programming problem for maximizing annua return.

(10)

Section B

5(a) The average hourly wages of auto mechanics in four metropolitan areas were the object of a recent study done by a consumer group. The data are shown below:

Observations	Location Sample			
	Delhi	Mumbai	Chennai	Hyderabad
1	6	12	11	9
2	9	11	8	7
3	9	10	12	10
4	6	8	9	10
5	5	9	10	9
Total	35	50	50	45

Determine if any real differences exist in wages between four locations. The level of significance is 5%.

(5)

(b) In a study of brand loyalty in the automotive industry, new-car customers were asked whether the make of their new car was the same as the make of their previous car. The break down of 600 responses shows the brand loyalty for domestic, European and American cars.

	Domestic	European	American
Purchaser			
Same make:	125	55	68
Different make:	140	105	107

Test a hypothesis to determine. Whether brand loyalty is independent of the manufacturer. Use level of significance 5%. What is your conclusion? If a significant difference is found, which manufacturer appears to have the greatest brand loyalty? (5)

(a) A consulting firm is preparing a study on consumer behavior. The company collected the following data in thousand dollars to determine whether there is a relationship between consumer income and consumption levels:

Consumer No	1	2	3	4	5	6	7	8	9	10	11	12
Income	24.3	12.5	31.2	28.0	35.1	10.5	23.2	10.0	8.5	15.9	14.7	15
Consumption	16.2	8.5	15	17	24.2	11.2	15	7.1	3.5	11.5	10.7	9.2

Compute and interpret the regression model. What does this model tell about the relationship between consumption and income? What consumption would the model predict for someone who earns $27500? (7)

(b) The daily trading volumes (millions of share) for stocks traded at New York Stock Exchange for 12 days in October 2007 are shown here.

917 983 1046 944 723 783

813 1057 766 836 992 973

The probability distribution of trading volume is approximately normal.

What is the probability that on a particular day the trading volume will be less than 800 million shares? If the exchange wants to issue a press release on the top 5% of trading days, what volume will trigger a release? (3)

7.(a) The variance in production process is an important measure of the quality process. A large variance often signals an opportunity for improvement in the process by finding ways to reduce the process variance. Conduct a statistical test to determine if there is a significant difference between the Mean and variances in the bag weights for the two machines. Use a 5% level of significance when weights are normally distributed. What is your conclusion? Which machine, if either, provides the greater opportunity for quality improvements?

	No of Observations	Mean	Standard Deviation
Machine 1	25	5.9	2
Machine 2	22	6.3	1.9

(5)

(b) Your Managing Director asked you to assist in the analysis of effectiveness of two advertising displays. Five consumers are randomly selected. Each is shown an advertisement and asked to rate it. The result is shown in the following table:

Consumer	Advertisement Display	
	1	2
1	50	45
2	45	30
3	30	25
4	45	35
5	40	30

Is there a significant difference in effectiveness of two advertising displays? Use level of significance 5%. (5)