National University of Computer and Emerging Sciences, Lahore Campus

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Student : Name: [redacted] **Roll No** [redacted] **Section:** [redacted]

Instruction/Notes: Attempt all questions. Programmable calculators are not allowed.
For Question 1, the best option is according to the given statement. (CUTTING IS NOT ALLOWED)
For Questions 1 to 3: Solve these on the question papers
For Questions 4 to 6: Use the Answer Sheet

QUESTION # 1: **(20)**

1. **In labor planning formulation, how would you write the constraint that there are only 10 full-time tellers (labeled as T) available?**
   a. $T + 10 > 0$
   b. $T > 10$
   c. $T \leq 10$
   d. None of the above
2. **When goods are shipped through an intermediate point before being shipped to their destination, a _____ problem becomes a _____ problem**
   a. transshipment; transportation
   b. truck loading, blending
   c. transportation; transshipment
   d. truck loading; transshipment
3. **Which of the following does NOT represent one of the advantages of mathematical modeling?**
   a. A model can be used to communicate problems and solutions to others.
   b. Models can help a decision maker formulate problems.
   c. Models can provide insight and information.
   d. None of the above
4. **Post optimality analysis is most closely associated with:**
   a. Collecting input data
   b. Developing a model
   c. Sensitivity analysis
   d. None of the above
5. **Which of the following is a property of all linear programming problems?**
   a. alternate courses of action to choose from
   b. minimization of some objective
   c. a computer program
   d. usage of linear and nonlinear equations and inequalities
6. **LP theory states that the optimal solution to any problem will lie at :**
   a. the origin.
   b. a corner point of the feasible region
   c. the highest point of the feasible region
   d. the lowest point in the feasible region
7. **Unboundedness is usually a sign that the LP problem**
   a. has finite multiple solutions
   b. is degenerate
   c. contains too many redundant constraints
   d. has been formulated improperly

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8. **If, when we are using a Simplex table to solve a maximization problem, we find that the r determining the pivot row are all negative, then we know that the solution is**
   a. unbounded
   b. infeasible
   c. degenerate
   d. optimal
9. **Two models of a product – Regular (X) and Deluxe (Y) – are produced by a company. A linear programming model is used to determine the production schedule. The formulation is as follows:**

   Maximize profit $50X + 60Y$
   Subject to: $8X + 10Y \leq 800$ (labor hours)
   $X + Y \leq 120$ (total units demanded)
   $4X + 5Y \leq 500$ (raw materials)
   all variables ≥ 0

   The optimal solution is X = 100 Y = 0.
   How many units of the labor hours must be used to produce this number of units?
   a. 400
   b. 500
   c. 120
   d. None of the above
10. **In a transportation problem, when the number of occupied routes is less than the number of rows plus the number of columns–1, we say that the solution is:**
    a. Unbalanced
    b. Infeasible
    c. Optimal
    d. Degenerate
11. **Which of the following is NOT a necessary linear programming assumption?**
    a. The decision variable values are discrete.
    b. The parameters are specified with certainty.
    c. Constant returns to scale in the linear constraints and the object function coefficients.
    d. No interactions permitted between decision variables.
12. **A feasible solution requires that all artificial variables is:**
    a. greater than zero
    b. less than zero
    c. equal to zero
    d. there are no special requirements on artificial variables; they may take on any value
13. **Which of the following is a valid objective function for a linear programming problem?**
    a. Max 5xy
    b. Min $4x + 3y + (2/3)z$
    c. Max $5x^2 + 6y^2$
    d. Min $(x_1 + x_2)/x_3$
14. **The term _____ implies that one or more variables in the solution and the profit can be infinitely large.**
    a. Degeneracy
    b. Unbounded
    c. infeasibility
    d. alternate solutions
15. **A city needs to design and build a completely new storm drainage system. The excess rainwater runoff in each neighborhood is to be channeled to a suburban reservoir. The appropriate network model would most likely be:**
    a. transportation/transshipment.
    b. shortest path.
    c. minimal spanning tree.
    d. maximal flow.

16. **A B-1 bomber must fly through a choice of "safe areas," deliver its bombing payload, and return to its home base using minimum fuel. Which network model would be the most appropriate representation?**
   a. Shortest path
   b. Minimal spanning tree
   c. Traveling salesman
   d. Transportation

17. **An environmental impact report for a proposed new industrial center complex must include the total amount of sewage that can be pumped through existing pipes. Which network model would be the most appropriate representation?**
   a. Shortest path
   b. Minimal spanning tree
   c. Traveling salesman
   d. Maximal flow

18. **A "non-binding" constraint is:**
   a. redundant.
   b. not satisfied with an equality at the optimal solution.
   c. one having zero slack or surplus
   d. never a non-negativity variable constraint.

19. **In a standard transportation model, each objective function coefficient represents the:**
   a. total cost of shipping from a source to a destination node.
   b. fixed cost of utilizing the route between a source and destination node.
   c. unit cost of shipping from a source to a destination node.
   d. negative "unit cost" of not using the route between a source and a destination node.

20. **If, when we are using a Simplex table to solve a maximization problem, we find that the ratios for determining the pivot row are all negative, then we know that the solution is**
   a. unbounded
   b. infeasible
   c. degenerate
   d. optimal

QUESTION – 2: Given the LP problem:

Maximize: $Z = 2X_1 + 1.5X_2$

Subject to:

$3X_1 + 4X_2 \leq 1000$ (Cast Irons Constraint)

$6X_1 + 3X_2 \leq 1200$ (Labor Hours Const.)

$X_1 \leq 180$ (Model-A Production Cont.)

$X_1, X_2 \geq 0$

and the following Excel Solver output

Adjustable Cells

Cell	Name	Final Value	Reduced Cost	Objective Coefficient	Allowable Increase	Allowable Decrease
G6	Quantity Produced: Model-A	120	0	2	1	0.875
H6	Quantity Produced: Model-B	160	0	1.5	1.166666667	0.5

Constraints

Cell	Name	Final Value	Shadow Price	Constraint R.H. Side	Allowable Increase	Allowable Decrease
I9	Cast Irons: TOTAL	1000	0.2	1000	600	300
I10	Labor Hour: TOTAL	1200	0.233333333	1200	225	450
I11	Model-A Production: TOTAL	120	0	180	1E+30	60

Answer the following questions:

1. What is the optimal solution and optimal value for the problem?

$Z = 480$

As the value of $x_1 = 120$ and $x_2 = 160$

$2x_1 + 1.5x_2 \Rightarrow 2 \times 120 + 1.5 \times 160 \Rightarrow 240 + 240 \Rightarrow 480$

$Z = 480$

2. What is the impact on the optimal solution and optimal value if we decrease the cost coefficient C_1=2 to 1.5? Why?

As optimum value is 480 but if we change the coefficient of X_1 to 1.5, then $1.5x_1 + 1.5x_2$. The Z value will be 320. The range of upper and lower will 1 & 0.875. Deviation from that reduce profit

3. What is the shadow price for the Cast Iron (RHS # 1)? How do you interpret it?

The shadow price of Cast Iron is 0.2 It means that by increasing the resource will add 0.2 value.

4. What is the shadow price for the Model–A Production (RHS # 3)? How do you interpret it?

The shadow price of model-A production is 0 It means that the product that we get will get max profit by increasing will not get the mase.

5. What is the impact on the optimal value if we decrease the right-hand side of constraint–1 (Cast Iron) by 30?

It will affect the optimal solution because the allowable increase are 600 and allowable decrease are 300 only Deviation of that value will affect the optimum solution badly if we set to 30.

QUESTION # 3: Consider the transportation problem shown below. **(01+01+01+02 = 05)**

Initial Start: Use the Northwest Corner Rule to form an initial basis for this problem.

	Moscow	Cape Town	Sydney	
Hamburg	4: 100	10	6	100 → 0
Minneapolis	8: 100	16: 200	6	300 → 200 → 0
Tokyo	14	18	10: 200	200 → 0
	200 → 100 → 0	200 → 0	200 → 0	

→ $m+n-1$
$3+3-1$
5
→ we got 4
⇒ Degeneracy

Reduced Shipping Costs:

a. Calculate the value of C_1 below.
b. Calculate the reduced cost for cell Minneapolis-CapeTown.
(Note that reduced costs for other non-basic cells are shown in brackets [ ] below.)

a) $R_i + K_j = C_{ij}$ → $0 + K_1 = 4$
b) $C_{ij} - R_i - K_j$
→ $16 - R_2 - K_2$
$= 16 - 4 - 10$
⇒ 2

	Moscow	Cape Town	Sydney	
Hamburg	4: 100	10: [0]	6: [4]	$R_1 = 0$
Minneapolis	8: 100	16: [2]	6: 200	$R_2 = 4$
Tokyo	14: [2]	18: 200	10: 0	$R_3 = 8$
	$C_1 = 4$	$C_2 = 10$	$C_3 = 2$	

c. Assuming that this is a cost minimization problem, which non-basic route would you next bring into the basis (ship through) to further reduce costs? Briefly explain.

We become the basic variable only when the improvement index value will be less than 0 or in negative because of minimiz ation objective function. In that case, no o one will have a improvement index (−) so no one will become the basic variable

$R1 + K2 = 0$ → this can cause multiple
$R1 + K3 = 4$ optimum solution.
$R2 + K2 = 2$ (All are positive value &
$R3 + K1 = 2$ this increase the value)
~~$R3 + K3$~~