THE OPEN UNIVERSITY OF SRI LANKA
BACHELOR OF MANAGEMENT STUDIES DEGREE PROGRAMME
LEVEL 06
FINAL EXAMINATION – 2015
OPERATIONS RESEARCH – MCU4202
DURATION: THREE (03) HOURS

DATE: 28th July 2015	TIME: 1.30 pm – 4.30pm

Answer 5 questions only.
Use of a non-programmable calculator is allowed.

1. The ABC Publishing Ltd publishes two types of magazines on a monthly basis, an 'Entertainment Guide' (x_1) and a 'Fashion Guide' (x_2). The company distributes the magazines free to businesses, hotels, and stores. The company's profits come exclusively from paid advertising published in the magazines. Each of the 'Entertainment Guide' distributed generates profits of Rs. 50/- per magazine while the 'Fashion Guide' generates Rs. 75/- per magazine. The fashion magazine is a more sophisticated publication that includes colour photos and accordingly it costs Rs. 25/- per each magazine to print, compared with only Rs. 17/- for the entertainment guide. The publishing company has a printing budget of Rs. 400,000/- per month. There is enough storage space to store the both type of printed magazines for at most 18,000 each month. ABC Publishing estimates that the maximum demand for each type magazine is limited to 10,000 copies per month.

   a) Formulate a linear programming model for the above problem. (5 marks)

   b) Prepare the first simplex table and find the pivot element, the incoming variable and the outgoing variable. (3 marks)

   c) Find the set of figures in the row containing the slack variable of unused rack space in the second simplex table. (5 marks)

   d) The final simplex table is given below. Note: s_1, s_2, s_3, s_4 relates to unused capacity in budget, unused rack space and unsatisfied demand in entertainment and fashion guides respectively.

Cj	Basic Variables	Quantity	50	75	0	0	0	0
			x_1	x_2	s_1	s_2	s_3	s_4
	s_1	14,000	0	0	1	-17	0	-8
	s_3	2,000	0	0	0	-1	1	1
	x_1	8,000	1	0	0	1	0	-1
	x_2	10,000	0	1	0	0	0	1
	Zj	1,150,000	50	75	50	50	0	25
	Cj -Zj		0	0	0	-50	0	-25

Interpret the final simplex table. (7 marks)

(Total 20 Marks)

2. The activities and costs given below are related to a system development project.

Activity	Preceeding activity	Duration (Normal Time) (weeks)	Crash time (weeks)	Normal Cost (Rs. '000)	Crash cost (Rs. '000)
A	-	5	3	20	30
B	-	3	2	10	20
C	A	3	2	16	24
D	A	6	3	25	43
E	B	5	4	22	30
F	B	7	4	30	48
G	C,D	9	5	25	53
H	E,F	7	6	30	44

a) Construct the network diagram for this project. (8 marks)

b) Find the critical path and the total project cost for the project. (4 marks)

c) To shorten the project by 3 weeks at the lowest possible cost, which task(s) should be shortened? (5 marks)

d) What would be the new total project cost after the shortening the project? (3 marks)

(Total: 20 marks)

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3. a) What is meant by a balanced transportation problem? Explain. (4 marks)

   b) The Apple Products Plc produces apple sauce at three plants in upstate New York. Much of the apple sauce is then put in 100 kg barrels and shipped to food processing companies in Europe where it is bottled and distributed. The company ships the apple sauce from the ports closest to its plants in New York City, Philadelphia and Norfolk. The European food processing plants are in Austria, Belgium, Germany, and France. When apple sauce is shipped it arrives in European port and then is transported by truck to the final destination. The shipping cost per barrel from each US port to the European plants, as well as the supply from each port and the demand at each plant, per week are as follows:

US Port of Shipping	European Plant				
	A Austria	B Belgium	C Germany	D France	Supply
New York	12	10	9	7	250
Philadelphia	10	6	7	8	350
Norfolk	13	8	12	11	300
Demand	170	205	130	260	

   (i) The Apple Products Plc wishes to minimize its overall transport cost. 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 plant has four operators to be assigned to four machines. The time (minutes) required by each worker to produce a product on each machine is shown in the following table.

Operator	Machine			
	A	B	C	D
1	10	12	9	11
2	5	10	7	8
3	12	14	13	11
4	8	15	11	9

a) Determine the optimal assignment and compute total minimum time. (10 marks)

b) Find how the projects be assigned if there is a condition that operator 4 should not be assigned to machine A. (10 marks)

(Total: 20 Marks)

5. The manager of a pharmacy has received several complaints about the longer time taken to issue medicine and drugs to customers. With a preliminary investigation, the manager found that the customers arrive at the rate of 100 per hour. The service of the person in the issuing counter averages for 30 seconds per customer. The issuing counter is open for 10 hours per day.

a) How many hours do a person in the issuing counter idles per day? (2 marks)

b) What is the average length in the queue? (3 marks)

c) What is the average customer waiting time in the system? (3 marks)

d) What is the probability that there are 2 customers at the queue? (3 marks)

e) On average how many customers are there at the pharmacy in a day? (3 marks)

f) If the pharmacy has a seating capacity of 10 chairs, what is the probability that there are customers standing in the system? (3 marks)

g) What is the least number of chairs required to arrange seats for all customers at any given time? (3 marks)

(Total: 20 marks)

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6. The Wheels Ltd is a wholesale distributor of bicycles. Its inventory manager is currently reviewing the inventory policy for one popular bicycle in which the annual demand is 1500 bicycles. The administrative cost of placing an order for this model from the manufacturer is Rs. 1200/- and the cost of holding per bicycle for one year is Rs. 90/-. The cost of a bicycle is Rs. 7000/-.

a) Calculate the economic order quantity (EOQ) of the bicycle for the company.　　　(3 marks)

b) Calculate the cost of maintaining the inventory of bicycles.　　　(3 marks)

c) Calculate the reorder level of bicycles if lead time is 1 month.　　　(2 marks)

d) Calculate the reorder level of bicycles if lead time is 4 months.　　　(2 marks)

e) Calculate EOQ if the capital available to purchase bicycles is Rs. 1,000,000/-.　　　(2 marks)

f) Calculate the EOQ if the total storage space available for bicycles is 6000 square feet while the capacity requirement for one bicycle is 250 square feet.　　　(2 marks)

g) Calculate the EOQ, if 5% discount is given when purchasing more than 150 bicycles at a time.　　　(3 marks)

h) If the company produces the bicycles with a capacity of 2000 bicycles at a time and if the setup cost of the machine is Rs. 500/-, calculate the EOQ.　　　(3 marks)

(Total: 20 marks)

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Formulae

λ Rate of arrival of units

μ Rate of service completion

θ = λ/μ

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)

$$\begin{bmatrix} Probability\ that \\ queuing\ system\ empty \end{bmatrix} = (1-\theta) \text{—————————— (4)}$$

$$\begin{bmatrix} Probability\ that \\ the\ server\ is\ idle \end{bmatrix} = (1-\theta) \text{—————————— (5)}$$

$$\begin{bmatrix} Number\ of\ hours \\ server\ idle\ per\ day \end{bmatrix} = H(1-\theta) \text{—————————— (5)}$$

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

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

L_s = λW_s —————————— (9)

L_q = λW_q —————————— (10)

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

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

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

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

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