Total number of printed pages–31

3 (Sem–3/CBCS) MAT HG 1/RC/HG 2

2022

MATHEMATICS

(Honours Generic/Regular)

Answer the Questions from any one Option.

OPTION–A

Paper : MAT–HG–3016 /MAT–RC–3016

(Differential Equations)

OPTION–B

Paper : MAT–HG–3026

(Linear Programming)

Full Marks : 80

Time : Three hours

The figures in the margin indicate full marks for the questions.

Contd.

OPTION–A

Paper : MAT–HG–3016 /MAT–RC–3016

(Differential Equations)

*Answer **either** in English **or** in Assamese.*

1. Answer the following questions : ***(any ten)*** 1×10=10

তলত দিয়া প্ৰশ্নবোৰৰ উত্তৰ কৰা ঃ *(যিকোনো দহটা)*

(a) Write down the order of the following differential equation :

তলৰ অৱকল সমীকৰণটোৰ ক্ৰম লিখা ঃ

$$\frac{d^6x}{dt^6} + \left(\frac{d^4x}{dt^4}\right)\left(\frac{d^3x}{dt^3}\right) + x = t$$

(b) What is meant by implicit solution of a differential equation ?

এটা অৱকল সমীকৰণৰ অন্তৰ্নিহিত সমাধান মানে কি ?

(c) Form the differential equation of the family of circles $x^2 + y^2 = a^2$.

$x^2 + y^2 = a^2$ বৃত্তৰ পৰিয়ালটোৰ অৱকল সমীকৰণটো গঠন কৰা।

(d) Define an exact differential equation.

এটা যথাৰ্থ অৱকল সমীকৰণৰ সংজ্ঞা লিখা।

(e) Evaluate the Wronskian of the functions $\sin x$ and $\cos x$.

$\sin x$ আৰু $\cos x$ ফলন দুটাৰ Wronskian নিৰ্ণয় কৰা।

(f) State whether the following equation is homogeneous or not :

তলৰ সমীকৰণটো সমমাত্ৰিক হয়নে নহয় লিখা ঃ

$$\left(x^2 + 3y^2\right)dx - 2xy\,dy = 0$$

(g) Check exactness of (যথাৰ্থতা পৰীক্ষা কৰা) ঃ

$$\left(x^2+2y^2\right)dx+\left(4xy-y^2\right)dy=0$$

(h) When is a family of curves said to be self-orthogonal?

এটা বক্ৰৰ পৰিয়ালক কেতিয়া স্বলম্বীয় বুলি কব পাৰি ?

(i) Write the UC set corresponding to the UC function x^2e^x.

UC ফলন x^2e^x সাপেক্ষে UC সংহতিটো লিখা।

(j) If e^{2x} and e^{3x} are two linearly independent solutions of a 2nd order linear differential equation, write down the general solution.

e^{2x} আৰু e^{3x} এটা দ্বিমাত্ৰাৰ অৰকল সমীকৰণৰ দুটা ৰৈখিকভাৱে স্বতন্ত্ৰ সমাধান হ'লে সমীকৰণটোৰ সাধাৰণ সমাধান লিখা।

(k) The roots of the auxiliary equation corresponding to a 5th order linear differential equation are 2, 2, 2, $3\pm4i$. Write the general solution of the equation.

এটা 5 মাত্ৰাৰ ৰৈখিক অৱকল সমীকৰণৰ সহায়ক সমীকৰণটোৰ মূল কেইটা 2, 2, 2, $3\pm4i$ হ'লে সমীকৰণটোৰ সাধাৰণ সমাধান লিখা।

(l) Consider the equation

$$(2x-5y)\,dx+(4x-y)\,dy=0$$

What transformation will reduce it to a separable equation?

$(2x-5y)\,dx+(4x-y)\,dy=0$ সমীকৰণটোক কি ৰূপান্তৰে এটা বিয়োজিত (separable) সমীকৰণলৈ সমানীত কৰিব ?

(m) Determine the integrating factor of:

অনুকলন গুণক উলিওৱা ঃ

$$\frac{dy}{dx}+\frac{3y}{x}=6x^2$$

(n) In the differential equation

$M(x, y)dx + N(x, y)dy = 0$, if

$$\frac{1}{N(x, y)}\left[\frac{\partial M(x, y)}{\partial y} - \frac{\partial N(x, y)}{\partial x}\right]$$ depends

upon x only, what will be the integrating factor of the equation?

$M(x, y)dx + N(x, y)dy = 0$

অৱকল সমীকৰণটোৰ যদিহে

$$\frac{1}{N(x, y)}\left[\frac{\partial M(x, y)}{\partial y} - \frac{\partial N(x, y)}{\partial x}\right]$$

অকল x ৰ নিৰ্ভৰশীল হয় তেন্তে সমীকৰণটোৰ অনুকলন গুণক কি ?

(o) Solve (সমাধান কৰা) :

$$ydx + xdy = 0$$

(p) Write down the general form of Cauchy-Euler equation of order n.

n মাত্ৰাৰ কচি-ইউলাৰ সমীকৰণৰ সাধাৰণ ৰূপটো লিখা।

(q) Is the equation linear?

সমীকৰণটো ৰৈখিক হয়নে ?

$$\frac{d^2y}{dx^2} + y\frac{dy}{dx} + x = 0$$

(r) Write down the UC set corresponding to UC function $\sin x$.

UC ফলন $\sin x$ সাপেক্ষে UC সংহতিটো লিখা।

2. Answer the following questions : ***(any five)*** 2×5=10

তলত দিয়া প্ৰশ্নবোৰৰ উত্তৰ কৰা ঃ *(যিকোনো পাঁচটা)*

(a) Determine all values of constant m for which $y = e^{mx}$ is a solution of the differential equation

$$\frac{d^2y}{dx^2} - 4\frac{dy}{dx} + 3y = 0.$$

m ৰ সকলো মান নিৰ্ণয় কৰা, যাৰ বাবে

$\frac{d^2y}{dx^2} - 4\frac{dy}{dx} + 3y = 0$ সমীকৰণটোৰ $y = e^{mx}$ এটা সমাধান হয়।

(b) What is meant by singular solution of a differential equation ?

এটা অৱকল সমীকৰণৰ একক সমাধান বুলিলে কি বুজা ?

(c) Write down the complementary function of the differential equation

$$\frac{d^2y}{dx^2} - y = \tan x.$$

$\frac{d^2y}{dx^2} - y = \tan x$ অৱকল সমীকৰণটোৰ পৰিপূৰক ফলনটো লিখা।

(d) Determine the most general function $M(x, y)$ such that the equation

$$M(x, y)dx + (2x^2y^3 + x^4y)dy = 0$$

is exact.

অত্যন্ত সাধাৰণ ফলন $M(x, y)$ উলিওৱা যাতে,

$$M(x, y)dx + (2x^2y^3 + x^4y)dy = 0$$

সমীকৰণটো যথাৰ্থ হয়।

(e) Show that the differential equation $(x^2 - 3y^2)dx + 2xy\,dy = 0$ is homogeneous.

দেখুওৱা যে $(x^2 - 3y^2)dx + 2xy\,dy = 0$ অৱকল সমীকৰণটো সমমাত্ৰিক।

(f) Show that the ordered pair of functions $(3e^{7t}, 2e^{7t})$ is a solution of the linear system :

দেখুওৱা যে ক্ৰমিত যুগ্ম ফলন $(3e^{7t}; 2e^{7t})$ তলৰ ৰৈখিক প্ৰণালীটোৰ এটা সমাধান হয় ঃ

$$\frac{dx}{dt} = 5x + 3y$$

$$\frac{dy}{dt} = 4x + y$$

(g) Write down the form of particular solution for the differential equation :

তলৰ অৱকল সমীকৰণটোৰ বিশেষ সমাধান (particular solution) ৰ ৰূপটো লিখা ঃ

$$\frac{d^2y}{dx^2} - 3\frac{dy}{dx} + 2y = 4x^2$$

(h) Solve (সমাধান কৰা) :

$$x \sin y\, dx + (x^2+1)\cos y\, dy = 0$$

(i) Reduce the Bernoulli's equation

$x\frac{dy}{dx}+y=-2x^6y^4$ to linear equation by appropriate transformation.

উপযুক্ত ৰূপান্তৰ সহায়ত বাৰ্নোলীৰ সমীকৰণ

$x\frac{dy}{dx}+y=-2x^6y^4$ ক বৈখিক সমীকৰণলৈ সমানীত কৰা।

(j) Find the general solution :
সাধাৰণ সমাধান উলিওৱা ঃ

$$4\frac{d^2y}{dx^2}-12\frac{dy}{dx}+5y=0$$

3. Answer the following questions : ***(any four)*** 5×4=20

তলত দিয়া প্ৰশ্নবোৰৰ উত্তৰ কৰা ঃ *(যিকোনো চাৰটা)*

(a) Show that the relation $x^2+y^2-25=0$ is an implicit solution of the differential equation $x+y\frac{dy}{dx}=0$ on the interval I defined by $-5<x<5$.

দেখুওৱা যে $-5<x<5$ অন্তৰালত

$x+y\frac{dy}{dx}=0$ অৱকল সমীকৰণটোৰ

$x^2+y^2-25=0$ এটা অন্তৰ্নিহিত সমাধান হয়।

(b) Write down the general form of a Bernoulli equation. Describe the method of reducing this equation to a linear equation. 1+4=5

বাৰ্নোলী সমীকৰণৰ সাধাৰণ ৰূপটো লিখা। এই সমীকৰণক এটা বৈখিক সমীকৰণলৈ সমানীত কৰা পদ্ধতিটো ব্যাখ্যা কৰা।

(c) Solve (সমাধান কৰা) :

$$(3x-y-6)dx+(x+y+2)dy=0$$

(d) Reduce to first order differential equation and then solve : 1+4=5

এক মাত্ৰাৰ (ক্ৰমৰ) অৱকল সমীকৰণলৈ সমানীত কৰি সমাধান কৰা ঃ

$$y''+y'=0$$

Contd.

(e) Solve the Cauchy-Euler equation :

কচি-ইউলাৰ সমীকৰণটো সমাধান কৰা ঃ

$$x^2\frac{d^2y}{dx^2}-2x\frac{dy}{dx}+2y=x^3$$

(f) Determine the constant A such that the following equation is exact :

Aৰ মান উলিওৱা যাতে তলৰ অৱকল সমীকৰণটো যথাৰ্থ হয় ঃ

$$\left(Ax^2y+2y^2\right)dx+\left(x^3+4xy\right)dy=0$$

Hence solve the resulting exact equation. 2+3=5

লগতে লব্ধ যথাৰ্থ সমীকৰণটো সমাধান কৰা।

(g) Show that $x=t+1,\ y=-5t-2$ is a particular solution of the non-homogeneous linear system

$$\frac{dx}{dt}=5x+2y+5t$$

$$\frac{dy}{dt}=3x+4y+17t$$

Write the general solution of the system.

দেখুওৱা যে $x=t+1,\ y=-5t-2$ তলৰ অসমমাত্ৰিক ৰৈখিক প্ৰণালীটোৰ সাধাৰণ সমাধান হয় ঃ

$$\frac{dx}{dt}=5x+2y+5t$$

$$\frac{dy}{dt}=3x+4y+17t$$

লগতে প্ৰণালীটোৰ সাধাৰণ সমাধান লিখা।

(h) Solve the initial value problem :

আদিমান বিশিষ্ট সমীকৰণটো সমাধান কৰা ঃ

$$\frac{d^2y}{dx^2}+7\frac{dy}{dx}+10y=0,\ y(0)=-4,$$
$$y'(0)=2$$

4. Answer the following questions : ***(any four)*** 10×4=40

তলত দিয়া প্ৰশ্নবোৰৰ উত্তৰ কৰা ঃ *(যিকোনো চাৰটা)*

(a) Prove that the linear differential equation $\frac{dy}{dx}+P(x)y=Q(x)$ has an integrating factor of the form $e^{\int P(x)dx}$ and one-parameter family of solution

$$y.e^{\int P(x)dx}=\int e^{\int P(x)dx}Q(x)dx+C$$

7+3=10

Contd.

প্ৰমাণ কৰা যে বৈখিক অৱকল সমীকৰণ

$\frac{dy}{dx}+P(x)y=Q(x)$ ৰ $e^{\int P(x)dx}$ এটা অনুকলন গুণক হয় আৰু সমীকৰণটোৰ এক চলকযুক্ত সমাধান হ'ল

$$y.e^{\int P(x)dx}=\int e^{\int P(x)dx}Q(x)dx+C$$

(b) (i) Find the orthogonal trajectories of the family of parabolas $y=cx^2$. 5

$y=cx^2$ অধিবৃত্তৰ পৰিয়ালটোৰ লাম্বিক প্ৰক্ষেপপথ নিৰ্ণয় কৰা।

(ii) Find a family of oblique trajectories that intersect the family of circles $x^2+y^2=c^2$ at an angle 45°. 5

$x^2+y^2=c^2$ বৃত্তৰ পৰিয়ালটোক 45° কোণত ছেদ কৰি থকা এটা তিৰ্যক প্ৰক্ষেপপথৰ পৰিয়াল উলিওৱা।

(c) Solve the initial value problem

$$\frac{dy}{dx}+y=f(x) \text{ where}$$

$$f(x)=\begin{cases}5, & 0\le x<10\\ 1, & x\ge 10\end{cases} \text{ and } y(0)=6$$

আদিমান বিশিষ্ট সমীকৰণ

$\frac{dy}{dx}+y=f(x)$ সমাধান কৰা য'ত

$$f(x)=\begin{cases}5, & 0\le x<10\\ 1, & x\ge 10\end{cases}$$

আৰু $y(0)=6$.

(d) Solve by method of variation of parameter:

প্ৰাচল বিচৰণ পদ্ধতিৰে সমাধান কৰা ঃ

$$\frac{d^2y}{dx^2}+y=\tan x\sec x$$

Contd.

(e) Consider the differential equation

অৱকল সমীকৰণ এটা লোৱা হ'ল

$$\frac{d^2y}{dx^2} - 2\frac{dy}{dx} + y = 0$$

(i) Show that e^x and xe^x are linearly independent solutions of this equation on the interval $-\infty < x < \infty$. 5

দেখুওৱা যে $-\infty < x < \infty$ অন্তৰালত e^x আৰু xe^x সমীকৰণটোৰ দুটা ৰৈখিকভাৱে স্বতন্ত্ৰ সমাধান হয়।

(ii) Write the general solution of the equation. 2

সমীকৰণটোৰ সাধাৰণ সমাধান লিখা।

(iii) Find the solution that satisfies the condition $y(0) = 1,\ y'(0) = 4$. Explain why this solution is unique. 2+1=3

$y(0) = 1,\ y'(0) = 4$ চৰ্ত্ত সাপেক্ষে সমীকৰণটোৰ সমাধান উলিওৱা।

এই সমাধান কিয় একক হয়, ব্যাখ্যা কৰা।

(f) Find the general solution by the method of undetermined co-efficients :

অনিৰ্ধাৰিত সহগ পদ্ধতিৰে সাধাৰণ সমাধান উলিওৱা ঃ

$$\frac{d^2y}{dx^2} + 2\frac{dy}{dx} + 5y = 6\sin 2x + 7\cos 2x$$

(g) Consider the linear system

ৰৈখিক প্ৰণালী এটা লোৱা হ'ল

$$\frac{dx}{dt} = 5x + 2y$$

$$\frac{dy}{dt} = 3x + 4y$$

(i) Show that (দেখুওৱা যে)

$x = 2e^{2t},\ x = e^{7t}$

and (আৰু)

$y = 3e^{2t},\ y = e^{7t}$

are solutions of this system. 5

এই প্ৰণালীটোৰ সমাধান হয়।

(ii) Show that the two solutions defined in part (i) are linearly independent on every interval $a \le t \le b$. 3

দেখুওৱা যে part (i) ত উল্লিখিত সমাধান দুটা $a \le t \le b$ অন্তৰালত বৈখিকভাৱে স্বতন্ত্ৰ হয়।

(iii) Write the general solution of the system. 2

প্ৰণালীটোৰ সাধাৰণ সমাধান লিখা।

(h) Solve the following: (সমাধান কৰা) 5+5=10

(i) $2x(y+1)dx-(x^2+1)dy=0, \quad y(1)=-5$

(ii) $(2x\sin y+y^3e^x)dx+(x^2\cos y+3y^2e^x)dy=0$

(i) (i) Given that $y=x+1$ is a solution of $(x+1)^2\dfrac{d^2y}{dx^2}-3(x+1)\dfrac{dy}{dx}+3y=0$.

Find a linearly independent solution by reducing the order. 7

$$(x+1)^2\frac{d^2y}{dx^2}-3(x+1)\frac{dy}{dx}+3y=0$$

অৱকল সমীকৰণটোৰ এটা সমাধান $y=x+1$ হয়। সমীকৰণটোৰ ক্ৰম লঘুকৃত কৰি এটা বৈখিকভাৱে স্বতন্ত্ৰ সমাধান উলিওৱা।

(ii) Given that e^{-x}, e^{3x} and e^{4x} are all solutions of

$$\frac{d^3y}{dx^3}-6\frac{d^2y}{dx^2}+5\frac{dy}{dx}+12y=0.$$

Show that they are linearly independent on the interval $-\infty < x < \infty$. 3

দিয়া আছে যে e^{-x}, e^{3x} আৰু e^{4x} আটাইবোৰেই.

$$\frac{d^3y}{dx^3}-6\frac{d^2y}{dx^2}+5\frac{dy}{dx}+12y=0$$

অৱকল সমীকৰণটোৰ সমাধান হয়।

দেখুওৱা যে $-\infty < x < \infty$ অন্তৰালত সমাধানবোৰ বৈখিকভাৱে স্বতন্ত্ৰ।

(j) Find the general solution : 5+5=10

সাধাৰণ সমাধান উলিওৱা ঃ

(i) $\frac{d^2y}{dx^2} - 2\frac{dy}{dx} - 3y = 3x^2$

(ii) $\frac{d^3y}{dx^3} - 6\frac{d^2y}{dx^2} + 11\frac{dy}{dx} - 6y = 0$

OPTION–B

Paper : MAT–HG–3026

(*Linear Programming*)

1. Answer ***any ten*** of the following : 1×10=10

(i) Define feasible solution of a linear programming problem (LPP).

(ii) If a given LPP has two feasible solutions, then how many feasible solutions are there for the LPP ?

(iii) How many basic solutions are possible in a system of m simultaneous linear equations in $n\,(>m)$ unknowns ?

(iv) When is a basic solution to the system of equations $Ax = b$ said to be degenerate ?

(v) Define surplus variable.

(vi) When is an LPP said to be in standard format ?

(vii) Define hyperplane.

(viii) "All boundary points of a convex set are necessarily extreme points." Is it true ?

(ix) Does the LPP

Maximize $3x_1 - 2x_2$

subject to
$$x_1 + x_2 \le 1$$
$$2x_1 + 2x_2 \ge 4$$
$$x_1, x_2 \ge 0$$

have an optimal solution?

(x) Name two methods that can be employed to solve LPP having artificial variables.

(xi) Consider the primal problem given as

Minimize $x_1 - 3x_2 - 2x_3$

subject to
$$3x_1 - x_2 + 2x_3 \le 7$$
$$2x_1 - 4x_2 \ge 12$$
$$-4x_1 + 3x_2 + 4x_3 = 10$$

$x_1, x_2 \ge 0$ and x_3 unrestricted.

Can the dual of this primal have unrestricted variables?

(xii) Write the relation between Z_P and Z_D, where Z_P is the optimal value of the primal objective function and Z_D is the optimal value of the dual objective function.

(xiii) A primal problem has 7 constraints in 3 variables. How many constraints are there in its dual?

(xiv) When is a transportation problem said to be unbalanced?

(xv) Write the full form of VAM.

(xvi) What is a fair game?

(xvii) Is it necessary that a game should always pass a saddle point?

(xviii) Can a two-person zero-sum game in normal form be solved as an LPP?

2. Answer ***any five*** of the following: 2×5=10

(i) Define basic feasible solution (B.F.S.) of an LPP. When is a B.F.S. said to be non-degenerate?

(ii) Explain the following terms in the context of LPP:

(a) Objective function

(b) Decision variables

(iii) Show that a hyperplane is a convex set.

(iv) Solve the following LPP graphically:

Maximize $Z = 4x_1 + 4x_2$

subject to $x_1 + x_2 \leq 5$

$3x_1 + x_2 \leq 9$

$x_1, x_2 \geq 0$

(v) What is meant by unbounded solution in linear programming?

(vi) Write the dual of the following primal problem:

Minimize $Z_P = 15x_1 + 12x_2$

subject to $x_1 + 2x_2 \geq 3$

$2x_1 - 4x_2 \leq 5$

$x_1, x_2 \geq 0$

(vii) State the fundamental theorem of duality.

(viii) Find an initial basic feasible solution to the following transportation problem by least cost method:

	D_1	D_2	D_3	D_4	*Supply*
O_1	2	1	3	4	30
O_2	3	2	1	4	50
O_3	5	2	3	8	20
Demand	20	40	30	10	

(ix) State the mathematical formulation of an assignment problem.

(x) In a two-person zero-sum game, the pay-off matrix is given by

		B I	II	III
A	I	6	8	6
	II	4	12	2

Find its saddle points.

3. Answer ***any four*** of the following: 5×4=20

(i) Define convex set and show that the intersection of any finite number of convex sets is a convex set.

(ii) Show that every basic feasible solution of an LPP is an extreme point of the convex set of its feasible solutions.

(iii) Solve the following LPP by simplex method:

Maximize $Z = 3x_1 + 2x_2$

subject to $x_1 + x_2 \leq 4$

$x_1 - x_2 \leq 2$

$x_1, x_2 \geq 0$

Contd.

(iv) Solve the following LPP by Big-M method :

Maximize $Z = 2x_1 + 3x_2$

subject to $x_1 + 2x_2 \leq 4$

$x_1 + x_2 = 3$

$x_1, x_2 \geq 0$

(v) Find the dual of the following primal problem :

Maximize $2x_1 + x_2$

subject to $x_1 + 5x_2 \leq 10$

$x_1 + 3x_2 \geq 6$

$x_1 + x_2 \leq 4$

$x_2 \geq 0$ and x_1 unrestricted

(vi) Use north-west corner method to find an initial basic feasible solution to the following transportation problem :

	D_1	D_2	D_3	D_4	D_5	Supply
O_1	2	11	10	3	7	4
O_2	1	4	7	2	1	8
O_3	3	9	4	8	12	9
Demand	3	3	4	5	6	

(vii) Find an optimal solution to the following assignment problem :

	I	II	III	IV
A	12	30	21	15
B	18	33	9	31
C	44	25	24	21
D	23	30	28	14

(viii) The pay-off matrix of a two-person zero-sum game is given below :

		B				
		I	II	III	IV	V
A	I	9	3	1	8	0
	II	6	5	4	6	7
	III	2	4	3	3	8
	IV	5	6	2	2	1

Find the best strategy for each player and the value of the game.

4. Answer ***any four*** questions : 10×4=40

(i) Show that the following system of linear equations has a degenerate solution :

$$2x_1 + x_2 - x_3 = 2$$
$$3x_1 + 2x_2 + x_3 = 3$$

(ii) Reduce the feasible solution

$x_1 = 2,\ x_2 = 3,\ x_3 = 1$

of the following system of linear equations to a basic feasible solution :

$$2x_1 + x_2 + 4x_3 = 11$$
$$3x_1 + x_2 + 5x_3 = 14$$

(iii) Explain the simplex procedure to solve a linear programming problem (LPP).

(iv) Use two-phase method to solve the LPP :

Maximize $Z = 5x_1 - 4x_2 + 3x_3$

subject to
$$2x_1 + x_2 - 6x_3 = 20$$
$$6x_1 + 5x_2 + 10x_3 \le 76$$
$$8x_1 - 3x_2 + 6x_3 \le 50$$
$$x_1, x_2, x_3 \ge 0$$

(v) Use Big-M method to solve the LPP :

Minimize $Z = 4x_1 + x_2$

subject to
$$3x_1 + x_2 = 3$$
$$4x_1 + 3x_2 \ge 6$$
$$x_1 + 2x_2 \le 4$$
$$x_1, x_2 \ge 0$$

(vi) *(a)* What is the significance of duality in linear programming? 4

(b) Show that the dual of the dual is the primal. 4

(c) State the complementary slackness theorem. 2

(vii) *(a)* Write the dual of the LPP : 5

Minimize $x_1 + x_2 + x_3$

subject to
$$x_1 - 3x_2 + 4x_3 = 5$$
$$2x_1 - 2x_2 \le 3$$
$$2x_2 - x_3 \ge 5$$

$x_1, x_2 \ge 0$ and x_3 unrestricted.

Contd.

(b) Solve the dual of the following primal problem: 5

Maximize $3x_1 - 2x_2$

subject to $x_1 \leq 4$

$x_2 \leq 6$

$x_1 + x_2 \leq 5$

$x_2 \geq 1$

$x_1, x_2 \geq 0$

(viii) Find and optimal solution to the following transportation problem:

	D_1	D_2	D_3	D_4	Supply
W_1	19	14	23	11	11
W_2	15	16	12	21	13
W_3	30	25	16	39	19
Demand	6	10	12	15	

(ix) Apply the Hungarian method to solve the following assignment problem:

	I	II	III	IV
A	12	10	8	9
B	8	9	11	7
C	11	14	12	10
D	9	9	8	9

(x) (a) What is game theory? 2

(b) Describe a two-person zero-sum game. Also mention *any two* basic assumptions in it. 4

(c) Explain the following terms: 2+2=4

Pure strategy, Mixed strategy

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3000