**Questions**

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| **1.**  | Which of the following statements about an LP problem and its dual is false?  |

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| **A.**  | If the primal and the dual both have optimal solutions, the objective function values for both problems are equal at the optimum  |

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| **B.**  | If one of the variables in the primal has unrestricted sign, the corresponding constraint in the dual is satisfied with equality  |

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| **C.**  | If the primal has an optimal solution, so has the dual  |

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| **D.**  | The dual problem might have an optimal solution, even though the primal has no (bounded) optimum  |

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| **2.**  | Mark the wrong statement:  |

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| **A.**  | If the optimal solution to an LPP exists then the objective function values for the primal and the dual shall both be equal.  |

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| **B.**  | The optimal values of the dual variables are obtained from ∆j values from slack/surplus variables, in the optimal solution tableau.  |

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| **C.**  | An n-variable m-constraint primal problem has an m-variable n-constraint dual.  |

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| **D.**  | If a constraint in the primal problem has a negative bi value, its dual cannot be written.  |

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| **3.**  | Choose the wrong statement:  |

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| **A.**  | In order that dual to an LPP may be written, it is necessary that it has at least as many constraints as the number of variables.  |

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| **B.**  | The dual represents an alternate formulation of LPP with decision variables being implicit values.  |

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| **C.**  | The optimal values of the dual variables can be obtained by inspecting the optimal tableau of the primal problem as well.  |

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| **D.**  | Sensitivity analysis is carried out having reference to the optimal tableau alone.  |

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| **4.**  | Which of the following LP problems has an optimal solution? Note: in all cases *x*1 > 0, *x*2 > 0.  |

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| **A.**  | Min -2x1 + x2 subject to x2 ≤ 2  |

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| **B.**  | Min -2x1 + x2 subject to x1 + x2 ≥ 52x1 + x2 ≥ 7  |

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| **C.**  | Max 2x1 + x2 subject to x1 – x2 ≤ 2  |

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| **D.**  | Max 2x1 + x2 subject to x1 – 3x2 ≥ 1x1 – 3x2 ≥ -2  |

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| **5.**  | Which of the following pairs is the solution to the LP problem: max x1 + x2 subject to x1 + 2x2 ≤ 7 3x1 + x2 ≤ 6x1 x2 ≥ 0 ?  |

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| **A.**  | (x1, x2) = (2, 0)  |

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| **B.**  | (x1, x2) = (1, 3)  |

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| --- | --- |
| **C.**  | (x1, x2) = (2, 3)  |

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| **D.**  | (x1, x2) = (0, 7/2)  |

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| **6.**  | Apply linear programming to this problem. A firm wants to determine how many units of each of two products (products D and E) they should produce to make the most money. The profit in the manufacture of a unit of product D is $100 and the profit in the manufacture of a unit of product E is $87. The firm is limited by its total available labor hours and total available machine hours. The total labor hours per week are 4,000. Product D takes 5 hours per unit of labor and product E takes 7 hours per unit. The total machine hours are 5,000 per week. Product D takes 9 hours per unit of machine time and product E takes 3 hours per unit. Which of the following is one of the constraints for this linear program?  |

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| **A.**  | 5 D + 7 E =< 5,000  |

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| **B.**  | 9 D + 3 E => 4,000  |

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| **C.**  | 5 D + 7 E = 4,000  |

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| **D.**  | 5 D + 9 E =< 5,000  |

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| **E.**  | 9 D + 3 E =< 5,000  |

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| **7.**  | To write the dual; it should be ensured that  I. All the primal variables are non-negative.II. All the bi values are non-negative.III. All the constraints are ‘≤’ type if it is maximization problem and ‘≥’ type if it is a minimization problem.  |

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| **A.**  | I and II  |

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| **B.**  | II and III  |

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| **C.**  | I and III  |

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| **D.**  | I, II and III  |

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| **8.**  | Consider the two LP problems:   (P) max 5x1 – 2x2 + x3 subject to   3x1 – 2x2 + 4x3 ≤ 44 2x1 – 4x2 + 5x3 ≤ 23 -x1 + 2x2 + x3 ≤ - 10 x1, x2 x3 ≥ 0   (D) min 44u1 + 23u2 – 10u3 subject to   3u1 + 2u2 – u3 ≥ 5 -2u1 – 4u2 + 2u3 ≥ -2 4u1 + 5u2 + u3 ≥ 1 u1, u2, u3 ≥ 0 (D) has the optimal solution (u1\* u2\*, u3\*) = (2, 0 1).   Then the solution to (P) is (x1\* x2\*, x3\*) =  |

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| **A.**  | (17, 7/2, 0)  |

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| --- | --- |
| **B.**  | (4, 0, 4)  |

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| **C.**  | (7/2, 0, 17)  |

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| **D.**  | (0, 0, 0)  |

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| **9.**  | The number of decision variables allowed in a linear program is which of the following?  |

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| **A.**  | Less than 5  |

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| **B.**  | Less than 72  |

|  |  |
| --- | --- |
| **C.**  | Less than 512  |

|  |  |
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| **D.**  | Less than 1,024  |

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| **E.**  | Unlimited  |

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| **10.**  | If problems (P) and (Q) are dual of each other, what are *a*, *b*, and *c*?   (P) max 2x1 + ax2 subject to      2x1 + x2 ≤ 3      bx1 + 2x2 ≤ c      x1 x2 ≥ 0 ?   (Q) min 3u1 + 4u2 subject to      2u1 + 4u2 ≥ 2      u1 + 2u2 ≥ 5      u1 u2 ≥ 0  |

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| **A.**  | (a, b, c) = (5, 5, 4)  |

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| **B.**  | (a, b, c) = (4, 4, 5)  |

|  |  |
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| **C.**  | (a, b, c) = (5, 4, 4)  |

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| **D.**  | (a, b, c) = (4, 5, 4)  |

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| **11.**  | How many of the following points satisfy the inequality 2*x* - 3*y* > -5?(1, 1), (-1, 1), (1, -1), (-1, -1), (-2, 1), (2, -1), (-1, 2) and (-2, -1)  |

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| **A.**  | 5  |

|  |  |
| --- | --- |
| **B.**  | 4  |

|  |  |
| --- | --- |
| **C.**  | 7  |

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| --- | --- |
| **D.**  | 6  |

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| **E.**  | 3  |

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| **12.**  | Leo has $12.50 to spend on his weekly supply of sweets, crisps and apples. A bag of crisps costs $0.65, a bag of sweets costs $0.85, and one apple costs $0.50. The total number of packets of crisps, sweets and apples consumed in a week must be at least seven, and he eats at least twice as many packets of sweets as crisps. His new healthy diet also means that the total number of packets of sweets and crisps must not exceed one-third of the number of apples. If *s*, *c* and *a*, denote the number of packets of sweets, packets of crisps, and apples respectively, which one of the following represents one of the constraints defining the feasible region?  |

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| **A.**  | S ≤ c - a  |

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| --- | --- |
| **B.**  | 3c + 3s ≤ a  |

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| **C.**  | A + c + s > 7  |

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| --- | --- |
| **D.**  | S ≥ 0.5c  |

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| **E.**  | 0.65s + 0.85c + 0.5a ≥ 12.5  |

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| **13.**  | Choose the incorrect statement:  |

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| **A.**  | All scare resources have marginal profitability equal to zero.  |

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| **B.**  | Shadow prices are also known as imputed values of the resources.  |

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| **C.**  | A constraint 3x1 – 7x2 + 13x3 – 4x4 ≥ -10 can be equivalently written as -3x1 + 7x2 – 13x3 + 4x4 ≤ 10.  |

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| **D.**  | If all constraints of a minimization problem are ‘≥’ type, then all dual variables are non-negative.  |

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| **14.**  | In linear programming context, sensitivity analysis is a technique to  |

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| **A.**  | Allocate resources optimally.  |

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| **B.**  | Minimize cost of operations.  |

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| **C.**  | Spell out relation between primal and dual.  |

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| **D.**  | Determine how optimal solution to LPP changes in response to problem inputs.  |

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| **15.**  | What can you say about the linear programming problem specified in question 5, if the second constraint is changed to 3*x* - 4*y* ≤ 24 and the problem is one of maximization?  |

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| **A.**  | Unique solution at (0, 6)  |

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| **B.**  | No solution  |

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| **C.**  | Unique solution at (0, 0)  |

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| **D.**  | Infinitely many solutions  |

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| **E.**  | Unique solution at (8, 0)  |

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| **16.**  | The point (*x*, 3) satisfies the inequality, -5*x* - 2*y* ≤ 13. Find the smallest possible value of *x*.  |

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| **A.**  | -1.4  |

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| **B.**  | 0  |

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| **C.**  | 1.4  |

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| **D.**  | -3.8  |

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| **E.**  | 3.8  |

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| **17.**  |        Which of the following pairs is the solution to the LP problem:        min u1 + 2u2 subject to        3u1 + u2 ≥ 7        u1 + 4u2 ≥ 6        u1 u2 ≥ 0 ?  |

|  |  |
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| **A.**  | (u1, u2) = (1, 4)  |

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| **B.**  | (u1, u2) = (2, 1)  |

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| **C.**  | (u1, u2) = (6, 0)  |

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| **D.**  | (u1, u2) = (0, 7)  |

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| **18.**  | Apply linear programming to this problem. A one-airplane airline wants to determine the best mix of passengers to serve each day. The airplane seats 25 people and flies 8 one-way segments per day. There are two types of passengers: first class (F) and coach (C). The cost to serve each first class passenger is $15 per segment and the cost to serve each coach passenger is $10 per segment. The marketing objectives of the airplane owner are to carry at least 13 first class passenger-segments and 67 coach passenger-segments each day. In addition, in order to break even, they must at least carry a minimum of 110 total passenger segments each day. Which of the following is one of the constraints for this linear program?  |

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| **A.**  | 15 F + 10 C => 110  |

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| **B.**  | 1 F + 1 C => 80  |

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| **C.**  | 13 F + 67 C => 110  |

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| **D.**  | 1 F => 13  |

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| **E.**  | 13 F + 67 C =< (80/200)  |

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| **19.**  | Which of the following is an essential condition in a situation for linear programming to be useful?  |

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| **A.**  | Nonlinear constraints  |

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| **B.**  | Bottlenecks in the objective function  |

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| **C.**  | Homogeneity  |

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| **D.**  | Uncertainty  |

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| **E.**  | Competing objectives  |

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| **20.**  | Apply linear programming to this problem. David and Harry operate a discount jewelry store. They want to determine the best mix of customers to serve each day. There are two types of customers for their store, retail (R) and wholesale (W). The cost to serve a retail customer is $70 and the cost to serve a wholesale customer is $89. The average profit from either kind of customer is the same. To meet headquarters' expectations, they must serve at least 8 retail customers and 12 wholesale customers daily. In addition, in order to cover their salaries, they must at least serve 30 customers each day. Which of the following is one of the constraints for this model?  |

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| **A.**  | 1 R + 1 W =< 8  |

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| **B.**  | 1 R + 1 W => 30  |

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| **C.**  | 8 R + 12 W => 30  |

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| **D.**  | 1 R => 12  |

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| **E.**  | 20 x (R + W) =>30  |

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| **21.**  | Solving an integer programming problem by rounding off answers obtained by solving it as a linear programming problem (using simplex), we find that  |

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| **A.**  | The values of decision variables obtained by rounding off are always very close to the optimal values.  |

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| **B.**  | The value of the objective function for a maximization problem will likely be less than that for the simplex solution.  |

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| **C.**  | The value of the objective function for a minimization problem will likely be less than that for the simplex solution.  |

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| **D.**  | All constraints are satisfied exactly.  |

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| --- | --- |
| **E.**  | None of the above.  |

|  |  |
| --- | --- |
| **22.**  | Leo has $12.50 to spend on his weekly supply of sweets, crisps and apples. A bag of crisps costs $0.65, a bag of sweets costs $0.85, and one apple costs $0.50. The total number of packets of crisps, sweets and apples consumed in a week must be at least seven, and he eats at least twice as many packets of sweets as crisps. His new healthy diet also means that the total number of packets of sweets and crisps must not exceed one-third of the number of apples. If *s*, *c* and *a*, denote the number of packets of sweets, packets of crisps, and apples respectively, which one of the following represents one of the constraints defining the feasible region? Which of the following represents one of the constraints in the question?  |

|  |  |
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| **A.**  | 3s - 3c + a ≥ 0  |

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| **B.**  | C ≤ 2s  |

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| **C.**  | 17s + 10a + 13c ≤ 250  |

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| **D.**  | 3c + 3s + a ≤ 0  |

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| **E.**  | A + c + s ≤ 7  |

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| **23.**  | Which of the following constraints is not linear?  |

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| **A.**  | 7A − 6B ≤ 45  |

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| **B.**  | X + Y + 3Z = 35  |

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| **C.**  | 2X + 10Y ≥ 60  |

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| **D.**  | 2XY + X ≥ 15  |

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| **E.**  | None of the above  |

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| **24.**  | Mark the wrong statement:  |

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| **A.**  | If the primal is a minimization problem, its dual will be a maximization problem.  |

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| **B.**  | Columns of the constraint coefficients in the primal problem become columns of the constraint coefficients in the dual.  |

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| **C.**  | For an unrestricted primal variable, the associated dual constraint is an equation.  |

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| **D.**  | If a constraint in a maximization type of primal problem is a ‘less-than-or-equal-to’ type, the corresponding dual variable is non-negative.  |

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| **25.**  | What can you say about the solution of the linear programming problem specified in question 5, if the objective function is to be maximised instead of minimized?  |

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| **A.**  | No solution  |

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| --- | --- |
| **B.**  | Unique solution at (2, 0)  |

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| --- | --- |
| **C.**  | Unique solution at (0, 0)  |

|  |  |
| --- | --- |
| **D.**  | Infinitely many solutions  |

|  |  |
| --- | --- |
| **E.**  | Unique solution at (0, 12)  |

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| **26.**  | The problem description Maximise: 7X1 + 3X2 Subjectto:5X1+7X2≤ 27  4X1 + X2 ≤ 14     3X1 - 2X2 ≤ 9    X1, X2 ≥ 0   X1 Integer represents a(n)  |

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| **A.**  | Integer programming problem.  |

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| **B.**  | Goal programming problem.  |

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| **C.**  | Nonlinear programming problem.  |

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| **D.**  | Multiple-objective programming problem.  |

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| **E.**  | None of the above  |

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| --- | --- |
| **27.**  | Apply linear programming to this problem. A firm wants to determine how many units of each of two products (products X and Y) they should produce in order to make the most money. The profit from making a unit of product X is $190 and the profit from making a unit of product Y is $112. The firm has a limited number of labor hours and machine hours to apply to these products. The total labor hours per week are 3,000. Product X takes 2 hours of labor per unit and Product Y takes 6 hours of labor per unit. The total machine hours available are 750 per week. Product X takes 1 machine hour per unit and Product Y takes 5 machine hours per unit. Which of the following is one of the constraints for this linear program?  |

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| **A.**  | 1 X + 5 Y =< 750  |

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| **B.**  | 2 X + 6 Y => 750  |

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| **C.**  | 2 X + 5 Y = 3,000  |

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| --- | --- |
| **D.**  | 1 X + 3 Y =< 3,000  |

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| **E.**  | 2 X + 6 Y =>3,000  |

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| **28.**  | The number of constraints allowed in a linear program is which of the following?  |

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| **A.**  | Less than 5  |

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| **B.**  | Less than 72  |

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| **C.**  | Less than 512  |

|  |  |
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| **D.**  | Less than 1,024  |

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| **E.**  | Unlimited  |

|  |  |
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| **29.**  | Which of the following quadruples (*x*1, *x*2, *x*3, *x*4) is the solution to the LP problem:   max x1 – 1x2 + 3x3 – 3x4 subject to              2       2   x1 + x2 + x3 + x4 ≤ 1 x1 – x2 + 2x3 – x4 ≤ 2 x1, x2, x3 ≥ 0 ?  |

|  |  |
| --- | --- |
| **A.**  | (0, 0, 1, 0)  |

|  |  |
| --- | --- |
| **B.**  | (0, 1, 0, 0)  |

|  |  |
| --- | --- |
| **C.**  | (0, 1/2, 1/4, 1/4)  |

|  |  |
| --- | --- |
| **D.**  | (1/4, 1/4, 1/4, 1/4)  |

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| --- | --- |
| **30.**  | Choose the most correct of the following statements relating to primal-dual linear programming problems:  |

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| **A.**  | Shadow prices of resources in the primal are optimal values of the dual variables.  |

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| **B.**  | The optimal values of the objective functions of primal and dual are the same.  |

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| **C.**  | If the primal problem has unbounded solution, the dual problem would have infeasibility.  |

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| **D.**  | All of the above.  |

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| **31.**  | Mark the wrong statement:  |

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| **A.**  | The dual of the dual is primal.  |

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| **B.**  | An equation in a constraint of a primal problem implies the associated variable in the dual problem to be unrestricted in sign.  |

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| **C.**  | If a primal variable is non-negative, the corresponding dual constraint is an equation.  |

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| **D.**  | The objective function coefficients in the primal problem become right-hand side of constraints of the dual.  |

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| **32.**  | How many points with integer coordinates lie in the feasible region defined by3*x* + 4*y* ≤ 12, *x* ≥ 0 and *y* ≥ 1?  |

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| **A.**  | 7  |

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| --- | --- |
| **B.**  | 5  |

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| --- | --- |
| **C.**  | 4  |

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| --- | --- |
| **D.**  | 8  |

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| **E.**  | 6  |

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| **33.**  | What can you say about the solution of the linear programming problem specified in question 5, if the second constraint is changed to *x* + *y* ≤ 2 and the problem is one of minimization?  |

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| --- | --- |
| **A.**  | Infinitely many solutions  |

|  |  |
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| **B.**  | Unique solution (0, 12)  |

|  |  |
| --- | --- |
| **C.**  | No solution  |

|  |  |
| --- | --- |
| **D.**  | Unique solution at (2, 0)  |

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| **E.**  | Unique solution at (0, 2)  |

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| **34.**  | Mark the wrong statement:  |

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| **A.**  | The primal and dual have equal number of variables.  |

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| **B.**  | The shadow price indicates the change in the value of the objective function, per unit increase in the value of the RHS.  |

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| **C.**  | The shadow price of a non-binding constraint is always equal to zero.  |

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| **D.**  | The information about shadow price of a constraint is important since it may be possible to purchase or, otherwise, acquire additional units of the concerned resource.  |

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| **35.**  |        Which of the following triples (*x*1, *x*2, *x*3) is the solution to the LP problem:               max 2x1 + 3x2 + 2x3 subject to             x1 + 4x2 ≤ 4             x1 – x2 + 3x3 ≤ 5             x1, x2, x3 ≥ 0    |

|  |  |
| --- | --- |
| **A.**  | (0, 1, 2)  |

|  |  |
| --- | --- |
| **B.**  | (4, 0, 1/3)  |

|  |  |
| --- | --- |
| **C.**  | (4, 0, 1/2)  |

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| --- | --- |
| **D.**  | (1, 0, 1)  |

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| **36.**  | An objective function in a linear program can be which of the following?  |

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| --- | --- |
| **A.**  | A maximization function  |

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| --- | --- |
| **B.**  | A nonlinear maximization function  |

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| --- | --- |
| **C.**  | A quadratic maximization function  |

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| --- | --- |
| **D.**  | An uncertain quantity  |

|  |  |
| --- | --- |
| **E.**  | A divisible additive function  |

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| **37.**  | Which of the following is not a feasible solution of dual of given problem:   max x1 + 2x2 subject to x1 + x2 ≤ 4 -x1 + x2 ≤ 1 2x1 – x2 ≤ 3 x1,x2 ≥ 0  |

|  |  |
| --- | --- |
| **A.**  | (0, 1/2, 3/2)  |

|  |  |
| --- | --- |
| **B.**  | (2, 1, 1)  |

|  |  |
| --- | --- |
| **C.**  | (3/2, 1/2, 0)  |

|  |  |
| --- | --- |
| **D.**  | (2, 1, 2)  |

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| --- | --- |
| **38.**  | Consider the LP problem:   min *p*u1 + u2 subject to 3u1 + u2 ≥ 3 u1 + 2u2 ≥ 4 u1 + 6u2 ≥ 6 u1, u2 ≥ 0  For which values of *p* is there no solution to this problem?  |

|  |  |
| --- | --- |
| **A.**  | p = 0  |

|  |  |
| --- | --- |
| **B.**  | P < 0  |

|  |  |
| --- | --- |
| **C.**  | p = 2  |

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| --- | --- |
| **D.**  | P > 0  |

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| **39.**  | The following five inequalities define a feasible region. Which one of these could be removed from the list without changing the region?  |

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| --- | --- |
| **A.**  | X - 2y ≥ -8  |

|  |  |
| --- | --- |
| **B.**  | Y ≥ 0  |

|  |  |
| --- | --- |
| **C.**  | -x + y ≤ 10  |

|  |  |
| --- | --- |
| **D.**  | X + y ≤ 20  |

|  |  |
| --- | --- |
| **E.**  | X ≥ 0  |

|  |  |
| --- | --- |
| **40.**  | Find, if possible, the minimum value of the objective function 3*x* - 4*y* subject to the constraints -2*x* + *y* ≤ 12, *x* - *y* ≤ 2, *x* ≥ 0 and *y* ≥ 0.  |

|  |  |
| --- | --- |
| **A.**  | 8  |

|  |  |
| --- | --- |
| **B.**  | 0  |

|  |  |
| --- | --- |
| **C.**  | No solution  |

|  |  |
| --- | --- |
| **D.**  | -8  |

|  |  |
| --- | --- |
| **E.**  | -36  |

|  |  |
| --- | --- |
| **41.**  | If x1 + x2 is less than or equal to 500y1 and y1 is 0-1, then x1 and x2 will be \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ if y1 is 0.  |

|  |  |
| --- | --- |
| **A.**  | Equal to 0  |

|  |  |
| --- | --- |
| **B.**  | Less than 0  |

|  |  |
| --- | --- |
| **C.**  | More than 0  |

|  |  |
| --- | --- |
| **D.**  | Equal to 500 |