



**OPEN UNIVERSITY OF SRI LANKA**  
**BACHELOR OF MANAGEMENT STUDIES – LEVEL 06 – 2013**  
**ASSIGNMENT TEST – 2013**  
**OPERATIONS RESEARCH – MCU 4202**  
**DURATION – TWO (02) HOURS**

Date: 12.10.2013

Time: 10.00 am to 12.00 noon

- *Answer any three (03) Questions. All questions carry equal marks.*
- *Graph papers will be provided.*
- *Use of a non-programmable calculator is permitted.*

- (1) Lanka Fruits Ltd., produces two types of soft drinks namely type (A) and type (B). They use sugar and citric acid as resources. One container of type (A) requires 12 kg of sugar and 9 grams of citric acid and gives a profit of Rs.600. One container of type (B) requires 10 kg of sugar and 15 grams of citric acid and gives a profit of Rs.800. 120 kg of sugar and 135 grams of citric acid are available for the daily production.

A summary of these details are shown in the table below.

| Type of soft drink | Resource requirement<br>(per container) |                   | Profit per<br>container (Rs.) |
|--------------------|---|-------------------|-------------------------------|
|                    | Sugar (KG)                              | Citric Acid (GR.) |                               |
| A                  | 12                                      | 9                 | 600                           |
| B                  | 10                                      | 15                | 800                           |
| Daily availability | 120                                     | 135               | -                             |

Lanka fruits in interested in maximizing profit.

- (a) Formulate the linear programming model for this problem.
  - (b) Using graphical method find how many containers of type (A) and type (B) that should be produced daily by Lanka Fruits Ltd.
  - (c) State the limitations of graphical method in solving linear programming models.
- (2) The world food programme hopes to supply food aid to four refugee camps  $C_1$ ,  $C_2$ ,  $C_3$  and  $C_4$  whose monthly demands are 70, 60, 90 and 40 tons respectively. This food aid is to be supplied by three depots  $D_1$ ,  $D_2$ ,  $D_3$  whose monthly capacities are 100, 90 and 70 respectively. The cost of transporting one ton between depots and refugee camps is explained in the table below.

**COST OF TRANSPORT Rs. "000"**

| DEPOT          | REFUGEE CAMPS  |                |                |                |
|----------------|----------------|----------------|----------------|----------------|
|                | C <sub>1</sub> | C <sub>2</sub> | C <sub>3</sub> | C <sub>4</sub> |
| D <sub>1</sub> | 3              | 7              | 3              | 1              |
| D <sub>2</sub> | 2              | 5              | 5              | 2              |
| D <sub>3</sub> | 6              | 4              | 8              | 7              |

It is required to find how food aid should be transported between depots and refugee camps so that the total cost of transport is a minimum.

- (i) Find an initial feasible solution using the North-West Corner Rule method or Least Cost method.
  - (ii) Solve the transportation problem.
  - (iii) State the assumptions to your answer.
- (3) A businessman has four machines M<sub>1</sub>, M<sub>2</sub>, M<sub>3</sub> & M<sub>4</sub> that produce plastic containers and four machine operators; P<sub>1</sub>, P<sub>2</sub>, P<sub>3</sub> & P<sub>4</sub> to work with the machines. Each operator is required to meet a target of 700 containers per day. The number of rejects per day by each operator would depend on the operators as well as the machine he uses as shown in the table below.

**NUMBER OF REJECTS PER DAY**

| OPERATOR       | MACHINE        |                |                |                |
|----------------|----------------|----------------|----------------|----------------|
|                | M <sub>1</sub> | M <sub>2</sub> | M <sub>3</sub> | M <sub>4</sub> |
| P <sub>1</sub> | 17             | 14             | 12             | 15             |
| P <sub>2</sub> | 7              | 10             | 6              | 9              |
| P <sub>3</sub> | 21             | 19             | 23             | 14             |
| P <sub>4</sub> | 14             | 17             | 16             | 11             |

- a) Use assignment theory to find how the operators should be assigned to the machines so as to minimize the total number of rejects.
- b) State the assumptions to your answer.

- (4) Four teachers  $T_1$ ,  $T_2$ ,  $T_3$  and  $T_4$  could teach any of the four subjects  $S_1$ ,  $S_2$ ,  $S_3$  or  $S_4$ . Past experience shows that certain teachers are better on certain subjects as their abilities differ. The average mark obtained by the students when a given teacher is assigned to a given subject is explained in the table below.

**AVERAGE MARK OBTAINED**

| TEACHER | SUBJECT |       |       |       |
|---------|---------|-------|-------|-------|
|         | $S_1$   | $S_2$ | $S_3$ | $S_4$ |
| $T_1$   | 40      | 70    | 30    | 35    |
| $T_2$   | 30      | 55    | 45    | 50    |
| $T_3$   | 65      | 75    | 70    | 80    |
| $T_4$   | 60      | 50    | 85    | 40    |

Use assignment theory to find how the teachers should be assigned the subjects so as to maximize the total marks obtained for all four subjects. (Note that this is a maximization problem and the initial step must be carried out)

Explain the final solution.

- (5) At a barber saloon there is only one barber who on the average takes ten minutes for a haircut. (This time has negative exponential distribution.) Customers arrive in a Poisson fashion at the rate of 5 per hour. The barber saloon works 8 hours a day.
- How many hours does the barber idle per day?
  - What is the probability that there are three customers at the saloon?
  - What is the probability that the barber is idle?
  - On the average how many customers are there at the saloon?
  - How long will a customer have to wait at the saloon?
  - On the average how many customers are waiting to get their hair cut?
  - How long will a customer have to wait until he is called for the hair cut?
  - Due to a closure of a nearby saloon, if the arrival rate of customers is increased to 6 customers per hour (in a Poisson fashion), what would be the length of the queue?

- (6) A project consist of seven activities A, B,....., and G whose precedence and durations are explained in the table below.

| ACTIVITY | PRECEDANCE        | DURATION(DAYS) |
|----------|-------------------|----------------|
| A        | PROJECT START     | 6              |
| B        | PROJECT START     | 7              |
| C        | PROJECT START     | 5              |
| D        | AFTER "A"         | 5              |
| E        | AFTER "C"         | 8              |
| F        | AFTER "B" AND "D" | 4              |
| G        | AFTER "E" AND "F" | 5              |

- Construct the network diagramme.
  - Calculate the float of each activity.
  - Name the critical path.
  - What is the duration of the project?
  - Calculate "EST", "EFT", "LFT" and "LST" of Activity (B).
- (7) Write short notes on **any three** of the following topics.
- Balance transportation problem.
  - Sensitivity analysis of linear programming models
  - Assignment theory.
  - Critical path of a network
  - Float of an activity.

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### MATHEMATICAL FORMULEE

$$\text{Server idle time} = H(1 - \theta)$$

$$\text{Probability that server idle} = (1 - \theta)$$

$$P(n) = \theta^n(1 - \theta)$$

$$L_s = \lambda w_s,$$

$$L_Q = \lambda w_Q$$

$$L_s = \frac{\theta}{(1 - \theta)}$$

$$L_Q = \frac{\theta^2}{(1 - \theta)}$$