Ref. No.: Ex/IT/BS/B/T/212/2024

B.E. INFORMATION TECHNOLOGY SECOND YEAR, FIRST SEMESTER EXAM 2024

Time: Three hours | **MATHEMATICS FOR IT- I** | Full Marks-100

CO1: Explain and illustrate sum and product of vectors with related applications

Attempt any **three (3)** questions. $3 \cdot 5 = 15$

I. If vectors { **u, v, w**} are linearly independent, examine the linearly independency of the set of vectors {**p, q, r**} where **p = u cos a + v cos b + w cos c, q = u sin a + v sin b + w sin c, and r= u sin(x+a) + v sin(x+b) + sin(x+c).**

II. If M and N are mid-points of the sides AB, CD of a parallelogram ABCD, prove that DM and BN cut the diagonal AC at its point of trisection, which are also the points of trisection of DM and BN, respectively.

III. Prove that **[a b+c d] = [a b d] + [a c d].**

IV. Show that the diagonals of a rhombus are at right angles.

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

Attempt any three (3) questions $3x5=15$

I. Solve $\sqrt{1+x^2+y^2+x^2y^2} + xy\frac{dy}{dx} = 0.$

II. Solve $(2\sqrt{xy} - x)dy + ydx = 0.$

III. Solve $p^2 + \left(x + y - 2\frac{y}{x}\right)p + xy + \frac{y^2}{x^2} - y - \frac{y^2}{x} = 0$, where $p = \frac{dy}{dx}$.

IV. Solve$(x^3 - x)\frac{dy}{dx} - (3x^2 - 1)y = x^5 - 2x^3 + x$..

V. Solve $(D^4 + D^3 + D^2 - D - 2)y = e^x$

VI. Using method of undetermined coefficients, solve $(D^2 - 2D + 3)y = cos\ cos\ x + x^2$

CO3: Express a given real-world problem as a linear programming problem and use the simplex method to solve it

Attempt any **three (3)** from {I, II, III, IV} $3 \cdot 5 = 15$

I. A firm produces three products. 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:

Machine	Time per unit (minutes)			Machine capacity minutes/day
	$Product_1$	$Product_2$	$Product_3$	
M_1	2	3	2	440
M_2	4	-	3	470
M_3	2	5	-	430

It is required to determine the daily number of units to be manufactured for each product. The profit per unit for products 1, 2, and 3 is Rs. 4, Rs.3, and Rs.6, respectively. It is assumed that all the amounts produced are consumed in the market. Formulate the mathematical (L.P.) model that will maximize the daily profit.

II. Solve the following problem graphically.

Minimize $Z = -x_1 + 2x_2$

Subject to

$-x_1 + 3x_2 \ \delta\ 10$

$x_1 + x_2 \ \delta\ 6$

$x_1 - x_2 \ \delta\ 2$

$x_1, x_2 \geq 0$

[Turn over

III. If any constraint of the primal problem is an equation, then prove that the corresponding dual variable is unrestricted in sign.

IV. Find the basic solutions of the following set of equations and classify the solutions as feasible, degenerate and non-degenerate.

$$5x_1 + 4x_2 + 2x_3 + x_4 = 100$$
$$2x_1 + 3x_2 + 8x_3 + x_4 = 75$$
$$x_1, x_2, x_3, x_4 \geq 0$$

Attempt any **two (2)** questions from {V, VI, VII} $2 \times 15 = 30$

V. Solve the following LPP by the Big-M method

Minimize $Z = 4x_1 + 2x_2$
Subject to $3x_1 + x_2 \; ε \; 27$
$x_1 + x_2 \; ε \; 21$
$x_1 + 2x_2 \; ε \; 30$
$x_1, x_2 \geq 0$

VI. Use two-phase method to solve the following LPP

Maximize $Z = 2x_1 + 3x_2 + x_3$
Subject to
$-3x_1 + 2x_2 + 3x_3 = 8$
$-3x_1 + 4x_2 + 2x_3 = 7$
$x_1, x_2, x_3 \geq 0$

VII. Construct and solve the dual of the following LPP and then solve the primal.

Maximize $Z = 3x_1 + 4x_2$
Subject to
$x_1 + x_2 \; δ \; 12$
$2x_1 + 3x_2 \; δ \; 21$
$x_1 \; δ \; 8$
$x_2 \; δ \; 6$
$x_1, \; x_2 \geq 0$

CO4: Solve transportation problem using suitable methods and test for optimality

Attempt any **one (1)** 15

I. Formulate the mathematical model for the transportation problem given below. Find an optimal solution and corresponding cost of transportation problem when the initial solution is obtained using VAM.

	W_1	W_2	W_3	W_4	W_5	Available
F_1	7	6	4	5	9	40
F_2	8	5	6	7	8	30
F_3	6	8	9	6	5	20
F_4	5	7	7	8	6	10
Required	30	30	15	20	5	100 (Total)

II. Formulate the mathematical model for the transportation problem given below. Find an optimal solution and corresponding cost of transportation problem when the initial solution is obtained using VAM.

		Stores 1	2	3	4	5	6
Warehouses	1	9	12	9	6	9	10
	2	7	3	7	7	5	5
	3	6	5	9	11	3	11
	4	6	8	11	2	2	10

CO5: Solve assignment problem using suitable methods and examine for optimality

Attempt any **one (1)** 10

I Solve the aside assignment problem. Formulate the mathematical model for the problem.

	I	II	III	IV	V
1	11	17	8	16	20
2	9	7	12	6	15
3	13	16	15	12	16
4	21	24	17	28	26
5	14	10	12	11	13

II Four different jobs can be done on four different machines. The set-up and take-down time costs are assumed to be prohibitively high for changeover. The matrix aside gives the costs in rupees of producing job i on machine j. How should the jobs be assigned to the various machines so that the total cost is minimized? Also, formulate the mathematical model for the problem.

		Machines M_1	M_2	M_3	M_4
Jobs	J_1	5	7	11	6
	J_2	8	5	9	6
	J_3	4	7	10	7
	J_4	10	4	8	3