

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

Vidyavihar, Mumbai- 400077

Program: PGFS (Batch 2017-19) Trim III

Subject: Operations Research

(End Term Examination) (In computer lab)

March/April, 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.**

PART A (Answer any three out of five questions. Marks 3 * 11 = 33).

1. Innis Investments manages funds for a number of companies and wealthy clients. The investment strategy is tailored to each client's needs. For a new client, Innis has been authorized to invest up to \$1.2 million in two investment funds: a stock fund and a money market fund. Each unit of the stock fund costs \$50 and provides an annual rate of return of 10%; each unit of the money market fund costs \$100 and provides an annual rate of return of 4%.
The client wants to minimize risk subject to the requirement that the annual income from the investment be at least \$60,000. According to Innis's risk measurement system, each unit invested in the stock fund has a risk index of 8, and each unit invested in the money market fund has a risk index of 3; the higher risk index associated with the stock fund simply indicates that it is the riskier investment. Innis's client also specified that at least \$300,000 be invested in the money market fund.
 - a. Formulate the mathematical model with details of objective function, decision variable, and constraints.
 - b. Solve the model in excel with Solver and write the optimal solution. How much annual income will this investment strategy generate?
 - c. Suppose the client desires to maximize annual return. How should the funds be invested? What is the risk associated with this solution?
2. Morton Financial must decide on the percentage of available funds to commit to each of two investments, referred to as A and B, over the next four periods. The following table shows the amount of new funds available for each of the four periods, as well as the cash expenditure required for each investment (negative values) or the cash income from the investment (positive values). The data shown (in thousands of dollars) reflect the amount of expenditure or income if 100% of the funds available in any period are invested in either A or B. For example, if Morton decides to invest 100% of the funds available in any period in investment A, it will incur cash expenditures of \$1000 in period 1, \$800 in period 2, \$200 in period 3, and income of \$200 in period 4. Note, however, if Morton made the decision to invest 80% in investment A, the cash expenditures or income would be 80% of the values shown.

Period	New Investment Funds Available	Investment	
		A	B
1	1500	-1000	-800
2	400	-800	-500
3	300	-200	-300
4	100	200	300

The amount of funds available in any period is the sum of the new investment funds for the period, the new loan funds, the savings from the previous period, the cash income from investment A, and the cash income from investment B. The funds available in any period can be used to pay the loan and interest from the previous period, placed in savings, used to pay the cash expenditures for investment A, or used to pay the cash expenditures for investment B.

Assume an interest rate of 10% per period for savings and an interest rate of 18% per period on borrowed funds. Let

$S(t)$ = the savings for period t

$L(t)$ = the new loan funds for period t

Then, in any period t , the savings income from the previous period is $1.1S(t-1)$, and the loan and interest expenditure from the previous period is $1.18L(t-1)$.

At the end of period 4, investment A is expected to have a cash value of \$3200 (assuming a 100% investment in A), and investment B is expected to have a cash value of \$2500 (assuming a 100% investment in B). Additional income and expenses at the end of period 4 will be income from savings in period 4 less the repayment of the period 4 loan plus interest.

Suppose that the decision variables are defined as

X_1 = the proportion of investment A undertaken

X_2 = the proportion of investment B undertaken

For example, if $x_1 = 0.5$, \$500 would be invested in investment A during the first period, and all remaining cash flows and ending investment A values would be multiplied by 0.5. The same holds for investment B. The model must include constraints $x_1 \leq 1$ and $x_2 \leq 1$ to make sure that no more than 100% of the investments can be undertaken. Additional constraint is that no more than \$200 can be borrowed in any period.

- a. Formulate a mathematical model to determine the proportions of investments A and B and the amount of savings and borrowing in each period that will maximize the cash value for the firm at the end of the four periods.
 - b. Solve the same in excel with Solver and write the optimal solution.
 - c. Prepare a savings/loan schedule.
3. A manager of an inventory system believes that inventory models are important decision-making aids. Even though often using an EOQ policy, the manager never considered a backorder model because of the assumption that backorders were "bad" and should be avoided. However, with upper management's continued pressure for cost reduction, you have been asked to analyze the economics of a backorder policy for some products that can possibly be backordered. For a specific product, consider the following data:
 $D = 800$ units per year, $C_o = \$150$, $C_h = \$3$, and $C_b = \$20$. Use the formula for back order EOQ as given below:

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

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

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

- a. What is the difference in total annual cost between the EOQ model and the planned shortage or backorder model?
 - b. If the manager adds constraints that no more than 25% of the units can be backordered and that no customer will have to wait more than 15 days for an order, should the backorder inventory policy be adopted? Assume 250 working days per year.
 - c. If the lead time for new orders is 20 days for the inventory system discussed above, find the reorder point for both the EOQ and the backorder models.
4. The price of a share of a particular stock listed on the New York Stock Exchange is currently \$39. The following probability distribution shows how the price per share is expected to change over a three-month period:

Stock Price Change (\$)	Probability
-2	0.05
-1	0.10
0	0.25
+1	0.20
+2	0.20
+3	0.10
+4	0.10

- a. Set up a simulation model in excel. Assuming the current price as a starting point, find out the ending simulated price after four quarters (in one trial).
 - b. Run 100 trials of the simulation and calculate summary measures.
 - c. Compare the ending simulated price obtained in part (a) with an appropriate summary measure in part (b) and discuss.
5. The following table reports the percentage of stocks in a portfolio for nine quarters from 2007 to 2009:

Quarter	Stock %
1st—2007	29.8
2nd—2007	31.0
3rd—2007	29.9
4th—2007	30.1
1st—2008	32.2
2nd—2008	31.5
3rd—2008	32.0
4th—2008	31.9
1st—2009	30.0

- Construct a time series plot. What type of pattern exists in the data?
- Use exponential smoothing to forecast this time series, using three different values for α and identify the most suitable α value.
- What is the forecast of the percentage of stocks in a typical portfolio for the second quarter of 2009?

PART B (Answer any one out of the two. Marks 1*17 = 17).

- The quarterly sales data (number of copies sold) for a college textbook over the past three years are given below:

Quarter	Year 1	Year 2	Year 3
1	1690	1800	1850
2	940	900	1100
3	2625	2900	2930
4	2500	2360	2615

- Construct a time series plot. What type of pattern exists in the data?
 - Show the four-quarter moving average values for this time series. Plot both the original time series and the moving averages on the same graph.
 - Compute seasonal indexes for the four quarters and deseasonalise the series.
 - Based on the deseasonalised series, identify the trend equation and trend estimates.
 - Based on the seasonal indexes and linear trend, compute the quarterly forecasts for next year.
- An investment advisor at Shore Financial Services wants to develop a model that can be used to allocate investment funds among four alternatives: stocks, bonds, mutual funds, and cash. For the coming investment period, the company developed estimates of the annual rate of return and the associated risk for each alternative. Risk is measured using an index between 0 and 1, with higher risk values denoting more volatility and thus more uncertainty.

Investment	Annual Rate of Return (%)	Risk
Stocks	10	0.8
Bonds	3	0.2
Mutual funds	4	0.3
Cash	1	0.0

Because cash is held in a money market fund, the annual return is lower, but it carries essentially no risk. The objective is to determine the portion of funds allocated to each investment alternative in order to maximize the total annual return for the portfolio subject to the risk level the client is willing to tolerate.

Total risk is the sum of the risk for all investment alternatives. For instance, if 40% of a client's funds are invested in stocks, 30% in bonds, 20% in mutual funds, and 10% in cash, the total risk for the portfolio would be $0.40(0.8) + 0.30(0.2) + 0.20(0.3) + 0.10(0.0) = 0.44$. An investment advisor will meet with each client to discuss the client's investment objectives and to determine a maximum total risk value for the client. A maximum total risk value of less than 0.3 would be assigned to a conservative investor; a maximum total risk value of between 0.3 and 0.5 would be assigned to a moderate tolerance to risk; and a maximum total risk value greater than 0.5 would be assigned to a more aggressive investor.

Shore Financial Services specified additional guidelines that must be applied to all clients. The guidelines are as follows:

- No more than 75% of the total investment may be in stocks.
 - The amount invested in mutual funds must be at least as much as invested in bonds.
 - The amount of cash must be at least 10%, but no more than 30% of the total investment funds.
- a. Suppose the maximum risk value for a particular client is 0.4. What is the optimal allocation of investment funds among stocks, bonds, mutual funds, and cash? What is the annual rate of return and the total risk for the optimal portfolio?
 - b. Suppose the maximum risk value for a more conservative client is 0.18. What is the optimal allocation of investment funds for this client? What is the annual rate of return and the total risk for the optimal portfolio?
 - c. Another more aggressive client has a maximum risk value of 0.7. What is the optimal allocation of investment funds for this client? What is the annual rate of return and the total risk for the optimal portfolio?
 - d. Refer to the solution for the more aggressive client in part (c). Would this client be interested in having the investment advisor increase the maximum percentage allowed in stocks or decrease the requirement that the amount of cash must be at least 10% of the funds invested? Explain.
 - e. What is the advantage of defining the decision variables as is done in this model rather than stating the amount to be invested and expressing the decision variables directly in dollar amounts?

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