

K. J. SOMAIYA INSTITUTE OF MANAGEMENT STUDIES AND RESEARCH,

Vidyavihar, Mumbai- 400077

Program: PGDM - IB (Batch 2016-18) Trim-III

Subject: Operations Research

(End Term Examination) (In computer lab)

29th Mar, 2017

Duration: 3 hours

Maximum Marks: 50

Instructions

- 1. Use Excel and solver as required and save your files on the computer. Before leaving the exam hall, ensure that your file is transferred to the destination exam folder following the instructions of data centre personnel.**
- 2. Write all your answers in the answer sheet clearly. Your submission in answer sheet will be primarily used for evaluation, supported by the excel submission. Individual marks for sub-questions are given alongside.**
- 3. If you assume any data not given, please provide suitable explanation of the same.**

Part A – Conceptual (16x0.5 = 8 marks)

Multiple Choice

Identify the choice that best completes the statement or answers the question.

- _____ 1. To find the optimal solution to a linear programming problem using the graphical method
- find the feasible point that is the farthest away from the origin.
 - find the feasible point that is at the highest location.
 - find the feasible point that is closest to the origin.
 - None of the alternatives is correct.
- _____ 2. The improvement in the value of the objective function per unit increase in a right-hand side is the
- sensitivity value.
 - dual price.
 - constraint coefficient.
 - slack value.
- _____ 3. Infeasibility means that the number of solutions to the linear programming models that satisfies all constraints is
- at least 1.
 - 0.
 - an infinite number.
 - at least 2.
- _____ 4. A negative dual price for a constraint in a minimization problem means
- as the right-hand side increases, the objective function value will increase.
 - as the right-hand side decreases, the objective function value will increase.
 - as the right-hand side increases, the objective function value will decrease.
 - as the right-hand side decreases, the objective function value will decrease.

5. The amount that the objective function coefficient of a decision variable would have to improve before that variable would have a positive value in the solution is the

- a. dual price.
- b. surplus variable.
- c. reduced cost.
- d. upper limit.

6. The objective of the transportation problem is to

- a. identify one origin that can satisfy total demand at the destinations and at the same time minimize total shipping cost.
- b. minimize the number of origins used to satisfy total demand at the destinations.
- c. minimize the number of shipments necessary to satisfy total demand at the destinations.
- d. minimize the cost of shipping products from several origins to several destinations.

7. The maximum inventory with backorders is

- a. Q
- b. $Q - S$
- c. S
- d. $(Q - S) / 2$

8. The definition of *service level* used in this chapter is

- a. the percentage of all demand that can be satisfied from inventory.
- b. the percentage of all order cycles that do not experience a stockout.
- c. the percentage of demand during the lead-time period that can be satisfied from inventory.
- d. None of the alternatives is correct.

9. A value for probabilistic input from a discrete probability distribution

- a. is the value given by the RAND() function.
- b. is given by matching the probabilistic input with an interval of random numbers.
- c. is between 0 and 1.
- d. must be non-negative.

10. Which of the following statements is INCORRECT regarding the disadvantages of simulation?

- a. Each simulation run only provides a sample of how the real system will operate.
- b. The summary of the simulation data only provides estimates about the real system.
- c. The process of developing a simulation model of a complex system can be time-consuming.
- d. The larger the number of probabilistic inputs a system has, the less likely a simulation will provide the best approach for studying the system.

11. Linear trend is calculated as $T_t = 28.5 + .75t$. The trend projection for period 15 is

- a. 11.25
- b. 28.50

- c. 39.75
- d. 44.25

True/False

Indicate whether the statement is true or false.

- _____ 12. An optimal solution to a linear programming problem can be found at an extreme point of the feasible region for the problem.
- _____ 13. Whenever total supply is less than total demand in a transportation problem, the LP model does not determine how the unsatisfied demand is handled.
- _____ 14. In the periodic review model, the order quantity at each review period must be sufficient to cover demand for the review period plus the demand for the following lead time.
- _____ 15. Quantitative forecasting methods do not require that patterns from the past will necessarily continue in the future.
- _____ 16. The exponential smoothing forecast for any period is a weighted average of all the previous actual values for the time series.

Part B – Problems (Answer any 3 out of 5: 3 x 9 = 27 marks)

1. The employee credit union at State University is planning the allocation of funds for the coming year. The credit union makes four types of loans to its members. In addition, the credit union invests in risk-free securities to stabilize income. The various revenue producing investments together with annual rates of return are as follows:

Type of loan/investment	Annual rate of return %
Automobile loans	8
Furniture loans	10
Other secured loans	11
Signature loans	12
Risk-free securities	9

The credit union will have \$2 million available for investment during the coming year. State laws and credit union policies impose the following restrictions on the composition of the loans and investments.

- Risk-free securities may not exceed 30% of the total funds available for investment.
- Signature loans may not exceed 10% of the funds invested in all loans (automobile, furniture, other secured, and signature loans).
- Furniture loans plus other secured loans may not exceed the automobile loans.
- Other secured loans plus signature loans may not exceed the funds invested in risk-free securities.

How should the \$2 million be allocated to each of the loan/investment alternatives to maximize total annual return? What is the projected total annual return?

2. Hatcher Enterprises uses a chemical called Rbase in production operations at five divisions. Only six suppliers of Rbase meet Hatcher's quality control standards. All six suppliers can produce Rbase in sufficient quantities to accommodate the needs of each division. The quantity of Rbase needed by each Hatcher division and the price per gallon charged by each supplier are as follows:

Division	Demand (1000s of gallons)	Supplier	Price per gallon (\$)
1	40	1	12.60
2	45	2	14.00
3	50	3	10.20
4	35	4	14.20
5	45	5	12.00
		6	13.00

The cost per gallon (in dollars) for shipping from each supplier to each division is provided in the following table:

Division	Supplier					
	1	2	3	4	5	6
1	2.75	2.50	3.15	2.80	2.75	2.75
2	0.80	0.20	5.40	1.20	3.40	1.00
3	4.70	2.60	5.30	2.80	6.00	5.60
4	2.60	1.80	4.40	2.40	5.00	2.80
5	3.40	0.40	5.00	1.20	2.60	3.60

Hatcher believes in spreading its business among suppliers so that the company will be less affected by supplier problems (e.g., labor strikes or resource availability). Company policy requires that each division have a separate supplier.

- a. **For each supplier–division combination, compute the total cost of supplying the division's demand.**
 - b. **Determine the optimal assignment of suppliers to divisions.**
3. Westside Auto purchases a component, used in the manufacture of automobile generators, directly from the supplier. Westside's generator production operation, which is operated at a constant rate, will require 1000 components per month throughout the year (12,000 units annually). Assume that the ordering costs are \$25 per order, the unit cost is \$2.50 per component, and annual holding costs are 20% of the value of the inventory. Westside has 250 working days per year and a lead time of 5 days. Answer the following inventory policy questions:
- a. **What is the EOQ for this component?**
 - b. **What are the total annual holding and ordering costs associated with your recommended EOQ?**
- Suppose that Westside Auto decided to operate with a backorder inventory policy. Backorder costs are estimated to be \$5 per unit per year. Identify the following:
- c. **Minimum cost order quantity**

- d. **Maximum number of backorders**
- e. **Total annual cost**

4. In preparing for the upcoming holiday season, Mandrell Toy Company designated a new doll called Freddy. The fixed cost to produce the doll is \$100,000. The variable cost, which includes material, labor, and shipping costs, is \$34 per doll. During the holiday selling season, Mandrell will sell the dolls for \$42 each. If Mandrell overproduces the dolls, the excess dolls will be sold in January through a distributor who has agreed to pay Mandrell \$10 per doll. Demand for new toys during the holiday selling season is extremely uncertain. Forecasts are for expected sales of 60,000 dolls with a standard deviation of 15,000. The normal probability distribution is assumed to be a good description of the demand.
- a. **Create a worksheet by including columns showing demand, sales, revenue from sales, amount of surplus, revenue from sales of surplus, total cost, and net profit. Use your worksheet to simulate the sales of the Freddy doll using a production quantity of 60,000 units.**
 - b. **Using 500 simulation trials, what is the estimate of the mean profit associated with the production quantity of 60,000 dolls?**
5. FRED® (Federal Reserve Economic Data), a database of more than 3000 U.S. economic time series, contains historical data on foreign exchange rates. The following data show the foreign exchange rate for the United States and China. The units for Rate are the number of Chinese yuan renmimbis to one U.S. dollar.

Month	Rate	Month	Rate
October 2007	7.5019	March 2008	7.0722
November 2007	7.4210	April 2008	6.9997
December 2007	7.3682	May 2008	6.9725
January 2008	7.2405	June 2008	6.8993
February 2008	7.1644	July 2008	6.8355

- a. **Construct a time series plot. Does a linear trend appear to be present?**
- b. **Identify the trend equation with Excel.**
- c. **Use the trend equation to forecast the exchange rate for August 2008. Would you feel comfortable using the trend equation to forecast the exchange rate for December 2008?**

Part C – Case Study (Answer anyone out of two: 1x 15 = 15 marks)

6. The Flamingo Grill is an upscale restaurant located in St. Petersburg, Florida. To help plan an advertising campaign for the coming season, Flamingo’s management team hired the advertising firm of Haskell & Johnson (HJ). The management team requested HJ’s recommendation concerning how the advertising budget should be distributed across television, radio, and newspaper advertisements. The budget has been set at \$279,000. In a meeting with Flamingo’s management team, HJ consultants provided the following information about the industry exposure effectiveness rating per ad, their estimate of the number of potential new customers reached per ad, and the cost for each ad. The exposure rating is viewed as a measure of the value of the ad to both existing customers and

potential new customers. It is a function of such things as image, message recall, visual and audio appeal, and so on. As expected, the more expensive television advertisement has the highest exposure effectiveness rating along with the greatest potential for reaching new customers. At this point, the HJ consultants pointed out that the data concerning exposure and reach were only applicable to the first few ads in each medium. For television, HJ stated that the exposure rating of 90 and the 4000 new customers reached per ad were reliable for the first 10 television ads. After 10 ads, the benefit is expected to decline. For planning purposes, HJ recommended reducing the exposure rating to 55 and the estimate of the potential new customers reached to 1500 for any television ads beyond 10. For radio ads, the preceding data are reliable up to a maximum of 15 ads. Beyond 15 ads, the exposure rating declines to 20 and the number of new customers reached declines to 1200 per ad. Similarly, for newspaper ads, the preceding data are reliable up to a maximum of 20; the exposure rating declines to 5 and the potential number of new customers reached declines to 800 for additional ads.

Flamingo's management team accepted maximizing the total exposure rating, across all media, as the objective of the advertising campaign. Because of management's concern with attracting new customers, management stated that the advertising campaign must reach at least 100,000 new customers. To balance the advertising campaign and make use of all advertising media, Flamingo's management team also adopted the following guidelines.

- Use at least twice as many radio advertisements as television advertisements.
- Use no more than 20 television advertisements.

The television budget should be at least \$140,000.

- The radio advertising budget is restricted to a maximum of \$99,000.
- The newspaper budget is to be at least \$30,000.

HJ agreed to work with these guidelines and provide a recommendation as to how the \$279,000 advertising budget should be allocated among television, radio, and newspaper advertising.

Managerial Report

Develop a model that can be used to determine the advertising budget allocation for the Flamingo Grill. Include a discussion of the following in your report.

- A schedule showing the recommended number of television, radio, and newspaper advertisements and the budget allocation for each medium. Show the total exposure and indicate the total number of potential new customers reached.**
- How would the total exposure change if an additional \$10,000 were added to the advertising budget?**
- A discussion of the ranges for the objective function coefficients. What do the ranges indicate about how sensitive the recommended solution is to HJ's exposure rating coefficients?**
- After reviewing HJ's recommendation, the Flamingo's management team asked how the recommendation would change if the objective of the advertising campaign was to maximize the number of potential new customers reached. Develop the media schedule under this objective.**
- Compare the recommendations from parts 1 and 4. What is your recommendation for the Flamingo Grill's advertising campaign?**

7. The Costello Music Company has been in business for five years. During that time, the sales of

pianos has grown from 12 units in the first year to 76 units in the most recent year. Fred Costello, the firm's owner, wants to develop a forecast for piano sales for the coming year based on the historical data presented below:

Year	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Total yearly sales
1	4	2	1	5	12
2	6	4	4	14	28
3	10	3	5	16	34
4	12	9	7	22	50
5	18	10	13	35	76

- Compute the seasonal indexes for the four quarters.
- When does Costello Music experience the largest seasonal effect? Does this appear reasonable? Explain.
- Deseasonalise the data and identify the trend.
- Use the results of part (c) to develop a quarterly forecast for next year based on trend.
- Use the seasonal indexes developed in (a) to adjust the forecasts developed in part (d) to account for seasonal effects.

* _____ * _____ *

Formulae for Inventory model with backorder

$$Q^* = \sqrt{\frac{2DC_0}{C_h} \left(\frac{C_h + C_b}{C_h} \right)} \quad (10.26)$$

$$S^* = Q^* \left(\frac{C_b}{C_h + C_b} \right) \quad (10.27)$$

$$TC = \frac{(Q - S)^2}{2Q} C_h + \frac{D}{Q} C_0 + \frac{S^2}{2Q} C_b \quad (10.25)$$