STELLA MARIS COLLEGE (AUTONOMOUS) CHENNAI – 600 086
(For candidates admitted from the academic year 2024 – 2025 and thereafter)

M.Sc. DEGREE EXAMINATION – APRIL 2026
DATA SCIENCE
SECOND SEMESTER

COURSE : ELECTIVE
PAPER : OPTIMIZATION TECHNIQUES
SUBJECT CODE : 24DS/PE/OT13
TIME : 3 HOURS **MAX. MARKS: 100**

<table>
<tr><th>Q. No.</th><th>SECTION A
Answer all the questions (10 x 2=20)</th><th>CO</th><th>KL</th></tr>
<tr><td>1.</td><td>Give any two examples of real-life application to LPP.</td><td>CO1</td><td>K1</td></tr>
<tr><td>2.</td><td>Define optimum solution to an LPP.</td><td>CO1</td><td>K1</td></tr>
<tr><td>3.</td><td>What are the algorithms that solve Goal programming?</td><td>CO1</td><td>K1</td></tr>
<tr><td>4.</td><td>Where Integer programming model can be applied?</td><td>CO1</td><td>K1</td></tr>
<tr><td>5.</td><td>What is the necessary and sufficient condition for a point to be an extreme point?</td><td>CO1</td><td>K1</td></tr>
<tr><td>6.</td><td>Does the simplex method allow simultaneous increase in variables? Justify your answer.</td><td>CO2</td><td>K2</td></tr>
<tr><td>7.</td><td>Explain the primal dual relationship.</td><td>CO2</td><td>K2</td></tr>
<tr><td>8.</td><td>Describe the mixed Integer Programming problem.</td><td>CO2</td><td>K2</td></tr>
<tr><td>9.</td><td>Explain the main idea of Greedy Heuristic.</td><td>CO2</td><td>K2</td></tr>
<tr><td>10.</td><td>Find the extreme points of $f(y) = y^4$</td><td>CO2</td><td>K2</td></tr>
<tr><th>Q. No.</th><th>SECTION B
Answer all the questions (4 x 5=20)</th><th>CO</th><th>KL</th></tr>
<tr><td>11.</td><td>a) Reddy Mikks produces both interior and exterior paints from two raw materials, M1 and M2 the following table provides the basic data of the problem:
<table>
<tr><td></td><td colspan="2">Tons of raw material per ton of</td><td></td></tr>
<tr><td></td><td>Exterior paint</td><td>Interior paint</td><td>Maximum daily availability (tons)</td></tr>
<tr><td>Raw Material M1</td><td>6</td><td>4</td><td>24</td></tr>
<tr><td>Raw Material M2</td><td>1</td><td>2</td><td>6</td></tr>
<tr><td>Profit per ton ($1000)</td><td>5</td><td>4</td><td></td></tr>
</table>
A market survey indicates that the daily demand for the interior paint cannot exceed that of exterior paint by more than 1 ton. Also, the maximum daily demand for interior paint is 2 tons. Ready Mikks wants to determine the optimum product mix of interior and exterior paints that maximizes the total daily profit. Formulate the LPP.
(OR)
b) Determine the feasible space for each of the following independent constraints, given that $x_1, x_2 \geq 0$
(i) $-3x_1 + x_2 \geq 6$; (ii) $2x_1 - 3x_2 \leq 12$</td><td>CO3</td><td>K3</td></tr>
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<tr><td>12.</td><td>a) Write the dual for the following primal problem:
Maximize $z = -5x_1 + 2x_2$;
subject to $-x_1 + x_2 \leq -2$; $2x_1 + 3x_2 \leq 5$; $x_1, x_2 \geq 0$
(OR)
b) List the cases that can arise in post optimal analysis and their corresponding recommendations.</td><td>CO3</td><td>K3</td></tr>
<tr><td>13.</td><td>a) Fairville is a small city with a population of about 20,000 residents. The annual taxation base for real estate property is $550 million. The annual taxation bases for food and drugs and for general sales are $35 million and $55 million, respectively. Annual local gasoline consumption is estimated at 7.5 million gallons. The city council wants to develop the tax rates based on four main goals:

(i) Tax revenues must be at least $16 million to meet the city’s financial commitments.
(ii) Food and drug taxes cannot exceed 10% of all taxes collected.
(iii)General sales taxes cannot exceed 20% of all taxes collected.
(iv)Gasoline tax cannot exceed 2 cents per gallon
Discuss the Goal programming approach to the problem.
(OR)

b) Five projects are being evaluated for a 3 year planning horizon. Following table gives the expected returns for each project and the associated yearly expenditures.

<table>
<tr><td></td><td colspan="3">Expenditure ($Million)/ year</td><td></td></tr>
<tr><td>Project</td><td>1</td><td>2</td><td>3</td><td>Returns ($Million)</td></tr>
<tr><td>1</td><td>5</td><td>1</td><td>8</td><td>20</td></tr>
<tr><td>2</td><td>4</td><td>7</td><td>10</td><td>40</td></tr>
<tr><td>3</td><td>3</td><td>9</td><td>2</td><td>20</td></tr>
<tr><td>4</td><td>7</td><td>4</td><td>1</td><td>15</td></tr>
<tr><td>5</td><td>8</td><td>6</td><td>10</td><td>30</td></tr>
<tr><td>Available funds ($Million)</td><td>25</td><td>25</td><td>25</td><td></td></tr>
</table>
Which project should be selected over the 3 year horizon?</td><td>CO4</td><td>K4</td></tr>
<tr><td>14.</td><td>a) Write a note on Tabu Search Algorithm.
(OR)
b) Explain the working of Constraint programming.</td><td>CO4</td><td>K4</td></tr>
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<tr><th>Q. No.</th><th>SECTION C
Answer all the questions (6 x 10=60)</th><th>CO</th><th>KL</th></tr>
<tr><td>15</td><td>a) Solve using Simplex method:
Maximize $Z = 2x_1 + 5x_2$;
subject to $x_1 + 4x_2 \leq 24$; $3x_1 + x_2 \leq 21$;
$x_1 + x_2 \leq 9$; $x_1, x_2 \geq 0$.
(OR)
b) Suppose TOYCO assembles three types of toys: trains, trucks and cars, using three operations. Available assembly times for the three operations are 430, 460 and 420 minutes per day, respectively and the revenues per toy train, truck and car are $3, $2, and $5 respectively. The assembly times per train for the three operations are 1, 3 and 1 minutes respectively. The corresponding times per truck and per car are (2, 0, 4) and (1, 2, 0) minutes.
If the above situation is formulated as the following LPP by letting x_1, x_2 and x_3 represent the daily number of units assembled of trains, trucks and cars, the associated optimal tableau will be obtained as follows:
Maximize $z = 3x_1 + 2x_2 + 5x_3$
subject to $x_1 + 2x_2 + x_3 \leq 430$; $3x_1 + 2x_2 \leq 460$;
$x_1 + 4x_2 \leq 420$; $x_1, x_2, x_3 \geq 0$.
<table><tr><td>Basic</td><td>x_1</td><td>x_2</td><td>x_3</td><td>x_4</td><td>x_5</td><td>x_6</td><td>Solution</td></tr><tr><td>z</td><td>4</td><td>0</td><td>0</td><td>1</td><td>2</td><td>0</td><td>1350</td></tr><tr><td>x_2</td><td>-1/4</td><td>1</td><td>0</td><td>½</td><td>-1/4</td><td>0</td><td>100</td></tr><tr><td>x_3</td><td>3/2</td><td>0</td><td>1</td><td>0</td><td>½</td><td>0</td><td>230</td></tr><tr><td>x_6</td><td>2</td><td>0</td><td>0</td><td>-2</td><td>1</td><td>1</td><td>20</td></tr></table>Determine the dual prices and feasibility ranges.</td><td>CO3</td><td>K3</td></tr>
<tr><td>16</td><td>a) Use the duality to solve the LPP:
Minimize $z = x_1 - x_2$
subject to $2x_1 - x_2 \geq 2$; $-x_1 + x_2 \geq 1$; $x_1, x_2 \geq 0$
(OR)
b) Solve using Artificial variable method:
Minimize $Z = 12x_1 + 20x_2$;
subject to $6x_1 + 8x_2 \geq 100$; $7x_1 + 12x_2 \geq 120$; $x_1, x_2 \geq 0$.</td><td>CO3</td><td>K3</td></tr>
<tr><td>17</td><td>a) Solve the following LP model by the upper bounding algorithm:
Maximize $z = 3x_1 + 5y + 2x_3$
subject to $x_1 + y + 2x_3 \leq 14$; $2x_1 + 4y + 3x_3 \leq 43$;
$0 \leq x_1 \leq 4$; $7 \leq y \leq 10$; $0 \leq x_3 \leq 3$
lower bound on y is $x_2 + 7$
(OR)
b) Solve the following LP by revised simplex method:
Maximize $z = 2x_1 + x_2 + 2x_3$
subject to $4x_1 + 3x_2 + 8x_3 \leq 12$; $4x_1 + x_2 + 12x_3 \leq 8$;
$4x_1 - x_2 + 3x_3 \leq 8$; $x_1, x_2, x_3 \geq 0$</td><td>CO4</td><td>K4</td></tr>
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<tr><td>18</td><td>a) TopAd, a new advertising agency with 10 employees, has received a contract to promote a new product. The agency can advertise by radio and television. The following table gives the number of people reached daily by each type of advertisement and the cost and labor requirements.
<table>
<tr><td></td><td>Radio</td><td>Television</td></tr>
<tr><td>Exposure (in millions of persons)/min</td><td>4</td><td>8</td></tr>
<tr><td>Cost (in thousands of dollars)/min</td><td>8</td><td>24</td></tr>
<tr><td>Assigned exployees/min</td><td>1</td><td>2</td></tr>
</table>
The contract prohibits TopAd from using more than 6 minutes of radio advertisement. Additionally, radio and television advertisements need to reach at least 45 million people. TopAd has a budget goal of $100,000 for the project. How many minutes of radio and television advertisement should TopAd use?
(OR)
b)Solve the ILP by the B&B algorithm: Maximize $z = 5x_1 + 4x_2$ subject to $x_1 + x_2 \leq 5$; $10x_1 + 6x_2 \leq 45$; x_1, x_2 nonnegative integers</td><td>CO4</td><td>K4</td></tr>
<tr><td>19</td><td>a) Explain the procedure involved in solving job sequencing problem of sequencing n jobs on a single machine by Tabu search algorithm.
(OR)
b) Discuss in detail the function for which Metaheuristics are primarily designed.</td><td>CO5</td><td>K5</td></tr>
<tr><td>20</td><td>a) Determine the extreme points of the following function:
$f(x_1, x_2, x_3) = x_1 + 2x_3 + x_2x_3 - x_1^2 - x_2^2 - x_3^2$
(OR)
b) Solve the following LPP by Lagrangean method:
Maximize $f(X) = x_1^2 + x_2^2 + x_3^2$
Subject to $g_1(X) = x_1 + x_2 + 3x_3 - 2 = 0$
$g_2(x) = 5x_1 + 2x_2 + x_3 - 5 = 0$</td><td>CO5</td><td>K5</td></tr>
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