Question 1. Circle the correct answer.

1. In simplex method , we add --------------- variables in the case of '='

A. Slack Variable	B. Surplus Variable	C. Artificial Variable	D. None of the above

2. If the feasible region of a LPP is empty, the solution is ---no Solution---

Infeasible	Unbounded	C. Alternative	D. None of the above

3. A minimization problem can be converted into a maximization problem by changing the sign of coefficients in the ----------------

A. Constraints	B. Objective Functions	C. Both A and B	D. None of the above

4. If in a LPP , the solution of a variable can be made infinity large without violating the constraints, solution is ----------------

A. Infeasible	B. Unbounded	C. Alternative	D. None of the above

5. In maximization cases , ----------- are assigned to the artificial variables as their coefficients in the objective function

A. +M	B. –M	C. 0	D. None of the above

RHS

6. Alternative solution exist in a linear programming problem when

A. one of the constraint is redundant	B. objective function is parallel to one of the constraints	C. two constraints are parallel	D. all of the above

7. . Constraints in an LP model represents

A. Limitations	B. Requirements	C. balancing limitations and requirements	D. all of above

8. To convert ≥ inequality constraints into equality constraints, we must

A. add a surplus variable	B. subtract an artificial variable	C. subtract a surplus variable and an add artificial variable	D. add a surplus variable and subtract an artificial variable

9. . If for a given solution, a slack variable is equal to zero, then

A. the solution is optimal	B. the solution is infeasible	C. there exist no solution	D. None of the above

10. . In the optimal simplex table $z_j - c_j = 0$ value indicates

A. unbounded solution	B. degenerate	C. alternative solution	D. None of these

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Question 2. Consider the following problem.

Maximize $Z = 4x_1 + 2x_2 + 3x_3 + 5x_4$

subject to

$$2x_1 + 3x_2 + 4x_3 + 2x_4 = 300$$
$$8x_1 + x_2 + x_3 + 5x_4 = 300$$

And $x_j \geq 0$, for $j = 1, 2, 3, 4$.

(a) Using the Big M method, construct the complete first simplex tableau for the simplex method and identify the corresponding initial (artificial) BF solution.

(b) Identify the initial entering basic variable and the leaving basic variable.

$\max Z - 4x_1 - 2x - 3x_3 - 5x_4 + M\bar{x}_5 + M\bar{x}_6 = 0$

$-M(2x_1 + 3x_2 + 4x_3 + 2x_4 + \bar{x}_5 = 300)$

$-M(8x_1 + x_2 + x_3 + 5x_4 + \bar{x}_6 = 300)$

a)

$\max Z + (-4-10M)x_1 + (-2-4M)x_2 + (-3-5M)x_3 + (-5-7M)x_4 = -600M$

	Z	x_1	x_2	x_3	x_4	$\bar{x}_5$	$\bar{x}_6$	RHS	Ratio
Z	1	(-4-10M)	(-2-4M)	(-3-5M)	(-5-7M)	0	0	-600M	
$\bar{x}_5$	0	2	3	4	2	1	0	300	300/2
$\bar{x}_6$	0	8	1	1	5	0	1	300	300/8

artificials $\Rightarrow$ $\bar{x}_5$ $\bar{x}_6$

first leaving variable $= x_1$

first intering variable $= \bar{x}_6$

	Z	x_1	x_2	x_3	x_4	$\bar{x}_5$	$\bar{x}_6$	RHS
Z	1	0	$-\frac{11}{4}M - \frac{3}{2}$	$-5/2 + \frac{-15}{4}M$	$21/4M - 5/2$	0	$\frac{10}{8}M + \frac{1}{2}$	$-225M + \frac{300}{2}$
$\bar{x}_5$	0	0	11/4	15/4	+3/4	1	-2/8	225
x_1	0	1	1/8	1/8	5/8	0	1/8	300/8

$\frac{-11}{4}M$

0

Question 3. A company produces precision medical diagnostic equipment at two factories. Three medical centers have placed orders for this month's production output. The table below shows what the cost would be for shipping each unit from each factory to each of these customers. Also shown are the number of units that will be produced at each factory and the number of units ordered by each customer.

From \ To	Unit Shipping Cost: Customer 1	Customer 2	Customer 3	Output
Factory 1	\$600	\$800	\$700	400 units
Factory 2	\$400	\$900	\$600	500 units
Order size	300 units	200 units	400 units	

A decision now needs to be made about the shipping plan for how many units to ship from each factory to each customer.

Formulate a linear programming model for this problem. DO NOT SOLVE

~~x_1 = units of 1~~ ~~x_2 = units of 2~~ ~~units of 3 = x_3~~

~~$x_1, x_2, x_3 \geq 0$~~

x_1 → units from fact 1

x_2 → units from fact 2

$x_1, x_2 \geq 0$

$400x_1 + 500x_2 \leq 300$

$400x_1 + 500x_2 \leq 200$

$400x_1 + 500x_2 \leq 400$

max $Z = (600+800+700)x_1 + (400+900+600)x_2$

↳ maximize Profit of shipping for factories

1.25 0 .5 3/4 3/4 2 8/3

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Question 4. Max Z= $2x_1 + 3x_2 + 4x_3$ max $z = (2+d_1)x_1 + (3+d_2)x_2 + (4+d_3)x_3$

s.t. $1x_1 + 2x_2 + 3x_3 \le 11$

$2x_1 + 3x_2 + 2x_3 \le 10$

$x_1, x_2, x_3 \ge 0$

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min W = $11y_2 + 10y_1$

$2y_1 + y_2 \ge 2$

$3y_1 + 2y_2 \ge 3$

$2y_1 + 3y_2 \ge 4$

$y_1, y_2 \ge 0$

Consider the FINAL tableau and answer the following questions

			Coefficient of					RHS
			d_1	d_2	d_3	0	0	
		Z	x_1	x_2	x_3	x_4	x_5	
1	Z	0	1	0	0.5	0	1	0.5	16
d_3	x_3	1	0	0	0.25	1	0.5	−0.25	3
d_1	x_1	2	0	1	1.25	0	−0.5	0.75	2

b_1

① $.5 + .25d_3 + 1.25d_1 - d_2$

$d_3 = d_1 = 0$

$d_2 \le .5$ allowable increse . $3+.5 = 3.5$ = decrease => ∞

$(-\infty, 3.5]$

2.5 1. *Calculate the allowable increase and allowable decrease for* c_2

3 2. *Calculate the allowable increase and allowable decrease for* b_1

b_1 3 3. *If we decrease change* b_1 *by one unit, what will be the new objective function value?*

$11 \to 10$ 3 4. *Find the Dual for the above problem*

0 5. *What is the complimentary optimal basic solution* = $\boxed{16}$ ~~Same~~ in primal

For each scenario (below) follow the sensitivity analysis procedure and ***comment on your results.***

z = y b

1 6. *Change the right-hand sides* $\begin{bmatrix} b_1 \\ b_2 \end{bmatrix} = \begin{bmatrix} 11 \\ 10 \end{bmatrix} \to \begin{bmatrix} 15 \\ 15 \end{bmatrix}$

$[1 \; .5]\begin{bmatrix}15\\15\end{bmatrix} = 15 + 7.5 =$

$\begin{bmatrix} .5 & -\frac{1}{4} \\ -\frac{1}{2} & \frac{3}{4} \end{bmatrix}\begin{bmatrix}15\\15\end{bmatrix} = \begin{bmatrix}\frac{15}{4}\\ \frac{15}{4}\end{bmatrix}$

6 Comment? = new opt solu 22.5

3 7. *Change the coefficients of* x_2 $\begin{bmatrix} c_2 \\ a_{12} \\ a_{13} \end{bmatrix} = \begin{bmatrix} 3 \\ 2 \\ 3 \end{bmatrix} \to \begin{bmatrix} 4 \\ 2 \\ 3 \end{bmatrix}$

$Z - C = YA - C = [1 \; \frac{1}{2}]\begin{bmatrix}2\\3\end{bmatrix} - 4 = 2 + 1.5 - 4 = -\frac{1}{2}$

$A = SA = \begin{bmatrix} .5 & -\frac{1}{4} \\ -\frac{1}{2} & \frac{3}{4} \end{bmatrix}\begin{bmatrix}2\\3\end{bmatrix}$

2.5 8. Introduce a new variable x_6 with coefficients x_6 $\begin{bmatrix} c_6 \\ a_{16} \\ a_{16} \end{bmatrix} = \begin{bmatrix} 4.5 \\ 3 \\ 3 \end{bmatrix}$

$A = \begin{pmatrix} 1 - \frac{3}{4} \\ -1 + \frac{9}{4} \end{pmatrix} = \begin{pmatrix} \frac{1}{4} \\ \frac{5}{4} \end{pmatrix} \Rightarrow \begin{pmatrix} -1/2 \\ 1/4 \\ 5/4 \end{pmatrix} \to$ new iteration ok

8 $\begin{bmatrix} 4.5 \\ 3 \\ 3 \end{bmatrix} \to Z - C = [0 \; .5]\begin{bmatrix}3\\ \end{bmatrix}$

x_6 $\begin{pmatrix} -3 \\ 3 \end{pmatrix}$