



THE OPEN UNIVERSITY OF SRI LANKA
BACHELOR OF MANAGEMENT STUDIES DEGREE PROGRAMME
LEVEL 06
FINAL EXAMINATION – 2016
OPERATIONS RESEARCH – MCU4202
DURATION: THREE (03) HOURS

DATE: 31st July, 2016	TIME: 9.30 am – 12.30 pm
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Answer any 5 questions.
 Use of a non-programmable calculator is allowed.

1. A company manufactures three types of wooden products: tables, chairs and racks. The resource utilization, resource availability and profit per unit of each product is given below:

Product	Resource Requirement			Profit/ unit (Rs.)
	Timber (Cubic feet)	Time in manufacturing department (hours)	Time in finishing department (hours)	
Table	10	7	2	12
Chair	2	3	4	3
Rack	1	2	1	1
Availability of resources	100	77	80	

The quantities of tables, chairs and racks should be determined so that the total profit be maximized.

- a) Formulate a linear programming model for the above problem. (Key: use x_1 , x_2 and x_3 as number of units produced for tables, chairs and racks respectively). (4 marks)
- b) Prepare the first simplex table and find the pivot element, the incoming variable and the outgoing variable. (3 marks)
- c) The final simplex table for the above problem is given below.

Note: s_1 , s_2 , s_3 relates to availability of timber, time in manufacturing department and time in finishing department respectively.

Cj	Basic Variables	Quantity	12	3	1	0	0	0
			x1	x2	x3	s1	s2	s3
12	x1	73/8	1	0	-1/16	3/16	-1/8	0
3	x2	35/8	0	1	13/16	-7/16	5/8	0
0	s3	177/4	0	0	-17/8	11/8	-9/4	1
Zj			12	3	27/16	15/16	3/8	0
Cj -Zj			0	0	-11/16	-15/16	-3/8	0

- (i) What is the optimal solution? (2 marks)
- (ii) What is the resource that restrict further manufacturing as per the above solution? (2 marks)
- (iii) Interpret the shadow prices. (3 marks)
- (iv) Develop the dual for the problem. (4 marks)
- (v) Find the optimal values for the dual variables. (2 marks)

(Total 20 Marks)

2. The following table gives data on time and cost of a project.

Activity	Preceding activity	Normal Time (days)	Crash time (days)	Normal Cost (Rs.)	Crash cost (Rs.)
A	-	6	4	60	100
B	-	4	2	60	200
C	A	5	3	50	150
D	A	3	1	45	65
E	B	6	4	90	200
F	C,E	8	4	80	300
G	E	4	2	40	100
H	F,G	3	2	45	80

- a) Construct the network diagram for this project. (6 marks)
- b) Find the critical path and the minimum project completion time at the lowest cost. (4 marks)
- c) Describe the floats of non-critical activities. (4 marks)
- d) To shorten the project by 2 weeks at the lowest possible cost, which task(s) should be shortened? What are the activities in the critical path(s) after this adjustment? (4 marks)
- e) What would be the increase in total project cost after the shortening the project as per c) above? (2 marks)

(Total: 20 marks)

3. a) Consider the following 9 observations of rainfall per day in milliliters.
2.1, 3.2, 1.5, 2.3, 1.7, 3.4, 1.0, 2.5, 0.8
Randomly identify 4 observations out of them. Explain your process. (Use the random number table below).

Part of a Table of Random Numbers			
61424	20419	86546	00517
90222	27993	04952	66762
50349	71146	97668	86523
85676	10005	08216	25906
02429	19761	15370	43882
90519	61988	40164	15815
20631	88967	19660	89624
89990	78733	16447	27932

(4 marks)

- b) A company has 4 manufacturing plants in cities, A, B, C and D. The goods produced in the plants have to be transported to 5 sales outlets, I, II, III, IV and V. The demand at each sales outlet, the production capacity of each manufacturing plant and the transportation costs (in Rs. Thousands) from each plant to sales outlet are given below:

	I	II	III	IV	V	Capacity
A	7	6	4	5	9	40
B	8	5	6	7	8	30
C	6	8	9	6	5	20
D	5	7	7	8	6	10
Demand	30	30	15	20	5	100

The company wishes to minimize its total transport cost while meeting the demand at sales outlets

- (i) Find the initial feasible solution using the least cost method and compute the cost at this level. (8 marks)
- (ii) Find the optimum solution and cost. (8 marks)
- (Total: 20 Marks)**

4. A small garment manufacturing unit has five tailors stitching five different types of garments. All the five tailors are capable of stitching all the five types of garments. The profit per day for each tailor and garment combinations are given below:

Tailors	Garments				
	1	2	3	4	5
A	14	27	8	24	24
B	8	27	10	21	32
C	16	15	4	27	32
D	12	15	16	30	40
E	14	24	20	27	36

You are required to;

a) Determine the optimal assignment and compute total maximum profit. (10 marks)

b) Suppose that tailor D cannot stitch garment type 3. Determine the new optimal assignment under new condition and compute total maximum profit. (10 marks)

(Total: 20 Marks)

5. Customers arrive at a counter of a theatre at the rate of 12 per hour. There is one clerk serving the customers at the rate of 30 per hour.

a) How many hours does the clerk idle per day? (2 marks)

b) What is the average length in the queue? (2 marks)

c) What is the average customer waiting time in the system? (2 marks)

d) What is the probability that there is no customer waiting to be served? (2 marks)

e) The company policy is to have not more than 2 customers wait in the queue. What is the probability that this policy is violated at the ticketing counter? (3 marks)

f) All customers who purchase a ticket can enter into the theater in that day. On average, how many customers are there at the theatre in a day? (3 marks)

g) If the arrival rate of customers have increased up to 14 per hour, how many clerks are required to provide an equilibrium level of service? (3 marks)

h) Explain the limitations to above answers in the practical situations. (3 marks)

(Total: 20 marks)

6. A stockiest has to supply 12,000 units of a product per year to his customers. The demand is fixed and known. The inventory holding cost is Rs. 0.2/- per unit per month and the ordering cost per order is Rs. 350/-. The cost of a product is Rs. 20/-.
- a) Calculate the economic order quantity (EOQ) of a product. (2 marks)
 - b) Calculate the cost of maintaining the inventory. (2 marks)
 - c) Calculate the reorder level of the products if lead time is 15 days. (2 marks)
 - d) Calculate the reorder level of the products if lead time is 2 months. (3 marks)
 - e) If a discount of 3% is offered for the orders greater than 1500 units but less than 2000 units and 6% discount is offered for orders equal or greater than 2000 units, calculate the inventory costs for every range. (6 marks)
 - f) Calculate the EOQ if the total budget available to purchase products is Rs. 15,000/-. (2 marks)
 - g) Briefly explain the common limitations to your answers given in above a) to f). (3 marks)
- (Total: 20 marks)**

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Formulae

λ Rate of arrival of units

μ Rate of service completion

$\theta = \lambda/\mu$

H = Number of working hours per day

$P_{(n)}$ = Probability of "n" units in the queuing system

L_s = Average number of units in queuing system

L_q = Average number of units in queue

W_s = Average time spent by unit in queuing system

W_q = Average time spent by unit in queue

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

$P(n) = \theta^n P(0)$ _____ (2)

$P(n) = \theta^n (1-\theta)$ _____ (3)

$\left[\begin{array}{l} \text{Probability that} \\ \text{queuing system empty} \end{array} \right] = (1-\theta)$ _____ (4)

$\left[\begin{array}{l} \text{Probability that} \\ \text{the server is idle} \end{array} \right] = (1-\theta)$ _____ (5)

$\left[\begin{array}{l} \text{Number of hours} \\ \text{server idle per day} \end{array} \right] = H(1-\theta)$ _____ (5)

$L_s = \theta/(1-\theta)$ _____ (7)

$L_q = \theta^2/(1-\theta)$ _____ (8)

$L_s = \lambda W_s$ _____ (9)

$L_q = \lambda W_q$ _____ (10)

$$EOQ = \sqrt{\frac{2DA}{C}}$$

$$EOQ = \sqrt{\frac{2DA}{C(1-\frac{D}{R})}}$$

$$K = \frac{DA}{Q} + \frac{QC}{2} - \frac{DRm}{100}$$

$$EOQ = \sqrt{\frac{2DA(C+S)}{CS}}$$