Ref No: EX/IT/BS/B/T/212/2025

B.E in INFORMATION TECHNOLOGY

2^{ND} YEAR, 1^{ST} SEMESTER EXAMINATION, 2025

MATHEMATICS FOR IT-1

Time: 3 hours **Full Marks**: 100

Note: Use separate answer scripts for each part

PART –A
[50 MARKS]

CO1 **[25 MARKS]**	1. a) If vector **A**=$\mathbf{a_x}$+3$\mathbf{a_z}$ and vector **B**=5$\mathbf{a_x}$+2$\mathbf{a_y}$-6$\mathbf{a_z}$ **,** find the angle θ_{AB} between **A** and **B**. Or, Let **G**=$x^2\mathbf{a_x}$-y$\mathbf{a_y}$+2z$\mathbf{a_z}$ and **H**=yz$\mathbf{a_x}$+3$\mathbf{a_y}$+xz$\mathbf{a_z}$**.** find the angle between **G** and **H** at point (1,-2,3). Where $\mathbf{a_x}$**,** $\mathbf{a_y}$ **and** $\mathbf{a_z}$ are unit vectors along x, y and z axis respectively. b) If vector **P**=2$\mathbf{a_x}$-$\mathbf{a_z}$ **,** vector **Q**=2$\mathbf{a_x}$-$\mathbf{a_y}$+2$\mathbf{a_z}$ **,** vector **R**=2$\mathbf{a_x}$-3$\mathbf{a_y}$+$\mathbf{a_z}$ Determine: i) (**P**+**Q**) × (**P**-**Q**) ii) **Q**.**R** × **P** iii) sinθ_{AB} iv) **P** × (**Q** × **R**) v) The component of **P** along **Q** vi) A unit vector perpendicular to both **Q** and **R** c) If vector **A**=x^2y$\mathbf{a_x}$+x$\mathbf{a_y}$+2yz$\mathbf{a_z}$, find divergence (**A)** at the point (-3, 4, 2). Or, Given the vector field **G**=(16xy-z)$\mathbf{a_x}$+8$x^2\mathbf{a_y}$-x$\mathbf{a_z}$ **,** check whether **G** is irrotational or not. Where $\mathbf{a_x}$**,** $\mathbf{a_y}$ **and** $\mathbf{a_z}$ are unit vectors along x, y and z axis respectively. d) Let V=xy^2z^3, evaluate ∇V and $\nabla^2 V$ at point P(1,2,3). Or, State Stoke's theorem. Hence prove it. [4+(2x6)+4+5=25]
CO2 **[25 MARKS]**	**2. Solve the following differential equations. [Any 5]** i) $(1+3e^{y/x})dy+3e^{y/x}(1-y/x)dx=0$ ii) $(4D^2-20D+25)y=0$, where D stands for d/dx iii) $\sin 2x\frac{dy}{dx}-y=\tan x$ iv) $x(x-1)\frac{dy}{dx} - y=x^2(x-1)^2$ v) $(1+y+x^2y)dx+(x+x^3)dy=0$ vi) $(1+x^2)\frac{dy}{dx}+y=e^{\tan^{-1}x}$ vii) $(x+y\cos\frac{y}{x})\,dx=x\cos\frac{y}{x}\,dy$ viii) $\frac{dy}{dx}=\frac{3x+4y+1}{-4x+2y-3}$ [5x5=25]

[Turn over

Part-B
[50 MARKS]

(Note: Answers of all parts/subparts of a question should be written together)

CO3 (25)

Q.1 *Answer (a) and any one from (b) and (c):*

a. Find the optimal solution of the problem i) graphically, and ii) using simplex method:

i. Min $z = 20x_1+10x_2$, where x_1 and $x_2 \geq 0$
s.t. $x_1+2x_2 \leq 40$
$3x_1+x_2 \geq 30$
$4x_1+3x_2 \geq 60$

ii. Min $z = 4x_1 + 3x_2$, where x_1 and $x_2 \geq 0$
s.t. $x_1 + 2x_2 \geq 8$
$3x_1 + 2x_2 \geq 12$

4+8

b.

i. Find the dual of the problem: Max $z = x_1-x_2+3x_3+2x_4$, where x_1 and $x_4 \geq 0$, x_2 and x_3 are unrestricted in sign; subject to: $x_1+x_2 \geq -1$, $x_1-3x_2-x_3 \leq 7$ and $x_1+x_3-3x_4 = -2$

ii. Show that the following L.P.P is degenerate. Hence find its optimal solution.
Max $z = 3x_1+9x_2$, where x_1 and $x_4 \geq 0$, s.t. $x_1+4x_2 \leq 8$, $x_1+2x_2 \leq 4$

iii. Under which condition (s) an L.P.P. becomes degenerate while solving using simplex methods.

5+6+2

c.

i. An agricultural firm has 180 tons of Nitrogen fertilizers, 250 tons of phosphate, and 220 tons of potash. It is able to sell 3:3:4 mixtures of these substances at a profit INR 15 per ton and 1:2:1 mixtures at a profit of INR 12 per ton respectively. Pose a linear programming problem on the given fact.

ii. Give comments on the solutions of the following problems:
Max $z = 3x_1+x_2$, where x_1 and $x_2 \geq 0$, s.t. $2x_1+3x_2 \geq 2$, $x_1+x_2 \geq 1$
Max $z = 3x_1+2x_2$, where x_1 and $x_2 \geq 0$, s.t. $x_1- x_2 \leq 1$, $x_1+ x_2 \geq 3$
Max $z = 6x_1+10x_2$, where x_1 and $x_2 \geq 0$ s.t. $3x_1+5x_2 \leq 10$, $5x_1+3x_2 \leq 15$

5+8

CO4 (13)

Q.3 *Answer any one:*

a.

i. Find the initial basic feasible solution of the following transportation problem by using *three* well known methods (symbols carry their usual meaning).

	D_1	D_2	D_3	D_4	a_i
O_1	19	20	50	10	*7*
O_2	70	30	40	60	*9*
O_3	40	8	70	20	*18*
b_j	*5*	*8*	*7*	*14*	

ii. What step (s) is/are taken if the number of occupied cells < m+n-1 w.r.t. a transportation problem? What step (s) is/are taken if some cells of an assignment problem are vacant and –ve?

9+2x2

b.

i. Find the optimal assignment of the following assignment problem.

	M_1	M_2	M_3	M_4	M_5
J_1	3	5	10	15	18
J_2	4	7	15	18	8
J_3	8	12	20	20	12
J_4	5	5	8	10	6
J_5	10	10	15	25	10

ii. For a transportation problem what step (s) is/are taken if at least one cell-evaluation is –ve? Determine the conditions of non-degeneracy and finding basic feasible solution of it.

9+2x2

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CO5 (12)

Q.2 *Answer any one:*

a.

i. Find the optimal solution of the following transportation problem:

	D_1	D_2	D_3	D_4	D_5	a_i
O_1	3	4	6	8	8	*20*
O_2	2	10	0	5	8	*30*
O_3	7	11	20	40	3	*15*
O_4	1	0	9	14	16	*13*
b_j	*40*	*6*	*8*	*18*	*6*	

ii. What are the conditions of an assignment problem to be degenerate? Suggests some rules/techniques to avoid it.

9+3

b. How is enumerative method applied in an assignment problem for solving a travelling salesman problem (TSP)? Hence solve the following:

	D_1	D_2	D_3	D_4	D_5	D_6
S_1	∞	20	23	27	29	34
S_2	21	∞	19	26	31	24
S_3	26	28	∞	15	36	26
S_4	25	16	25	∞	23	18
S_5	23	40	23	31	∞	10
S_6	27	18	12	35	16	∞

3+10

Course Outcomes

CO1: Explain and illustrate sum and product of vectors with related applications.
CO2: Solve homogeneous, non-homogeneous linear ordinary differential equations of the 1st order and higher orders having constant and variable coefficients and system of linear differential equations.
CO3: Express a given real-world problem as a linear programming problem and use simplex method to solve it.
CO4: Solve transportation problem using suitable methods and test for optimality.
CO5: Solve assignment problem using suitable methods and examine for optimality.