Mathematics Practical

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Submitted To: ***Submitted By:***

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Create And Transform Vectors And Matrices (The Transpose Vector (Matrix) Conjugate Transpose Of A Vector (Matrix)).

(%i5)
```
/*1. Create and transform vectors and matrices (the transpose vector (matrix) conjugate transpose of a vector (matrix)).*/
Matrix:entermatrix(3,3);
("Enter Your Vector");
Vector:entermatrix(1,3);        /* RATNESH KUMAR*/
Transpose_Matrix:transpose(Matrix);
Transpose_Vector:transpose(Vector);
```

(%o0) done

Is the matrix 1. Diagonal 2. Symmetric 3. Antisymmetric 4. General Answer 1, 2, 3 or 4 :**4**; Row 1 Column 1:**8**; Row 1 Column 2:**06**; Row 1 Column 3:**5**; Row 2 Column 1:**3**; Row 2 Column 2: **7**; Row 2 Column 3:**5**; Row 3 Column 1:**1**; Row 3 Column 2:**4**; Row 3 Column 3:**0**;

Matrix entered.

Matrix $\begin{pmatrix} 8 & 6 & 5 \\ 3 & 7 & 5 \\ 1 & 4 & 0 \end{pmatrix}$

(%o2) Enter Your Vector Row 1 Column 1:**8**; Row 1 Column 2:**06**; Row 1 Column 3:**5**;

Matrix entered.

Vector $\begin{pmatrix} 8 & 6 & 5 \end{pmatrix}$

Transpose_Matrix $\begin{pmatrix} 8 & 3 & 1 \\ 6 & 7 & 4 \\ 5 & 5 & 0 \end{pmatrix}$

Transpose_Vector $\begin{pmatrix} 8 \\ 6 \\ 5 \end{pmatrix}$

Generate The Matrix Into Echelon Form And Find Its Rank.

(%i3)
```
/*2. Generate the matrix into echelon form and find its rank.*/
Matrix:entermatrix(3,3);
Echelon:echelon(Matrix);
Rank:rank(Echelon);          /*RATNESH KUMAR*/
```

(%o0) done

Is the matrix 1. Diagonal 2. Symmetric 3. Antisymmetric 4. General Answer 1, 2, 3 or 4 :**4**; Row 1 Column 1:**8**; Row 1 Column 2:**7**; Row 1 Column 3:**6**; Row 2 Column 1:**6**; Row 2 Column 2:**5**; Row 2 Column 3:**1**; Row 3 Column 1:**68**; Row 3 Column 2:**7**; Row 3 Column 3:**9**;

Matrix entered.

Matrix $\begin{pmatrix} 8 & 7 & 6 \\ 6 & 5 & 1 \\ 68 & 7 & 9 \end{pmatrix}$

Echelon $\begin{pmatrix} 1 & \frac{7}{8} & \frac{3}{4} \\ 0 & 1 & 14 \\ 0 & 0 & 1 \end{pmatrix}$

Rank 3

Find Cofactors, Determinant, Adjoint And Inverse Of A Matrix.

(%i5)
```
/*3. Find cofactors, determinant, adjoint and inverse of a matrix.*/
Matrix:entermatrix(3,3);
Cofactors:transpose(adjoint(Matrix));
Determinant:determinant(Matrix);        /*RATNESH KUMAR*/
Adjoint:adjoint(Matrix);
Inverse:invert(Matrix);
```

Is the matrix 1. Diagonal 2. Symmetric 3. Antisymmetric 4. General Answer 1, 2, 3 or 4 :**4**; Row 1 Column 1:**9**; Row 1 Column 2:**7**; Row 1 Column 3:**6**; Row 2 Column 1:**8**; Row 2 Column 2:**1**; Row 2 Column 3:**2**; Row 3 Column 1:**5**; Row 3 Column 2:**9**; Row 3 Column 3:**7**;

Matrix entered.

Matrix $\begin{pmatrix} 9 & 7 & 6 \\ 8 & 1 & 2 \\ 5 & 9 & 7 \end{pmatrix}$

Cofactors $\begin{pmatrix} -11 & -46 & 67 \\ 5 & 33 & -46 \\ 8 & 30 & -47 \end{pmatrix}$

Determinant -19

Adjoint $\begin{pmatrix} -11 & 5 & 8 \\ -46 & 33 & 30 \\ 67 & -46 & -47 \end{pmatrix}$

Inverse $\begin{pmatrix} \frac{11}{19} & -\left(\frac{5}{19}\right) & -\left(\frac{8}{19}\right) \\ \frac{46}{19} & -\left(\frac{33}{19}\right) & -\left(\frac{30}{19}\right) \\ -\left(\frac{67}{19}\right) & \frac{46}{19} & \frac{47}{19} \end{pmatrix}$

Solve A System Of Homogeneous And Non-Homogeneous Equations Using Gauss Elimination Method.

(%i4)
```
/*4. Solve a system of Homogeneous and non-homogeneous equations using Gauss elimination method.
Non-homogeneous equation
-5x-2y+2z=14
3x+1y-1z=-8
2x+2y-1z=-3*/
eq:[−5·x−2·y+2·z=−14,3·x+1·y−1·z=8,2·x+2·y−1·z=3];
Matrix:augcoefmatrix(eq,[x,y,z]);                    /*RATNESH KUMAR*/
Echelon:echelon(Matrix);
Solution:linsolve([Echelon[1][1]·x+Echelon[1][2]·y+Echelon[1][3]·z=Echelon[1][4],Echelon[2][2]·y+
    Echelon[2][3]·z=Echelon[2][4], Echelon[3][3]·z=Echelon[3][4]], [x,y,z]);
```

eq $[2z-2y-5x=-14, -z+y+3x=8, -z+2y+2x=3]$

Matrix $\begin{pmatrix} -5 & -2 & 2 & 14 \\ 3 & 1 & -1 & -8 \\ 2 & 2 & -1 & -3 \end{pmatrix}$

Echelon $\begin{pmatrix} 1 & \frac{2}{5} & -\left(\frac{2}{5}\right) & -\left(\frac{14}{5}\right) \\ 0 & 1 & -1 & -2 \\ 0 & 0 & 1 & 5 \end{pmatrix}$

Solution $[x=-2, y=3, z=5]$

(%i4)
```
/*Homogeneous equation
x+y+7z=0
2x+3y+17z=0
x+2y+z=0*/
eq:[x+y+7·z=0,2·x+3·y+17·z=0,x+2·y+z=0];
Matrix:augcoefmatrix(eq,[x,y,z]);                    /*RATNESH KUMAR*/
Echelon:echelon(Matrix);
Solution:linsolve([Echelon[1][1]·x+Echelon[1][2]·y+Echelon[1][3]·z=0,Echelon[2][2]·y+Echelon[2][3]·z=0, Echelon[3][3]·z=0], [x,y,z]);
```

eq $[7z+y+x=0, 17z+3y+2x=0, z+2y+x=0]$

Matrix $\begin{pmatrix} 1 & 1 & 7 & 0 \\ 2 & 3 & 17 & 0 \\ 1 & 2 & 1 & 0 \end{pmatrix}$

Echelon $\begin{pmatrix} 1 & 1 & 7 & 0 \\ 0 & 1 & 3 & 0 \\ 0 & 0 & 1 & 0 \end{pmatrix}$

Solution $[x=0, y=0, z=0]$

Solve A System Of Homogeneous Equations Using The Gauss Jordan Method.

(%i6)
```
/*5. Solve a system of Homogeneous equations using the Gauss Jordan method.
2x+2y+2z=0
x+2y+z=0
3x+y-z=0*/
eq:[2·x+2·y+2·z=0,x+2·y+z=0,3·x+y−z=0];
Matrix:augcoefmatrix(eq,[x,y,z]);
Echelon:echelon(Matrix);                    /*RATNESH KUMAR*/
Oper:row(Echelon,1)−(row(Echelon,2)+row(Echelon,3));
Rref:addrow(Oper,row(Echelon,2),row(Echelon,3));
Solution:linsolve([Echelon[1][1]·x=0,Echelon[2][2]·y=0, Echelon[3][3]·z=0], [x,y,z]);
```

eq $[2z+2y+2x=0, z+2y+x=0, -z+y+3x=0]$

Matrix $\begin{pmatrix} 2 & 2 & 2 & 0 \\ 1 & 2 & 1 & 0 \\ 3 & 1 & -1 & 0 \end{pmatrix}$

Echelon $\begin{pmatrix} 1 & 1 & 1 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \end{pmatrix}$

Oper $\begin{pmatrix} 1 & 0 & 0 & 0 \end{pmatrix}$

Rref $\begin{pmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \end{pmatrix}$

Solution $[x=0, y=0, z=0]$

Generate Basis Of Column Space, Null Space, Row Space And Left Null Space Of A Matrix Space.

```
(%i5)  /*6. Generate basis of column space, null space, row space and left null space of a matrix space. */
       mat:matrix([1,1,4,1,2],[0,1,2,1,1],[0,0,0,1,2],[1,-1,0,0,2],[2,1,6,0,1]);
       ColumnSpace:columnspace(mat);
       NullSpace:nullspace(mat);                    /*RATNESH KUMAR*/
       RowSpace:columnspace(transpose(mat));
       leftNullSpace:nullspace(transpose(mat));
```

mat $\begin{pmatrix} 1 & 1 & 4 & 1 & 2 \\ 0 & 1 & 2 & 1 & 1 \\ 0 & 0 & 0 & 1 & 2 \\ 1 & -1 & 0 & 0 & 2 \\ 2 & 1 & 6 & 0 & 1 \end{pmatrix}$

ColumnSpace $\operatorname{span}\left(\begin{pmatrix} 1 \\ 0 \\ 0 \\ 1 \\ 2 \end{pmatrix}, \begin{pmatrix} 1 \\ 1 \\ 0 \\ -1 \\ 1 \end{pmatrix}, \begin{pmatrix} 1 \\ 1 \\ 1 \\ 0 \\ 0 \end{pmatrix}\right)$

NullSpace $\operatorname{span}\left(\begin{pmatrix} -2 \\ -2 \\ 1 \\ 0 \\ 0 \end{pmatrix}, \begin{pmatrix} 0 \\ -4 \\ 1 \\ 4 \\ -2 \end{pmatrix}\right)$

RowSpace $\operatorname{span}\left(\begin{pmatrix} 0 \\ 0 \\ 0 \\ 1 \\ 2 \end{pmatrix}, \begin{pmatrix} 0 \\ 1 \\ 2 \\ 1 \\ 1 \end{pmatrix}, \begin{pmatrix} 1 \\ 1 \\ 4 \\ 1 \\ 2 \end{pmatrix}\right)$

leftNullSpace $\operatorname{span}\left(\begin{pmatrix} 0 \\ -3 \\ 3 \\ -2 \\ 1 \end{pmatrix}, \begin{pmatrix} 1 \\ -2 \\ 1 \\ -1 \\ 0 \end{pmatrix}\right)$

Check The Linear Dependence Of Vectors. Generate A Linear Combination Of Given Vectors Of Rn/ Matrices Of The Same Size And Find The Transition Matrix Of Given Matrix Space.

(%i13)
```
/*7. Check the linear dependence of vectors. Generate a linear combination of given vectors of
Rn/ matrices of the same size and find the transition matrix of given matrix space. */
load("eigen")$;
vector1:covect([1,2,3]);
vector2:covect([4,5,6]);
vector3:covect([7,8,9]);
mat:addcol(vector1,vector2,vector3);        /*RATNESH KUMAR*/
Echelon:echelon(mat);
Rank:rank(mat);
if Rank=3 then("vector are linear independence")else("vector are linear dependence");
for i: 1 thru 3 do
      poly:print(mat[i][1]·"x"+mat[i][2]·"y"+mat[i][3]·"z"=0);
unit1:mat[1]·1/(mat[1][1]+mat[1][2]+mat[1][3]);
unit2:mat[2]·1/(mat[2][1]+mat[2][2]+mat[2][3]);
unit3:mat[3]·1/(mat[3][1]+mat[3][2]+mat[3][3]);
transition_matrix:addrow(matrix(unit1),matrix(unit2),matrix(unit3));
```

vector1 $\begin{pmatrix} 1 \\ 2 \\ 3 \end{pmatrix}$

vector2 $\begin{pmatrix} 4 \\ 5 \\ 6 \end{pmatrix}$

vector3 $\begin{pmatrix} 7 \\ 8 \\ 9 \end{pmatrix}$

mat $\begin{pmatrix} 1 & 4 & 7 \\ 2 & 5 & 8 \\ 3 & 6 & 9 \end{pmatrix}$

Echelon $\begin{pmatrix} 1 & 4 & 7 \\ 0 & 1 & 2 \\ 0 & 0 & 0 \end{pmatrix}$

Rank 2

(%o8) vector are linear dependence

$7z+4y+x=0$

$8z+5y+2x=0$

$9z+6y+3x=0$

(%o9) done

unit1 $\left[\frac{1}{12},\frac{1}{3},\frac{7}{12}\right]$

unit2 $\left[\frac{2}{15},\frac{1}{3},\frac{8}{15}\right]$

unit3 $\left[\frac{1}{6},\frac{1}{3},\frac{1}{2}\right]$

transition_matrix $\begin{pmatrix} \frac{1}{12} & \frac{1}{3} & \frac{7}{12} \\ \frac{2}{15} & \frac{1}{3} & \frac{8}{15} \\ \frac{1}{6} & \frac{1}{3} & \frac{1}{2} \end{pmatrix}$

Find The Orthonormal Basis Of Given Vectorspace Using The Gram-Schmidt Orthogonalization Process.

(%i10)
```
/*8. Find the orthonormal basis of a given vector space using the Gram-Schmidt orthogonalization process. */
load("eigen")$;
matrix: entermatrix (3,3);
Orthogonal_Basis: gramschmidt (matrix);
len1:(Orthogonal_Basis[1][1]^2+Orthogonal_Basis[1][2]^2+Orthogonal_Basis[1][3]^2)^0.5;
unitvect1:Orthogonal_Basis[1]/%;
len2:(Orthogonal_Basis[2][1]^2+Orthogonal_Basis[2][2]^2+Orthogonal_Basis[2][3]^2)^0.5;      /*RATNESH KUMAR*/
unitvect2:Orthogonal_Basis[2]/%;
len3:(Orthogonal_Basis[3][1]^2+Orthogonal_Basis[3][2]^2+Orthogonal_Basis[3][3]^2)^0.5;
unitvect3:Orthogonal_Basis[3]/%;
Orthonormal_Basis:addrow(matrix(unitvect1),matrix(unitvect2),matrix(unitvect3));
```

(%o0) done

Is the matrix 1. Diagonal 2. Symmetric 3. Antisymmetric 4. General Answer 1, 2, 3 or 4 :4; Row 1 Column 1:8; Row 1 Column 2:6; Row 1 Column 3:5; Row 2 Column 1:2; Row 2 Column 2:9; Row 2 Column 3:1; Row 3 Column 1:0; Row 3 Column 2:7; Row 3 Column 3:6;

Matrix entered.

matrix matrix([8,6,5],[2,9,1],[0,7,6])

Orthogonal_Basis $\left[[8,6,5],\left[-\left(\frac{2\ 7}{5}\right),\frac{3^3}{5},-2\right],\left[-\left(\frac{2\ 3\ 11\ 13\ 17}{5^3\ 41}\right),\frac{2^2\ 11\ 17}{5^3\ 41},\frac{2^3\ 3\ 11\ 17}{5^2\ 41}\right]\right]$

len1 11.180339887498949

unitvect1 [0.7155417527999327,0.5366563145999496,0.4472135954999579]

len2 6.4031242374328485

unitvect2 $\left[-0.437286533288097,0.03123475237772121\,6\ 3^3,-0.31234752377721214\right]$

len3 5.2242586123564445

unitvect3 $\left[-\left(\frac{68.09695383753389}{5^3}\right),\frac{0.8730378697119728\ 2^2}{5^3},\frac{2.6191136091359186\ 2^3}{5^2}\right]$

Orthonormal_Basis matrix([0.7155417527999327,0.5366563145999496,0.4472135954999579],

$\left[-0.437286533288097,0.03123475237772121\,6\ 3^3,-0.31234752377721214\right],\left[-\left(\frac{68.09695383753389}{5^3}\right),\frac{0.8730378697119728\ 2^2}{5^3},\frac{2.6191136091359186\ 2^3}{5^2}\right]$)

Check The Diagonalizable Property Of Matrices And Find The Corresponding Eigenvalue And Verify The Cayley- Hamilton Theorem.

```
(%i14) /*9. Check the diagonalizable property of matrices and find the corresponding eigenvalue and verify the Cayley- Hamilton theorem. */
load("eigen")$;
mat:entermatrix(4,4);
poly:expand(charpoly(mat,x));
Eigenvalues:eigenvalues(mat);            /*RATNESH KUMAR*/
Eigenvectors:eivects(mat)[2];
P:determinant(addrow(matrix(Eigenvectors[1][1]),matrix(Eigenvectors[2][1]),matrix(Eigenvectors[2][2]),matrix(Eigenvectors[3][1])));
if P = 0 then("given matrix is not diagonalizable")
else ("given matrix is diagonalizable");
```

Is the matrix 1. Diagonal 2. Symmetric 3. Antisymmetric 4. General Answer 1, 2, 3 or 4 :**4**; Row 1 Column 1:**−4**; Row 1 Column 2:**7**; Row 1 Column 3:**1**; Row 1 Column 4:**4**; Row 2 Column 1:**6**; Row 2 Column 2:**−16**; Row 2 Column 3:**−3**; Row 2 Column 4:**−9**; Row 3 Column 1:**12**; Row 3 Column 2: **−27**; Row 3 Column 3:**−4**; Row 3 Column 4:**−15**; Row 4 Column 1:**−18**; Row 4 Column 2:**43**; Row 4 Column 3:**7**; Row 4 Column 4:**24**;

Matrix entered.

$$\text{mat} \quad \begin{pmatrix} -4 & 7 & 1 & 4 \\ 6 & -16 & -3 & -9 \\ 12 & -27 & -4 & -15 \\ -18 & 43 & 7 & 24 \end{pmatrix}$$

$$\text{poly} \quad x^4 - 3x^2 - 2x$$

Eigenvalues [[2, −1, 0], [1, 2, 1]]

Eigenvectors $\left[[[1,-2,-4,6]],[[1,0,-1,1],[0,1,1,-2]],[[1,-3,-3,7]] \right]$

P −1

(%o14) given matrix is diagonalizable

```
(%i15) verify_cayley_hamilton:mat^^4-3·mat^^2-2·mat;
```

$$\text{verify\_cayley\_hamilton} \quad \begin{pmatrix} 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \end{pmatrix}$$

Application Of Linear Algebra: Coding And Decoding Of Messages Using Non singular Matrices.
Eg Code "Linear Algebra Is Fun" And Then Decode It.

```
(%i10) /*10. Application of Linear algebra: Coding and decoding of messages using nonsingular matrices. Eg Code "Linear Algebra Is Fun" And Then Decode It. */
x[i,j]:=i+j;
mat:genmatrix(x,5,4);
"{A:1,B:2,C:3,D:4,E:5,F:6,G:7,H:8,I:9,J:10,K:11,L:12,M:13,N:14,O:15,P:16,Q:17,R:18,S:19,T:20,U:21,V:22,W:23,X:24,Y:25,Z:26, :27}";
"Enter your message in matrix form (numbers should be equal to alphabetical positions)";
mat_input:matrix([12,9,14,5],[1,18,27,1],[12,7,5,2],[18,1,27,6],[21,14,27,27]);          /*RATNESH KUMAR*/
("This is the decode message of ' linear algebra is fun'");
decodeMatrix:mat·mat_input;
alpha:[A,B,C,D,E,F,G,H,I,J,K,L,M,N,O,P,Q,R,S,T,U,V,W,X,Y,Z," "];
cm:decodeMatrix/mat;
for i: 1 thru 5 do
    codeMessage:print(alpha[cm[i][1]],alpha[cm[i][2]],alpha[cm[i][3]],alpha[cm[i][4]]);
```

(%o1) $x_{i,j} := i + j$

mat $\begin{pmatrix} 2 & 3 & 4 & 5 \\ 3 & 4 & 5 & 6 \\ 4 & 5 & 6 & 7 \\ 5 & 6 & 7 & 8 \\ 6 & 7 & 8 & 9 \end{pmatrix}$

(%o3) {A:1,B:2,C:3,D:4,E:5,F:6,G:7,H:8,I:9,J:10,K:11,L:12,M:13,N:14,O:15,P:16,Q:17,R:18,S:19,T:20,U:21,V:22,W:23,X:24,Y:25,Z:26, :27}

(%o4) Enter your message in matrix form (numbers should be equal to alphabetical positions)

mat_input $\begin{pmatrix} 12 & 9 & 14 & 5 \\ 1 & 18 & 27 & 1 \\ 12 & 7 & 5 & 2 \\ 18 & 1 & 27 & 6 \\ 21 & 14 & 27 & 27 \end{pmatrix}$

(%o6) This is the decode message of ' linear algebra is fun'

decodeMatrix $\begin{pmatrix} 24 & 27 & 56 & 25 \\ 3 & 72 & 135 & 6 \\ 48 & 35 & 30 & 14 \\ 90 & 6 & 189 & 48 \\ 126 & 98 & 216 & 243 \end{pmatrix}$

alpha [A,B,C,D,E,F,G,H,I,J,K,L,M,N,O,P,Q,R,S,T,U,V,W,X,Y,Z,]

cm $\begin{pmatrix} 12 & 9 & 14 & 5 \\ 1 & 18 & 27 & 1 \\ 12 & 7 & 5 & 2 \\ 18 & 1 & 27 & 6 \\ 21 & 14 & 27 & 27 \end{pmatrix}$

L I N E
A R   A
L G E B
R A   F
U N

(%o10) done

Compute Gradient Of A Scalar Field.

(%i5)
```
/*11. Compute Gradient of a scalar field. */
load("vect")$;
F(x,y,z):=x·y·exp(z^2);
Grad:grad(F(x,y,z));
Express:express(Grad);                         /*RATNESH KUMAR*/
Solution:ev(Express,diff);
```

(%o2) $F(x,y,z):=x\ y\ \exp(z^2)$

Grad $\mathrm{grad}\left(x\ y\ \%e^{z^2}\right)$

Express $\left[\frac{d}{d\,x}\left(x\ y\ \%e^{z^2}\right),\frac{d}{d\,y}\left(x\ y\ \%e^{z^2}\right),\frac{d}{d\,z}\left(x\ y\ \%e^{z^2}\right)\right]$

Solution $\left[y\ \%e^{z^2},x\ \%e^{z^2},2\ x\ y\ z\ \%e^{z^2}\right]$

Compute Divergence Of A Vector Field.

(%i5)
```
/*12. Compute Divergence of a vector field. */
load("vect")$;
F(x,y,z):=[x,2·y,exp(z·y)];
Div:div(F(x,y,z));                    /*RATNESH KUMAR*/
Express_div:express(Div);
Solution_div:ev(Express_div,diff);
```

(%o2) $F(x,y,z):=[x,2\ y,\exp(z\ y)]$

Div $\mathrm{div}\left(\left[x,2\ y,\%e^{y\ z}\right]\right)$

Express_div $\frac{d}{d\,z}\ \%e^{y\ z}+\frac{d}{d\,y}\ (2\ y)+1$

Solution_div $y\ \%e^{y\ z}+3$

Compute Curl Of A Vector Field.

(%i5)
```
/*13. Compute Curl of a vector field.*/
load("vect")$;
F(x,y,z):=[x,2·y,exp(z·y)];
Curl:curl(F(x,y,z));                  /*RATNESH KUMAR*/
Express_curl:express(Curl);
Solution_curl:ev(Express_curl,diff);
```

(%o2) F(x,y,z):=[x,2 y,exp(z y)]

Curl $\mathrm{curl}\left(\left[x,2\,y,\%e^{y\,z}\right]\right)$

Express_curl $\left[\frac{d}{d\,y}\,\%e^{y\,z}-\frac{d}{d\,z}\,(2\,y),\frac{d}{d\,z}\,x-\frac{d}{d\,x}\,\%e^{y\,z},\frac{d}{d\,x}\,(2\,y)-\frac{d}{d\,y}\,x\right]$

Solution_curl $\left[z\,\%e^{y\,z},0,0\right]$