THE OPEN UNIVERSITY OF SRI LANKA
BACHELOR OF MANAGEMENT STUDIES DEGREE PROGRAMME
LEVEL 6
FINAL EXAMINATION - 2014
OPERATIONS RESEARCH MCU4202
DURATION – THREE (3) HOURS

DATE: 19th July, 2014	TIME: 1.30 pm – 4.30 pm

Instructions

(i) *Answer any **FIVE (5)** questions.*
(ii) *All questions carry equal (20) marks.*
(iii) *Use of a non-programmable calculator is allowed.*
(iv) *Use graph papers where necessary.*

Q (1). A businessman observes that the annual demand for a small size plastic water tanks is 750. He needs advice in inventory management. He finds that the cost of holding one tank in stock for one year is 5% of the cost of the tank. The cost of placing one order for tanks is Rs. 1800/-. The cost of a water tank is Rs. Rs. 600/-.

a). If stock outs are not allowed find,
(i) Economic order quantity (EOQ) of water tanks for the businessman.
(ii) The minimum inventory cost corresponding to the economic order quantity.
(iii) Reorder level of water tanks, if lead time is two months.
(iv) Economic order quantity of water tanks, if a discount of 10% is given to all orders more than 200 tanks.

b). If stock outs are allowed, and cost of running one item out of stock for one year is Rs. 25 find,
(i). Economic order quantity (EOQ).
(ii). Illustrate this result graphically. (You are not required to draw this at a proper scale.)

Q (2). A project consist of ten activities, A, B, C, ... and J, whose precedence, duration, crash cost per day and number of days the activity could be crashed are given below.

Activity	Precedence	Duration days	Crash cost "Rs. 000"	Maximum possible days crash
A	Project start	5	5	2
B	Project start	8	9	1
C	Project start	6	1	1
D	After "A"	4	7	1
E	After "A"	3	2	1
F	After "B" and "D"	6	1	2
G	After "C"	4	3	2
H	After "C"	8	1	5
I	After "E","F" and "G"	7	2	1
J	After "H" and "I"	3	2	2

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(i) Construct the network diagram for the project.
(ii) Find the float of each activity.
(iii) Name the critical path.
(iv) What is the shortest time to complete the project without crashing activities?
(v) Find "EST", "EFT", "LST" and "LFT" of activity "G".
(vi) It is proposed to reduce the duration of the project by five days with least cost. What are the activities you would crash and the additional cost of reducing the project duration as proposed?

Q(3). (a). State the six factors that govern the behavior of a queuing system.

(b). A service station has only one plant to service vehicle and two parking lots within the service station to park vehicles to be serviced. Vehicles arrive in a Poisson fashion at the rate of 20 per day and if they find that both parking lots are occupied the vehicle is parked on the wayside. The time taken to service one vehicle is 25 minutes it and has a negative exponential distribution. The service station works 10 hours a day.

(i) What is the probability that there are three vehicles at the service station?
(ii) How many hours will the service station idle per day?
(iii) On the average how many vehicles are there at the service station?
(iv) On the average how long will a vehicle be there at the service station?
(v) What is the probability that both parking lots are vacant?
(vi) What is the probability that a vehicle that just arrives will be parked on the wayside?

Q(4). (a). State the limitations of assignment theory.

(b). Tenders have being called for four projects, P_1, P_2, P_3 and P_4, from four contractors, C_1, C_2, C_3 and C_4, who are genuine and has kept a good past record. Each contractor has quoted for all four projects and their quotations differ as shown in the table below.

<u>Quotation in Rs. "000"</u>

Contractor	Projects			
	P_1	P_2	P_3	P_4
C_1	17	14	12	18
C_2	11	7	9	8
C_3	21	27	15	12
C_4	20	17	14	16

(i) Develop the above as a linear programming model.
(ii) Using the assignment theory find how the projects should be assigned among the contractors such that the total cost of all four projects is a minimum.
(iii) Find how the projects be assigned if there is a condition to say that project "P_2" should not be given to contractor "C_2".

Q(5). Ceylon Electrical Ltd. is a manufacturer of electrical items hopes to close down their factory and wishes to programme their work for the remaining five days. They work 24 hours a day and produce two components, Type (A) and Type (B). The resources they use are machine time and capital to buy raw materials. One item of Type (A) needs one hour of machine time and Rs. 1000/- worth of raw materials. It gives a profit of Rs. 500/- per unit. One item of Type (B) needs two hours of machine time, Rs. 1500/- worth of raw materials and gives a profit of Rs. 750/-. The factory has only one machine that works 24 hours a day. Rs. 80,000/- is available to be spent on raw materials. In view of the size of Type "A" component and limited storage capacity of the factory, the number of items of Type (A) component produced for the remaining five days should not exceed 50. Ceylon Electricals Ltd. hopes to maximize profit and wishes to know how many of Type (A) and Type (B) items they should produce for the remaining five days.

You are required to;

(i) Formulate the above issue as a linear programming model.

(ii) Solve the problem using graphical method.

(iii) Would your optimal solution change if the limit on maximum of Type (A) items produced is removed? If so what is the new solution and increase in total profits.

Q(6). R_1, R_2, R_3 and R_4 are four refinery plants whose weekly demand for crude oil are 80, 170, 110 and 140 metric tons, respectively. This crude oil is distributed from three ports P_1, P_2 and P_3, whose weekly capacities are 175, 200 and 125 metric tons, respectively. The cost of transporting one metric ton from a given port to a given refinery plant is explained in the table below.

Cost of transporting one metric ton "Rs. 000"

Port	Refinery plant			
	R_1	R_2	R_3	R_4
P_1	4	2	5	3
P_2	3	1	2	6
P_3	2	3	4	1

(i) Find an initial feasible solution using Least Cost method or North West Corner Rule method.

(ii) Solve the transportation problem using MODI method or Stepping Stone Method

(iii) Interpret the results with distribution plan and the total cost of the plan.

(iv) If the transport from Port P_3 to Refinery R_4 is not possible, is your solution remains optimal? If not what should be the new solution.

Q(7). Lanka Metal Craft Inc. produces trays and buckets. They use brass and labor as resources. The management of the company wishes to maximize its profits. The linear programming model for the problem is as follows.

Maximize Z, $Z = 6x_1 + 10x_2$

For brass $x_1 + 4x_2 \leq 90$

For labour $2x_1 + 2x_2 \leq 60$

$x_1 \geq 0,\ x_2 \geq 0$

The final simplex table for the problem which is incomplete is shown below.

C_b \ C_j	Basis	Solution	6	10		
			x_1	x_2	s_1	s_2
	x_2	20			1/3	- 1/6
	x_1	10			-1/3	2/3
	Z_j					
	$C_j - Z_j$					

(i) Copy the above table and complete it.

(ii) Is the solution feasible? (Give reasons)

(iii) Is the solution optimal? (Give reasons)

(iv) Write down the optimal solution with proper interpretation.

(v) Are their multiple optimal solutions? (Give reasons)

(vi) Find the range of values of the objective function coefficients for which the solution remains optimal.

(vii) Write down the dual of this problem.

(viii) By looking at the final simplex table write down the solution of the dual problem.

Formula list with standard notations

(i) EOQ $= \sqrt{\frac{2DA}{C}}$

(ii) $K_{(COST)} = \frac{DA}{Q} + \frac{1}{2} QC$

(iii) EOQ $= \sqrt{\frac{2DA}{C}\left(\frac{C+S}{S}\right)}$ - (with stock outs)

(iv) Maximum level of stock (a) $= \frac{S \times EOQ}{(C+S)}$

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

(vi) Server idle time $= H(1-\theta)$

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

(ix) $L_s = \lambda w_s$