# UNIVERSITY OF COLOMBO, SRI LANKA
# FACULTY OF MANAGEMENT AND FINANCE

Bachelor of Business Administration (Semester-V) Examination, July 2022

## FIN-3314 Management Science Applications

**Instructions.**

- Time allowed is **Three (03)** Hours.
- This paper comprises **FIVE (05)** questions in **Eight (08) pages** including the formula sheet and the standard normal distribution table.
- Answer **ALL** questions.
- Use of non-programmable calculators is permitted.
- This is an online and open book examination.

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01.

i. A bank makes four kinds of loans to its personal customers and these loans yield the following annual interest rates to the bank:

| | |
|---|---|
| First mortgage loans | 14% |
| Second mortgage loans | 20% |
| Home improvement loans | 20% |
| Personal overdraft loans | 10% |

The bank has a maximum foreseeable lending capability of Rs. 75,000 million and is further constrained by the policies:

1. first mortgages must be at least 55% of all mortgages issued and at least 25% of all loans issued (in Rs. terms).
2. second mortgages cannot exceed 25% of all loans issued (in Rs. terms).
3. to avoid public displeasure and the introduction of a new windfall tax the average interest rate on all loans must not exceed 15%.

Formulate the bank's loan problem as a Linear Programming so as to maximize interest income whilst satisfying the policy limitations.

(05 marks)

ii. A manufacturer produces three products daily X1, X2, and X3. All three products are processed through three production operations with time constraints and then stored. The problem has been formulated as:

Maximize $Z = 40X_1 + 50X_2 + 60X_3$ (Profit, Rs)

Subject to:

$<= 140$ (operation-1 Hrs)

$6X_1 + 4X_2 + X_3 <= 180$ (operation-2 Hrs)

$<= 120$ (operation-3 Hrs)

$X_1 + X_2 + X_3 <= 60$ (storage $ft^2$)

$X_1, X_2, X_3 >= 0$

(Certain coefficients and decision variables are purposely omitted from the model)

The final optimum simplex table for this problem is:

| Cj Cb | Basis | Solution | x1 | x2 | x3 | s1 | s2 | s3 | s4 |
|---|---|---|---|---|---|---|---|---|---|
| | X2 | | 0.4 | | | 0.4 | | -0.2 | |
| | S2 | 48 | 3.93 | | | -1.4 | | 0.53 | |
| | X3 | 4 | 0.46 | | | -0.2 | | 0.26 | |
| | S4 | 24 | 0.13 | | | -0.2 | | -0.06 | |
| | ZJ | 1,840 | 48 | | | 8 | | 6 | |
| | CJ-ZJ | | | | | | | | |

a. Based on your knowledge on the Simplex Solution Method of Linear Programming, fill the above table.
b. What is the optimum solution to this problem?
c. Is this solution represent any special case? If so identify it.
d. Determine the sensitivity of the optimal solution to change in the contribution coefficients of X1 and the basis variables (x2, x3). Explain your results.
e. Determine the sensitivity of the optimal solution to change in the Right-Hand side values for the first and the third constraint equations. Explain your reasons.
f. As a manager, what kind of additional useful information you can get from the above table.

(17 marks)
**(Total 22 Marks)**

02.

A Clothing company has factories in cities A and B. Each factory is able to produce 1,600 items of clothing per week, and the retail stores receive shipments of:

1,400 items to store X
700 items to store Y and
1,700 items to store Z per week.

Each piece of cloth must be shipped to warehouses located in cities P and Q to be inspected and packaged for stores.

The transportation cost between cities for each item of clothing is given below

| Cost | P | Q |
|---|---|---|
| A | 4 | 1 |
| B | 2 | 5 |

| Cost | X | Y | Z |
|---|---|---|---|
| P | 4 | 3 | 5 |
| Q | 6 | 4 | 2 |

Based on the above information, develop

i. The transportation diagram of this company
ii. The Linear Programming model for this problem.
iii. The best transportation cost from each factory to each retail store *(hint: among alternative routes*)
iv. Find the initial feasible solution using any method you are familiar with.

**(20 Marks)**

03.

Consider the information given in the table below, draw the network diagram for the project and answer the questions given below.

| Activity | Predecessor | Estimates in weeks |
|---|---|---|
| A | None | 6 |
| B | None | 4 |
| C | None | 3 |
| D | A | 7 |
| E | B | 2 |
| F | C | 5 |
| G | DEF | 2 |
| H | DEF | 3 |
| I | C | 4 |
| J | I | 6 |
| K | J | 3 |
| L | G | 5 |
| M | H | 2 |

i. How many paths are in the network, and what are they?

ii. What is the critical path and its duration?

iii. What is the float on activity G?

iv. What is the impact on the project if activity B takes three weeks longer than planned?

*v.* Given, that the expected duration of a project = 47 days, variance = 9 days. What is the probability of not completing the project in 50 days?

vi. Given, that the expected duration of a project = 47 days, variance = 9 days. Expected Time for Project Completion: 50 days, what is the probability of completing the project within three days, more or less than the expected time?

**(20 Marks)**

04.

i. "At the Economic Order Quantity (EOQ), the total ordering cost is equal to the total holding cost. Also, at the EOQ level the total inventory cost will be minimum".

Elaborate on this statement.

(06 Marks)

ii. A Computer repairs shop in Colombo uses 72,000 units of parts each year to repair Lap-Top computers (The maximum number of computers repaired per day is 50 and for each computer required 4 units of that part.). The ordering cost for one order is Rs. 500/= and it cost Rs. 50 to carry one unit per year of inventory. The shop orders in lots of 1,000 units at a time.

Based on the above information calculate:

a. The present total annual ordering cost
b. The present total annual carrying cost
c. The present total annual inventory cost
d. The Economic Order Quantity
e. The total annual inventory cost using EOQ inventory Policy
f. How much of cost can be saved using the EOQ inventory policy
g. Compute the ordering point assuming the lead time is 3 days

(10 marks)

**(Total 16 Marks)**

05.

i. A company is to decide whether to develop and launch a new product. Research and development costs are expected to be $ 400,000 and there is a 70% chance that the product launch will be successful, and a 30% chance that it will fail. If it is successful, the levels of expected profits and the probabilities of each occurring have been estimated as follows, depending on whether the product's popularity is high, medium, or low:

| Level of success | Probability | Expected profit $ |
|---|---|---|
| High | 0.2 | 1,000,000 |
| Medium | 0.5 | 800,000 |
| Low | 0.3 | 600,000 |

If it is a failure, there is a 0.6 probability that the research and development work can be sold for $ 50,000 and a 0.4 probability that it will be worth nothing at all.

a. The company is risk-neutral, and expects advice from you to which decision should the company make?
b. Calculate the value of perfect information.

(10 marks)

ii. Nadeesha Jewelers sells watches for $ 50 each. During the next month, they estimate that they will sell 15, 25, 35, or 45 watches with respective probabilities of 0.35, 0.25, 0.20, and ... (figure it out). They can only buy watches in lots of ten from their dealer. 20, 30, and 40, watches cost $ 39, $ 37, and $ 36, per watch respectively. Every month, the shop has a clearance sale and will get rid of any unsold watches for $ 24 (watches are only in style for a month and so they have to buy the latest model each month). Any customer that comes in during the month to buy a watch, but is unable to, costs the shop $ 6 in lost goodwill.

Find the best action that could be taken by Nadeesha Jewelers based on the Expected Value decision criteria.

(12 marks)

**(Total 22 Marks)**

**Formula Sheet - Chang in the Right-Hand Side values of constraints**

**Upper limit**

$$Min\left(bi - \frac{Bk}{akj}\right) for \quad all \quad akj < 0$$

Where

bi = the original Right-Hand side values of the $i^{th}$ constraint
bk = the solution value of the $k^{th}$ basic variable
akj = the coefficient in the $k^{th}$ row and $i^{th}$ slack variable column where bi has been changed

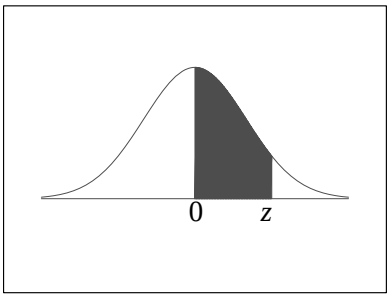
**Lower limit:**

$$Max\left(bi - \frac{Bk}{akj}\right) for\ all \quad akj > 0$$

Where

bi = the original Right-Hand values of the $i^{th}$ constraint
bk = the solution value of the $k^{th}$ basic variable
akj = the coefficient in the $k^{th}$ row and $i^{th}$ slack variable column where bi has been changed

# Standard Normal Distribution Table




| $z$ | .00 | .01 | .02 | .03 | .04 | .05 | .06 | .07 | .08 | .09 |
|---|---|---|---|---|---|---|---|---|---|---|
| 0.0 | .0000 | .0040 | .0080 | .0120 | .0160 | .0199 | .0239 | .0279 | .0319 | .0359 |
| 0.1 | .0398 | .0438 | .0478 | .0517 | .0557 | .0596 | .0636 | .0675 | .0714 | .0753 |
| 0.2 | .0793 | .0832 | .0871 | .0910 | .0948 | .0987 | .1026 | .1064 | .1103 | .1141 |
| 0.3 | .1179 | .1217 | .1255 | .1293 | .1331 | .1368 | .1406 | .1443 | .1480 | .1517 |
| 0.4 | .1554 | .1591 | .1628 | .1664 | .1700 | .1736 | .1772 | .1808 | .1844 | .1879 |
| 0.5 | .1915 | .1950 | .1985 | .2019 | .2054 | .2088 | .2123 | .2157 | .2190 | .2224 |
| 0.6 | .2257 | .2291 | .2324 | .2357 | .2389 | .2422 | .2454 | .2486 | .2517 | .2549 |
| 0.7 | .2580 | .2611 | .2642 | .2673 | .2704 | .2734 | .2764 | .2794 | .2823 | .2852 |
| 0.8 | .2881 | .2910 | .2939 | .2967 | .2995 | .3023 | .3051 | .3078 | .3106 | .3133 |
| 0.9 | .3159 | .3186 | .3212 | .3238 | .3264 | .3289 | .3315 | .3340 | .3365 | .3389 |
| 1.0 | .3413 | .3438 | .3461 | .3485 | .3508 | .3531 | .3554 | .3577 | .3599 | .3621 |
| 1.1 | .3643 | .3665 | .3686 | .3708 | .3729 | .3749 | .3770 | .3790 | .3810 | .3830 |
| 1.2 | .3849 | .3869 | .3888 | .3907 | .3925 | .3944 | .3962 | .3980 | .3997 | .4015 |
| 1.3 | .4032 | .4049 | .4066 | .4082 | .4099 | .4115 | .4131 | .4147 | .4162 | .4177 |
| 1.4 | .4192 | .4207 | .4222 | .4236 | .4251 | .4265 | .4279 | .4292 | .4306 | .4319 |
| 1.5 | .4332 | .4345 | .4357 | .4370 | .4382 | .4394 | .4406 | .4418 | .4429 | .4441 |
| 1.6 | .4452 | .4463 | .4474 | .4484 | .4495 | .4505 | .4515 | .4525 | .4535 | .4545 |
| 1.7 | .4554 | .4564 | .4573 | .4582 | .4591 | .4599 | .4608 | .4616 | .4625 | .4633 |
| 1.8 | .4641 | .4649 | .4656 | .4664 | .4671 | .4678 | .4686 | .4693 | .4699 | .4706 |
| 1.9 | .4713 | .4719 | .4726 | .4732 | .4738 | .4744 | .4750 | .4756 | .4761 | .4767 |
| 2.0 | .4772 | .4778 | .4783 | .4788 | .4793 | .4798 | .4803 | .4808 | .4812 | .4817 |
| 2.1 | .4821 | .4826 | .4830 | .4834 | .4838 | .4842 | .4846 | .4850 | .4854 | .4857 |
| 2.2 | .4861 | .4864 | .4868 | .4871 | .4875 | .4878 | .4881 | .4884 | .4887 | .4890 |
| 2.3 | .4893 | .4896 | .4898 | .4901 | .4904 | .4906 | .4909 | .4911 | .4913 | .4916 |
| 2.4 | .4918 | .4920 | .4922 | .4925 | .4927 | .4929 | .4931 | .4932 | .4934 | .4936 |
| 2.5 | .4938 | .4940 | .4941 | .4943 | .4945 | .4946 | .4948 | .4949 | .4951 | .4952 |
| 2.6 | .4953 | .4955 | .4956 | .4957 | .4959 | .4960 | .4961 | .4962 | .4963 | .4964 |
| 2.7 | .4965 | .4966 | .4967 | .4968 | .4969 | .4970 | .4971 | .4972 | .4973 | .4974 |
| 2.8 | .4974 | .4975 | .4976 | .4977 | .4977 | .4978 | .4979 | .4979 | .4980 | .4981 |
| 2.9 | .4981 | .4982 | .4982 | .4983 | .4984 | .4984 | .4985 | .4985 | .4986 | .4986 |
| 3.0 | .4987 | .4987 | .4987 | .4988 | .4988 | .4989 | .4989 | .4989 | .4990 | .4990 |
| 3.1 | .4990 | .4991 | .4991 | .4991 | .4992 | .4992 | .4992 | .4992 | .4993 | .4993 |
| 3.2 | .4993 | .4993 | .4994 | .4994 | .4994 | .4994 | .4994 | .4995 | .4995 | .4995 |
| 3.3 | .4995 | .4995 | .4995 | .4996 | .4996 | .4996 | .4996 | .4996 | .4996 | .4997 |
| 3.4 | .4997 | .4997 | .4997 | .4997 | .4997 | .4997 | .4997 | .4997 | .4997 | .4998 |
| 3.5 | .4998 | .4998 | .4998 | .4998 | .4998 | .4998 | .4998 | .4998 | .4998 | .4998 |

Gilles Cazelais. Typeset with LaTeX on April 20, 2006.