STELLA MARIS COLLEGE (AUTONOMOUS) CHENNAI – 86
(For candidates admitted from the academic year 2023 – 2024 and thereafter)

B.C.A. DEGREE EXAMINATION, NOVEMBER 2024
THIRD SEMESTER

COURSE : ALLIED CORE
PAPER : MATHEMATICS FOR COMPUTER SCIENCE-1
SUBJECT CODE : 23MT/AC/MS35
TIME : 3 HOURS MAX. MARKS: 100

Q. No.	**SECTION A ($5 \times 2 = 10$)** **Answer ANY FIVE questions**	CO	KL
1.	Find the eigen values of the matrix $\begin{bmatrix} 1 & 2 \\ 5 & 4 \end{bmatrix}$.	1	1
2.	Find the unit vector normal to $\phi = x^2 - y^2 + z$ at $(1, -1, 2)$.	1	1
3.	Define solenoidal vector.	1	1
4.	Write Newton-Raphson formula to obtain the cube root of N.	1	1
5.	Define numerical differentiation and numerical integration	1	1
6.	Define slack and surplus variables in LPP	1	1

Q. No.	**SECTION B ($10 \times 1 = 10$)** **Answer ALL questions**	CO	KL
7.	Cayley-Hamilton theorem can be verified for which type of matrix? a) column matrix b) row matrix c) square matrix d) zero matrix	2	2
8.	Given a matrix $A = \begin{bmatrix} 1 & 2 \\ 0 & 1 \end{bmatrix}$, which of the following is the characteristic equation of A? a) $\lambda^2 + 2\lambda + 1 = 0$ b) $\lambda^2 + 2\lambda - 1 = 0$ c) $(\lambda - 1)^2 = 0$ d) $\lambda^2 - 2\lambda = 0$	2	2
9.	For a vector field $\vec{f}$, if $\nabla . \vec{f} = 0$, then the vector field is _____ a) rotational b) solenoidal c) irrotational d) Scalar potential	2	2
10.	If $\phi(x, y, z) = x^2 + y^2 + z^2$ is a scalar function, what is grad ϕ? a) $(2x, 2y, 2z)$ b) (x, y, z) c) $(2, 2, 2)$ d) $(0, 0, 0)$	2	2
11.	How does the bisection method determine the next interval? a) By taking the derivative of the function. b) By evaluating the function at multiple points. c) By finding the midpoint of the current interval. d) By randomly selecting points in the interval.	2	2

..2

12.	What does the Gauss elimination process convert a system into? a) A triangular matrix. b) A diagonal matrix. c) A row-reduced matrix. d) A symmetric matrix.	2	2
13.	For Newton's forward interpolation, which term is used to represent the first difference? a) Δy_0 b) y_0 c) $\Delta^2 y_0$ d) $\Delta^3 y_0$	2	2
14.	To estimate a value using Newton's backward interpolation, what is the formula for the first backward difference ∇y_n? a) $\nabla y_n = y_n - y_{n+1}$ b) $\nabla y_n = y_{n+1} - y_n$ c) $\nabla y_n = y_n - y_{n-1}$ d) $\nabla y_n = y_n + y_{n-1}$	2	2
15.	Which of the following is NOT a requirement for a linear programming problem? a) The objective function must be linear b) All variables must be non-negative c) Constraints can be non-linear d) All constraints must be expressed as linear inequalities or equations	2	2
16.	What is the feasible solution in linear programming? a) A solution that maximizes the objective function b) A solution that satisfies all constraints c) A solution that minimizes the objective function d) A solution that includes all possible variable values	2	2

Q. No.	**SECTION C ($2 \times 15 = 30$)** **Answer ANY TWO questions**	CO	KL
17.	Verify Cayley Hamilton theorem for $\begin{bmatrix} 1 & 0 & 2 \\ 0 & 2 & 1 \\ 2 & 0 & 3 \end{bmatrix}$ and find its inverse.	3	3
18.	Using bisection method, find a real root of the equation $x^3 - x - 11 = 0$.	3	3
19.	Obtain the first and second derivatives of $y = log_e x$ from the following data x: 500, 510, 520, 530, 540, 550 $y = \log_e^x$: 6.2146, 6.2344, 6.2538, 6.2729, 6.2916, 6.3099 (i) at $x = 500$ by Newton's forward difference formula and (ii) at $x = 550$ by Newton's backward difference formula.	3	3
20.	Apply Simplex method to find the non negative values of x, y and z which $Maximize\ Z = 3x + 2y + 5z$ Subject to $x + 4y \leq 420$ $3x + 2z \leq 460$ $x + 2y + z \leq 430$, x, y, z ≥ 0	3	3

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<tr><th>Q. No.</th><th>SECTION D ($2 \times 15 = 30$)
Answer ANY TWO questions</th><th>CO</th><th>KL</th></tr>
<tr><td>21.</td><td>Diagonalize the matrix $\begin{bmatrix} 8 & -6 & 2 \\ -6 & 7 & -4 \\ 2 & -4 & 3 \end{bmatrix}$</td><td>4</td><td>4</td></tr>
<tr><td>22.</td><td>If $\phi = \frac{x}{r^3}$, $\vec{r} = x\hat{i} + y\hat{j} + z\hat{k}$ and $r = |\vec{r}|$, then prove that
(i) $div\ \vec{r} = 3$.
(ii) $curl\ \vec{r} = 0$.
(ii) $\nabla^2\phi = 0$.</td><td>4</td><td>4</td></tr>
<tr><td>23.</td><td>Solve the following system of linear equations by Gauss Jordan method
$x + y + z = 9$
$2x - 3y + 4z = 13$
$3x + 4y + 5z = 40$</td><td>4</td><td>4</td></tr>
<tr><td>24.</td><td>A company manufactures 2 types of printed circuits. The requirements of transistors, resistors and capacitors for each type of printed circuits along with other data are given below
<table>
<tr><th></th><th colspan="2">Circuit</th><th rowspan="2">Stock available</th></tr>
<tr><th></th><th>A</th><th>B</th></tr>
<tr><td>Transistor</td><td>15</td><td>10</td><td>180</td></tr>
<tr><td>Resistor</td><td>10</td><td>20</td><td>200</td></tr>
<tr><td>Capacitor</td><td>15</td><td>20</td><td>210</td></tr>
<tr><td>Profit</td><td>Rs.5</td><td>Rs.8</td><td></td></tr>
</table>
Determine, how many circuits of each type should the company produce from the stock to earn maximum profit by graphical method ?</td><td>4</td><td>4</td></tr>
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Q. No.	SECTION E ($2 \times 10 = 20$) Answer ANY TWO questions	CO	KL
25.	If $\phi = x^3 + y^3 + z^3 - 3xyz$, find $div\ grad\phi, curl\ grad\phi$.	5	5
26..	Evaluate $\int_0^5 \frac{dx}{4x+5}$ by Trapezoidal rule using 11 coordinates.	5	5
27.	Evaluate $\sqrt{12}$ to four decimal places by Newton-Raphson method.	5	5

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a) Express the following LPP in standard matrix form
Maximize $Z = 4x_1 + 2x_2 + 6x_3$
Subject to $2x_1 + 3x_2 + 2x_3 \geq 6$
$3x_1 + 4x_2 = 8$
$6x_1 - 4x_2 + x_3 \leq 10$ and $x_1, x_2, x_3 \geq 0$
b) A firm produces three product. These products are processed on three different machines. The time required to manufacture one unit of each of the three products and the daily capacity of the three machines are given in the table below:
<table>
<tr><th rowspan="2">Machine</th><th colspan="3">Time per unit (minutes)</th><th rowspan="2">Machine capacity (Minutes/ day)</th></tr>
<tr><th>Product 1</th><th>Product 2</th><th>Product 3</th></tr>
<tr><td>M_1</td><td>2</td><td>3</td><td>2</td><td>440</td></tr>
<tr><td>M_2</td><td>4</td><td>-</td><td>3</td><td>470</td></tr>
<tr><td>M_3</td><td>2</td><td>5</td><td>-</td><td>430</td></tr>
</table>
It is required to find the number of units to be manufactured for each product daily. The profit per unit for product 1,2, 3 is Rs.4, Rs.3, Rs. 6 respectively. It is assumed that all the amounts produced are consumed in the market. Formulate the mathematical model for the problem. (5+5)
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