National University of Computer and Emerging Sciences, Lahore Campus

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Instruction/Notes: Attempt all questions. Programmable calculators are not allowed.
For Question 1, the best option according to the given statement. (CUTTING IS NOT ALLOWED)

QUESTION # 1: **(08)**

18+10 = 28/30

1. **When compared with standard linear programming, integer linear programming typically has:**
   a. more feasible solution points to evaluate.
   b. fewer feasible solution points to evaluate.
   c. the same number of feasible solution points to evaluate.
   d. more linear constraints.

2. **TicToc produces product A and product B. These products have the following resource requirements.**

Product	Cost/Unit ($)	Labor hours/Unit
A	12	4
B	8	3

The firm has a weekly production budget of $3000 and a maximum of 1000 hours of labor per week. Each A produced generates $35.00 in profit for the company. Each B produced generates $25.00 in profit for the company. The company's objective function is

   a. Maximize Z = $35.00A + $25.00B.
   b. Minimize Z = $12A + 8B.
   c. Minimize Z = 4A + 3B.
   d. None of these answer choices is correct.

3. **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.

4. **Atlas Inc. produces product A and product B. Each product must go through two processes. Each A produced requires two hours in process 1 and five hours in process 2. Each B produced requires six hours in process 1 and three hours in process 2. There are 80 hours of capacity available each week in each process. Each A produced generates $6.00 in profit for the company. Each B produced generates $9.00 in profit for the company. The constraint for process 1 is represented by**
   a. $2A + 5B \le 80$.
   b. $2A + 6B \ge 80$.
   c. $2A + 6B < 80$.
   d. $2A + 6B \le 80$.

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5. In a Branch-and-Bound problem, if $X_1 = 5$ and $X_2 = 3.7$, then which of the followin[g] possible branching option?
   a. $X_2 \geq 3$
   b. $X_2 \geq 4$
   c. $X_1 \leq 5$
   d. $X_2 \leq 4$
6. A surplus variable subtracts from a linear programming constraint to make it
   a. an equality.
   b. an inequality.
   c. an optimal variable.
   d. an extreme point.
7. The optimal solution obtained to a maximization integer linear programming model, where the integer requirements are at first ignored, provides a lower bound for the optimal objective function value of the integer model.
   a. True
   b. False
8. The objective function coefficients for X1, X2, and X3 are 15, 32, and 48 respectively. Excel prints that their ranges of optimality are from 10 to 20, from 30 to 40, and from $-\infty$ to 50 respectively. If the objective function coefficients are changed to 14, 31, and 45, the optimal solution:
   a. will not change.
   b. may not change.
   c. will definitely change.
   d. may change.
9. The optimal solution value of an integer linear programming problem with a minimization objective function may not be __________ the optimal solution value if integer requirements are ignored.
   a. the same as
   b. less than
   c. greater than
   d. a rounded form of
10. Relaxing the integer restrictions to an integer linear model produces an optimal solution of $X_1 = 23$ and $X_2 = 15$. This must also be the optimal solution to the integer linear model.
    a. True
    b. False
11. The feasible region does not include:
    a. interior points.
    b. boundary points.
    c. points at which at least one of the decision variables is zero.
    d. points which violate at least one of the functional or non-negativity constraints.
12. One approach for solving an integer linear programming problem is simply to enumerate all feasible points and select the one yielding the "best" value for the objective function. However, the number of feasible integer points is usually so large, even for small problems, that this approach is inefficient for solving most models even with a computer.
    a. True
    b. False
13. Which of the following is not an integer linear programming problem?
    a. pure integer
    b. mixed integer
    c. 0-1integer
    d. Continuous
14. It takes two pounds of steel and three pounds of copper to make a particular product. If there are 100 pounds of steel and 100 pounds of cooper available, one constraint will be $2X_1 + 3X_2 \leq 200$.
    a. True
    b. False

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are currently paying $12 per hour for labor, and labor costs are included in the calculation of objective function coefficients of a maximization problem. The shadow price for labor printed on the sensitivity analysis report is $8. It would be economically beneficial to you if you could secure extra labor for $15 per hour.

a) True
b) False

16. Joe Chan is modeling the installation of smoke alarms. The constraint Y1 – Y2 ≥ 0 uses the binary variables Y1 for upstairs installation and Y2 for downstairs installation. The constraint implies that if the first installation is performed, the second must also be performed.

a. True
b. False

17. Nike must build a factory at either Millville or Greenfield, but not both. The appropriate linear constraint to express this restriction using binary variables Y_1 and Y_2 is:

a. $Y_1 - Y_2 \le 1$
b. $Y_1 + Y_2 \le 1$
c. $Y_1 + Y_2 = 1$
d. $Y_1 - Y_2 \le 0$

18. Squire Leathers produces two sizes of wallets from cowhide. The first requires 60 squire inches of cowhide and the second requires 100 square inches. The company has 1000 square feet of cowhide. Part of the model is:

a. $60X_1 + 100X_2 \ge 144{,}000$
b. $60X_1 + 100X_2 \le 144{,}000$
c. $60X_1 + 100X_2 = 144{,}000$
d. $60X_1 \le 144{,}000$ and $100X2 \le 144{,}000$

19. Billyboy Toys' toy balls, bats, and gloves net profits, excluding fixed costs, of $7, $8, and $13 respectively. The products require 2, 3, and 5 production hours each. Using current facilities, 1600 production hours are available for the production of these products each month. If Billyboy also leases a second, smaller production facility for $3000 per month, this will increase the availability of production hours for these products by 800. This situation can be modeled using a mixed integer model that includes the following:

a. An objective function of: MAX $7X_1 + 8X_2 + 13X_3$
Constraints including: $2X_1 + 3X_2 + 5X_3 \le 2400$
Variable constraints including $X_1, X_2, X_3 \ge 0$

b. An objective function of: MAX $7X_1 + 8X_2 + 13X_3 - 3000Y_1$
Constraints including: $2X_1 + 3X_2 + 5X_3 - 800Y_1 \le 2400$
Variable constraints including $X_1, X_2, X_3 \ge 0$, $Y_1 = 0$ or 1

c. An objective function of: MAX $7X_1 + 8X_2 + 13X_3 - 3000Y_1$
Constraints including: $2X_1 + 3X_2 + 5X_3 + 800Y_1 \le 1600$
Variable constraints including $X_1, X_2, X_3 \ge 0$, $Y_1 = 0$ or 1

d. An objective function of: MAX $7X_1 + 8X_2 + 13X_3 - 3000Y_1$
Constraints including: $2X_1 + 3X_2 + 5X_3 - 800Y_1 \le 1600$
Variable constraints including $X_1, X_2, X_3 \ge 0$, $Y_1 = 0$ or 1

1 foot = 12 inch.
1 feet =
1 feet = 12 inch

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20. The shadow price for a constraint that expresses that the availability of wood is 3000 board-feet is $0.50, and the range of feasibility (i.e., RHS) is between 2800 and 4000 board-feet. Which of the following is NOT correct?

a. All 3000 board-feet of wood will be used.
b. If only 2900 board-feet of wood are available, the optimal objective function value will be reduced by $50
c. If only 2900 board-feet of wood are available, the optimal solution will not change
d. If 6000 board-feet of wood are available, the objective function value will increase by at least $500

Question – 2: Formulate the following problem as Integer Linear Programming Model. **(10)**

Kings Department Store has 625 rubies, 800 diamonds, and 700 emeralds from which they will make bracelets and necklaces that they have advertised in their Christmas brochure. Each of the rubies is approximately the same size and shape as the diamonds and the emeralds. Kings will net a profit of $250 on each bracelet, which is made with 2 rubies, 3 diamonds, and 4 emeralds, and $500 on each necklace, which includes 5 rubies, 7 diamonds, and 3 emeralds. How many of each should Kings make to maximize its profit?

X_1 = Ruby
X_2 = diamond
X_3 = Emeralds

10

	R	E	D
N	5	3	7
B	2	4	3
	625	700	800

$2x_1 + 3X_2 + 4X_3 = 250$
$5X_1 + 7x_2 + 3x_3 = 500$

Basic variables
Y_1 = Brocelet
Y_2 = Necklace

$Z = 250Y_1 + 500Y_2$ - objective function.

S.t

$5Y_2 + 2Y_1 \leq 625$ — constraint for ruby
$3Y_2 + 4Y_1 \leq 700$ — constraint for emerald
$7Y_2 + 3Y_1 \leq 800$ - constraint for diamond
$Y_1, Y_2 \geq 0$ and are integers.

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