Seat No. : _______________

LA-106

April-2014

T.Y. M.B.A. (Integrated) (K.S.)

Operations Research

Time : 3 Hours] **[Max. Marks : 100**

Instructions : (1) Non-programmable scientific calculators are allowed.
(2) Attempt questions in sequence and answer fresh question on fresh age.

1. Attempt any **two** : **20**

(a) Give the mathematical and economic structure of the linear programming problem. What requirements should be met in order that the linear programming may be applied ?

(b) Use the graphical method to solve the following linear programming problem :

Min. $Z = 20x_1 + 10x_2$

Subject to the constraints

$$x_1 + 2x_2 \leq 40$$
$$3x_1 + x_2 \geq 30$$
$$4x_1 + 3x_2 \geq 60$$
$$x_1, x_2 \geq 0$$

(c) A firm plans to purchase atleast 200 quintals of scrap containing high quality metal X and low quality metal Y. It decides that the scrap to be purchased must contain atleast 100 quintals of X-metal and not more than 35 quintals of Y-metal. The firm can purchase the scrap from two supplies (A and B) in unlimited quantities. The percentage of X and Y metals in terms of weight in the scrap supplied by A and B is given below :

Metals	**Supplier A**	**Supplier B**
X	25%	75%
Y	10%	20%

The price of A's scrap is ₹ 200 per quintal and that of B is ₹ 400 per quintal. Formulate it as a linear programming problem.

2. Attempt any **two :** **20**

(a) Solve the following LPP using a simplex method :

Max. $Z = 8x_1 - 4x_2$

Subject to the constraints

$4x_1 + 5x_2 \leq 20$

$-x_1 + 3x_2 \geq -23$

$x_1 \geq 0$, x_2 unrestricted in sign.

(b) Solve the following LPP by using two-phase simplex method :

Minimize $Z = x_1 - 2x_2 - 3x_3$

Subject to the constraints :

$-2x_1 + x_2 + 3x_3 = 2$

$2x_1 + 3x_2 + 4x_3 = 1$

$x_1, x_2, x_3 \geq 0$

(c) Solve the following LPP using dual simplex method :

Minimize $Z = 2x_1 + 4x_2$

Subject to the constraints :

$2x_1 + x_2 \geq 4$

$x_1 + 2x_2 \geq 3$

$2x_1 + 2x_2 \leq 12$

$x_1, x_2 \geq 0$

3. (a) Obtain the dual problem of the following primal LPP : **5**

Min. $Z = x_1 - 3x_2 - 2x_3$

Subject to the constraints

$3x_1 - x_2 + 2x_3 \leq 7$

$2x_1 - 4x_2 \geq 12$

$-4x_1 + 3x_2 + 8x_3 = 10$

$x_1, x_2 \geq 0$; x_3 unrestricted in sign.

(b) A company sells two different products : A and B. The selling price and incremental cost information is as follows : **15**

	Product A	**Product B**
Selling Price (₹)	60	40
Incremental Cost (₹)	30	10
Incremental Profit (₹)	30	30

The two products are produced in a common production process and are sold in two different markets. The production process has a capacity of 30000 labour hours. It takes three hours to produce a unit of A and one hour to produce a unit of B. The market has been surveyed and company officials feel that the maximum number of units of A that can be sold is 8000 and that of B is 12000 units :

(i) Find the optimal product mix.

(ii) Suppose maximum number of units of A and B that can be sold is actually 9000 units and 13000 respectively instead of as given in the problem, what effect does this have on the solution and the profit.

(iii) Suppose there are 31000 labour hours available instead of 30000 as in the base case, what effect does this have on the solution and the profit.

4. Attempt any **two :** **20**

(a) The demand and production costs vary from month to month in an industry. The following table contains budgeted information of a firm in this industry on the quantity demanded, the production cost per unit and the production capacity in each of the coming five months :

Month	**Jan**	**Feb**	**Mar**	**Apr**	**May**
Demand :	200	250	150	80	120
Production Cost :	24	27	32	30	34
Capacity :	250	225	250	200	225

It is known that the production in any month can meet demand in that month or can be held for the future. The holding cost is ₹ 5 per unit per month. Using this information formulate a transportation model of assist in the production planning.

(b) A company is producing three products P_1, P_2 and P_3 at two of its plants situated in cities A and B. The company plans to start a new plant in either city C or in City D. The unit profits from the various plants are listed in the table, along with the demand for various products and capacity available in each of the plants :

Plant	**Product**			**Capacity**
	P_1	P_2	P_3	
A	35	24	20	600
B	30	28	25	1000
C	20	25	37	800
D	24	32	28	800
Demand	500	800	600	

The company would set up the new plant on the basis of maximizing aggregate profits from the three cities' plants. Using transportation method determine in which city would the plant be set up and what would the corresponding profit be ?

(c) Consider a firm having two factories. The firm is to ship its products from the factories to three-retail stores. The number of units available at factories X and Y are 200 and 300, respectively, while those demanded at retail stores A, B and C are 100, 150 and 250, respectively. Rather than shipping directly from factories to retails stores, it is asked to investigate the possibility of trans-shipment. The transportation cost (in rupees) per unit is given in the table :

		Factory		**Retail Store**		
		X	**Y**	**A**	**B**	**C**
Factory	X	0	8	7	8	9
	Y	6	0	5	4	3
Retail Store	A	7	2	0	5	1
	B	1	5	1	0	4
	C	8	9	7	8	0

Formulate it as a trans-shipment problem.

5. Attempt any **two :** **20**

(a) A college is having a degree programme for which the effect semester time available in very less and the programme requires field work. Hence, a few hours can be saved from the total number of class hours and can be utilized for the field work. Based on past experience, the college has estimated the number of hours required to teach each subject by each faculty. The course in its present semester has 5 subjects and the college has considered 6 existing faculty members to teach these courses. The objective is to assign the best 5 teachers out of these 6 faculty members to teach 5 different subjects so that the total number of class hours required is minimized. The data of this problem is summarized in the table. Solve this assignment problem optimally.

		Subject				
		1	2	3	4	5
Faculty	1	30	39	31	38	40
	2	43	37	32	35	38
	3	34	41	33	41	34
	4	39	36	43	32	36
	5	32	49	35	40	37
	6	36	42	35	44	42

(b) The flight timings between two cities X and Y are as given in the following tables. The minimum layover time of any crew in either of the cities is 2 hours. Determine the base city for each crew so that the sum of the layover times of all the crew members in non-base cities is minimized.

Flight Timings from City X to City Y			**Flight Timings from City Y to City X**		
Flight No.	**Departure time (from City X)**	**Arrival time (to City Y)**	**Flight No.**	**Departure time (from City X)**	**Arrival time (to City Y)**
101	5 a.m.	6.15 a.m.	201	6.30 a.m.	7.30 a.m.
102	9 a.m.	10.15 a.m.	202	9.00 a.m.	10.30 a.m.
103	1 p.m.	2.15 p.m.	203	3.30 p.m.	4.30 p.m.
104	6 p.m.	7.15 p.m.	204	10.00 p.m.	11.00 p.m.

(c) A machine operator processes four types of items on his machine and he must choose a sequence for them. The set-up cost per change depends on the items currently on machine and the set-up to be made according to the following table :

		To			
		A	B	C	D
	A	–	4	7	3
From item	B	4	–	6	3
	C	7	6	–	7
	D	3	3	7	–

If he processes each of the items once and only once each week, then how should he sequence the item on his machine ? Use the method for the problem of traveling salesman.