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NOIDA INSTITUTE OF ENGINEERING AND TECHNOLOGY, GREATER NOIDA
(An Autonomous Institute Affiliated to AKTU, Lucknow)

B.Tech

SEM: III - THEORY EXAMINATION (2025- 2026)

Subject: Numerical Methods and Optimization

Time: 2 Hours

Max. Marks: 50

General Instructions:

IMP: Verify that you have received the question paper with the correct course, code, branch etc.

1. This Question paper comprises of **three Sections -A, B, & C**. It consists of Multiple Choice Questions (MCQ's) & Subjective type questions.

2. Maximum marks for each question are indicated on right -hand side of each question.

3. Illustrate your answers with neat sketches wherever necessary.

4. Assume suitable data if necessary.

5. Preferably, write the answers in sequential order.

6. No sheet should be left blank. Any written material after a blank sheet will not be evaluated/checked.

SECTION-A

15

1. Attempt all parts:-

- 1-a. Constraints in LP problem are called active if they(CO1,K2) 1
- (a) Represent optimal solution
- (b) At optimality do not consume all the available resources
- (c) Not Represent optimal solution
- (d) None of these
- 1-b. If the Hessian matrix of a function is everywhere positive definite, then the function is (CO2,K1) 1
- (a) Strictly convex
- (b) Convex
- (c) Non-Convex
- (d) None of these.
- 1-c. The root of $xe^{-x} - 0.3 = 0$ using Bisection Method in the interval [1,5] after 1st iteration is(CO3,K3) 1
- (a) 1.78
- (b) 3.00
- (c) 1.88
- (d) 1.66
- 1-d. The following indicates the formula for Trapezoidal rule. (CO4, K1) 1
- (a)
$$\int_{x_0}^{x_0 + nh} f(x) dx = \frac{h}{3} [(y_0 + y_n) + 4(y_1 + y_3 + \dots + y_{n-1}) + 2(y_2 + y_4 + \dots + y_{n-2})]$$

(b)
$$\int_{x_0}^{x_0+nh} f(x)dx = \frac{3h}{8} [(y_0 + y_n) + 4(y_1 + y_3 + \dots + y_{n-1}) + 2(y_2 + y_4 + \dots + y_{n-2})]$$

(c)
$$\int_{x_0}^{x_0+nh} f(x)dx = \frac{h}{2} [(y_0 + y_n) + 2(y_1 + y_2 + y_3 + \dots + y_{n-1})]$$

(d)
$$\int_{x_0}^{x_0+nh} f(x)dx = \frac{3h}{8} [(y_0 + y_n) + (y_1 + y_3 + \dots + y_{n-1}) + (y_2 + y_4 + \dots + y_{n-2})]$$

1-e. In cubic spline interpolation, each interval between data points is fitted with a: 1
(CO4, K2)

- (a) Linear polynomial
- (b) Quadratic polynomial
- (c) Cubic polynomial
- (d) Exponential function

2. Attempt all parts:-

2.a. A manufacturer makes two products A and B using two machines P and Q. Product A requires 2 hours on machine P and 6 hours on machine Q. Product B requires 5 hours on machine P and no time on machine Q. There are 16 hours of time per day available on machine P and 30 hours on Q. Profit margin from A and B is Rs. 2 and Rs. 10 per unit respectively. Formulate the above as an LPP to maximize the profit. (CO1,K2) 2

2.b. Construct the Hessian Matrix for the given function $f(x,y) = 6xy - x^2$ (CO2,K2) 2

2.c. Determine the lower triangular matrix L from the LU decomposition of $A = \begin{bmatrix} 2 & 1 \\ 8 & 7 \end{bmatrix}$ if $u_{ii}=1$ (CO3,K2) 2

2.d. Solve by Gauss Elimination method $x-y=2, x+y=5$. (CO3,K3) 2

2.e. Construct a backward difference table for the following data (CO4, K3) 2

x	0.5	1.5	2.0
y	13	15	21

SECTION-B 15

3. Answer any three of the following:-

3-a. Solve by Big M Method: (CO1,K3) 5
 Maximize $Z = 14x + 12y$
 s.t. $7x + 6y \leq 13$
 $3x + 5y \geq 15$
 Both x and y all ≥ 0 .

3-b. Use the Kuhn-Tucker conditions to solve the following problems: (CO2,K3) 5
 Maximize $f(x,y) = 8 - x^2 - y^2 + xy + 8x + 4y$
 Subject to , $2x + 3y \leq 24$,
 $x, y \geq 0$.

3-c. Use the Lagrange's multipliers to solve the following non-linear programming problem: (CO2,K3) 5

Optimize $Z = -x_1^2 - x_2^2 + 4x_1 + 6x_2$

Subject to $x_1 + x_2 = 2$,

$x_1, x_2 \geq 0$

- 3.d. Find the approximate root of $x^3 - 2x - 5 = 0$ which is near to $x = 2$, using Newton-Raphson method. (CO3, K3) 5
- 3.e. Apply Runge Kutta (fourth order) method to Determine an approximate value of y when $x = 1.1$, given that $dy/dx = x - y$, $y = 1$ when $x = 1$. (CO4, K3) 5

SECTION-C

20

4. Answer any five of the following:-

- 4-a. Write the dual equation to the following LPP (CO1, K2) 4
 Maximize $Z = 3x_1 + 5x_2 + 4x_3$
 Subject to $2x_1 + 3x_2 \leq 8$,
 $2x_2 + 5x_3 \leq 10$,
 $3x_1 + 2x_2 + 4x_3 \leq 15$
 And $x_1, x_2, x_3 \geq 0$
- 4-b. Solve the following L.P.P. by graphical method (CO1, K3) 4
 Min $z = 3x + 2y$
 Subject to constraint $x + 4y \geq 12$,
 $x + y \geq 6$,
 $5x + y \geq 10$, $x, y \geq 0$.
- 4-c. Find the extreme points $f(x_1, x_2) = 20x_1 + 26x_2 + 4x_1x_2 - 4x_1^2 - 4x_2^2$. (CO2, K3) 4
- 4-d. Optimize the given NLPP and perform 2 iteration of gradient decent method. 4
 $f(x_1, x_2, x_3) = x_1 + 2x_3 + x_2x_3 - x_1^2 - x_2^2 - x_3^2$. (CO2, K3)
- 4-e. Solve using Gauss- Seidel Method (perform two iterations): (CO3, K3) 4
 $10x + y + z = 12$, $x + 10y + z = 12$, $x + y + 10z = 12$ Initial guess:
 $x(0) = 0, y(0) = 0, z(0) = 0$
- 4-f. Solve $x^3 - 5x + 3$ by using Regula Falsi method. (CO3, K3) 4
- 4-g. Calculate an approximate value of $\int_0^1 \sin x \, dx$ by using Simpson's Rule (CO4, K3) 4
- 4-h. Apply Lagrange's interpolation to estimate the value of $f(1.5)$ using: (CO4, K3) 4
 $(1, 1), (2, 4), (3, 9)$