K. J. SOMAIYA INSTITUTE OF MANAGEMENT STUDIES AND RESEARCH,
Vidyavihar, Mumbai- 400077
Program: *PG/MMS (Ops) Core & Elective (Batch 2016-18) Trim V*
Subject: Supply Chain Modeling
(End Term Examination) (In computer lab)

Date : 5th Jan, 2018

Maximum Marks: 50 **Duration: 3 hours**

Instructions

- **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.**
- **Use Excel and solver as required and keep saving your work (one single file with reference of your program and roll no) as you proceed. Follow the instructions of data centre personnel and transfer your folder to an appropriate place in the server.**
- **If you assume any data not given, please provide suitable explanation of the same.**

Question no. **1** is **compulsory**. Answer any **three** questions out of **2-6.**

1. Ajax sells three types of computers: Alpha, Beta, and Gamma. The net profit of each computer sold is: Alpha - $385, Beta -$530 and Gamma - $615. This week, 120 hours are available on the A-line testing equipment where Alphas and Betas are tested and 48 hours available on the c-line test equipment where Gammas are tested. The testing of each Alpha requires 0.85 hour while each Beta requires 0.80 hour and each Gamma requires 1 hour. Production is constrained by assembly hours of 2000. For assembly, each Alpha requires 10 hours, each beta – 15, and each Gamma – 20 hours. The production manager has been permitted to add upto 200 hours of assembly time through overtime which costs $ 25/hour.
   a) Formulate the LP algebraic model describing the decision variables, objective function, and constraints.(5)
   b) Construct an LP model in excel to determine the optimum net profit and solve.(5)

   Historically, before the implementation and use of a model, Ajax followed the weekly strategy of assembling and testing 64 Alphas, 48 Betas, and 32 gammas. Under this strategy, the historical weekly utilization was 112 hours of the A-line test equipment and 32 hours of the C-line test equipment. Based on these utilizations, the unit charge for A-line testing was 5600/112 = 50/hour, or per unit of Alpha or Beta tested. Similarly, the unit charge of C-line testing was 2432/32 = 76/hour, or per unit of Gamma tested. Replace the linear approximations (50/hour for A-line usage, 76/hour for C-line usage) employed in our model by the more accurate cost functions involving fixed and variable costs. For the A-line, the function involves a fixed cost of 2016 if the A-line test equipment is used at all during the week and a variable cost of 32/hour consumed. For the C-line, the function involves a fixed cost of 1200 if the C-line test equipment is used at all during the week and a variable cost of 38.50 for each hour consumed. These fixed costs equal the cost of supervisory and repair personnel who must be available full time during the week if the test equipment is used.

   c) Reformulate the model and solve for explicit accounting of fixed costs.(4)

2. Ajax sells three types of computers: Alpha, Beta, and Gamma. Net profit equals the sales price of each computer minus the direct costs of purchasing components, producing computer cases, and assembling and testing the computer. We assume that all production can and will be sold immediately. While various activities are involved in producing the computers, three resources involving testing and assembly are scarce and hence are constraining. the relevant details are given below:

Details	Alpha	Beta	Gamma	Availability
Profit/unit	350	470	610	
A-line testing hours	1	1		120
C-line testing hours			1	48
Labour hours	10	15	20	2000

<u>Sales Forecasts</u>

	Week 1	Week 2	Week 3	Week 4
Alphas	[20,60]	[20,80]	[20,120]	[20,140]
Betas	[20,40]	[20,40]	[20,40]	[20,40]
Gammas	[20,50]	[20,40]	[20,30]	[20,70]

Because Ajax has capital tied up in its products, carrying costs must be charged for items held in inventory. These carrying costs are 9/week for each Alpha, 10/week for each beta, and 18/week for each Gamma. Initial inventory at the start of this week equals 22 Alphas, 42 betas, and 36 Gammas.

The production manager wishes to allocate these resources to maximize the profits for the planning period (4-weeks).

a) Briefly describe (in verbal form) the formulation of the problem.(5)
b) Develop a 4-week optimization model in excel to maximize the overall profits during the 4 weeks. (5)
c) Explain modifications required for allowing backlogging.(4)

3. Given the set of items $S = \{4, 8, 5, 1, 7, 6, 1, 4, 2, 2\}$ and bins of size 10, pack the items into as few bins as possible.
   a) Use any one heuristic taught in the class and provide a reasonable and useful solution.(5)
      - Explain why you would never need more than n bins for n objects.
      - If you double the capacity of the bins, is the number of bins required cut in half?
      - If you cut the capacity of the bins in half, is the number of bins required doubled?
   b) Model the above as an MIP optimization problem in excel and solve it.(5)
   c) Compare the results obtained in the above steps and discuss. (4)

4. A company trading in auto components wishes to determine the level of stock to be carried for

item X. demand for X is not certain and stock replenishment takes three days from order date. Regarding demand, the following distribution is obtained based on past data:

Demand (units/day)	1	2	3	4	5
Probability	0.1	0.2	0.3	0.3	0.1

Each time an order is placed, the company incurs an ordering cost of Rs. 20 per order. The company also incurs a carrying cost of Rs. 2.50 per unit per day. The inventory carrying cost is calculated on the basis of average stock. The manager wants to compare the following two alternative inventory policies:

I. Order 12 units when the inventory at the end of the day plus order outstanding is less than 12 units.
II. Order 10 units when the inventory at the end of the day plus order outstanding is less than 10 units.

Currently the company has a stock of 17 units as opening stock. You are required to do the following:

a) Carry out simulations for a month (30 days) incorporating the decision rules in separate sheets and recommend which inventory policy the manager should adopt. (5+5)
b) Repeat 500 times and summarise the results. (5)
c) Describe the use of different excel formulas used in the sheets and discuss.(4)

5. Monthly demand at A&D Electronics for flat-screen TVs are as follows:

Month	1	2	3	4	5	6
Demand	1000	1113	1271	1445	1558	1648
Month	7	8	9	10	11	12
Demand	1724	1850	1864	2076	2167	2191

a) Estimate demand for the next two weeks using simple exponential smoothing with α = 0.3 and obtaining the level at period 0 (L_0 = the average demand over the 12 months).(5)
b) Estimate demand for the next two weeks with Holt's model with α = 0.05 and β = 0.1, using the level at period 0 (L_0) and the trend in period 0 (T_0) through regression. (5)
c) Evaluate the MSE in each case. Which of the two methods do you prefer? Why?(4)

6. Write short notes on any two of the following (2x 4 = 8 marks) (**Compulsory**):

I. Diseconomies and Economies of Scale and Formulation Requirements
II. Formulation for Accounting of Fixed Costs
III. Stochastic Programming
IV. Holt's and Winters' Forecasting models

Formulas for exponential smoothing and Holt's Model are given in the next page.

Simple Exponential Smoothing

Given data for Periods 1 to n $$L_0 = \frac{1}{n}\sum_{i=1}^{n} D_i$$

Current forecast $$F_{t+1} = L_t \quad \text{and} \quad F_{t+n} = L_t$$

Revised forecast using smoothing constant $0 < \alpha < 1$ $$L_{t+1} = \alpha D_{t+1} + (1-\alpha)L_t$$

Thus $$L_{t+1} = \sum_{n=0}^{t-1} \alpha(1-\alpha)^n D_{t+1-n} + (1-\alpha)^t D_1$$

Trend-Corrected Exponential Smoothing (Holt's Model)

- Obtain initial estimate of level and trend by running a linear regression
$$D_t = a_t + b$$
$$T_0 = a, \; L_0 = b$$

- In Period t, the forecast for future periods is
$$F_{t+1} = L_t + T_t \text{ and } F_{t+n} = L_t + nT_t$$

- Revised estimates for Period t
$$L_{t+1} = \alpha D_{t+1} + (1-\alpha)(L_t + T_t)$$
$$T_{t+1} = \beta(L_{t+1} - L_t) + (1-\beta)T_t$$

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