LINEAR PROGRAMMING PROBLEM

PART A : FORMULATION

Q.1. A company has three operational departments (weaving, processing and packing) with capacity to produce three different types of clothes namely suitings, shirtings and woollens yielding the profit ₹ 2, ₹ 4 and ₹ 3 per meter respectively. One - meter suiting requires 3 minutes in weaving, 2 minutes in processing and 1 minute in packing. Similarly one meter of shirting requires 4 minutes in weaving. 1 minute in processing and 3 minutes in packing while one meter woollen requires 3 minutes in each department. In a week, total run time of each department is 60, 40 and 80 hours for weaving, processing and packing departments respectively.
Formulate the linear programming problem to find the product mix to maximize the profit.

Q.2. The Voltex Company produces an air conditioner / heating unit. The company currently has firm orders for 6 months into the future. The company can schedule its production over the next 6 months to meet orders on either a regular or on overtime basis. Consider orders and the associated production costs for the next 6 months as follows :

Month	Jan.	Feb.	March	April	May	June
Orders	590	610	650	700	500	700
Cost per unit (₹)						
: Regular Production	50	52	51	55	47	50
: Overtime Production	62	58	63	60	55	52

Maximum number of units which can be produced on regular and overtime basis are 500 and 300 respectively.
With 75 air conditioners in stock at the beginning of January, the company wishes to have at least 100 air conditioners in stock at the end of June. The inventory - carrying costs for air conditioners is ₹ 10 per unit per month.
Formulate the problem as Linear Programming Problem.

Q.3. A city hospital has the following minimal daily requirement for nurses:

Period	Clock time (24 hours day)	Minimal number of nurses required
1	6 AM – 10 AM	2
2	10 AM – 2 PM	7
3	2 PM – 6 PM	15
4	6 PM – 10 PM	8
5	10PM – 2 AM	20
6	2 AM – 6 AM	6

Nurses report to the hospital at the beginning of each period and work for consecutive 8 hours. The hospital wants to determine the minimal number of nurses to be employed so that there will be sufficient number of nurses available for each period. Formulate LPP. Do not solve.

PART B : SIMPLEX METHOD

Q.1. Solve the following L.P.P. by the Simplex Method

Maximize Z $6x_1 + 7x_2$

Subject to : $2x_1 + 3x_2 \leq 12$

$2x_1 + x_2 \leq 8$

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

Q.2. Solve the following L. P. P. by the Simplex Method.

Minimize Z = $750y_1 + 200y_2 + 600y_3$

Subject to : $y_1 + y_3 \leq 3$

$3/2y_1 + 5y_2 + y_3 \geq 4$

Where $y_1, y_2, y_3 \geq 0$

Q.3. Given below are the objective function, the constraints and the final simplex tableau for a linear programming product - mix problem.

Objective function :

Maximize z = 2x1 + 5x2 + 8x3 + 0.s1 + 0.s2 + 0.s3

subject to the constraints

6x1 + 8x2 + 4x3 < 96 (hours, Department I)

2x1 + x2 + 2x3 < 40 (hours, Department II)

5x1 + 3x2 + 2x3 < 60 (hours, Department III)

x1, x2, x3 > 0

FINAL SIMPLEX TABLEAU

Basic Variable	Profit Per Unit	Quantity	2 X_1	5 X_2	8 X_3	0 S_1	0 S_2	0 S_3	
X_2	5	8/3	1/3	1	0	1/6	-1/3	0	
X_3	8	56/3	5/6	0	1	-1/12	2/3	0	
S_3	0	44/3	7/3	0	0	-1/3	-1/3	1	
Z_j			25/3	5	8	1/6	11/3	0	$162\frac{2}{3}$
$C_j - Z_j$			-19/3	0	0	-1/6	-11/3	0	

(i) Write the optimum product mix and the profit contribution shown by the above solution.

(ii) Is this solution feasible? Why? Given brief reason(s).

(iii) Does the problem have any alternative optimum solution? If, so show one such solution.

(iv) Indicate the shadow prices of three departments.

(v) If the company wishes to expand the production capacity, which of the three departments should be given priority.

(vi) If the customer is prepared to pay higher prices for x1 how much should price being increased so that companies profit remain unchanged?

PART B : GRAPHICAL METHOD

Q.1. Solve the following L.P.P. by the graphical method.

Maximize Z = $8x_1 + 16x_2$

Subject to : $x_1 + x_2 < 200$

$x_2 < 125$

$3x_1 + 6x_2 < 900$

$x_1 , x_2 > 0$

Q.2. An advertising firm desires to reach two types of audiences - customers with annual income of more than ₹ 40,000 (target audience A) and customers with annual income of less than ₹ 40,000 (target audience B). The total advertising budget is ₹ 2,00,000. One programme of T.V. advertising costs ₹ 50,000 and one programme of Radio advertising costs ₹ 20,000. Contract conditions ordinarily require that there should be at least 3 programmes on T.V. and the number of programmes on Radio must not exceed 5. Survey indicates that a single T.V. programme reaches 7,50,000 customers in target audience A and 1,50,000 in target audience B. One Radio programme reaches 40,000 customers in target audience A and 2,60,000 in target audience B.

Formulate this as a linear programming problem and determine the media mix to maximize the total reach using graphic method.