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Computing Tools for Mathematics

For BS & MSc Mathematics

Available at www.MathCity.org

Computing Tools in Mathematics

For BS & MSc Mathematics

Contents & Summary

These notes contain codes and techniques to work on famous software Mathematica.

- List as sets
- Newton Raphson Method by using “Do Command”
- Age Calculator
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- Coding for Newton Raphson Method
- Regula Falsi Method
- Jacobi’s Method
- Cholesky’s Factorization Method
- Gauss-Seidel Method
- Relaxation Method
- Short Questions

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list as sets

to put both brackets together we use ALT+]

```
A = {1, 2, 3, 4, a, b, c, d};

Length[A]

8

B = {2, 5, 9};

Union[A, B]

{1, 2, 3, 4, 5, 9, a, b, c, d}

Intersection[A, B]

{2}

N[e]

2.71828

Complement[A, B]

{1, 3, 4, a, b, c, d}

PSA = Subsets[A]

{{}, {1}, {2}, {3}, {4}, {a}, {b}, {c}, {d}, {1, 2}, {1, 3}, {1, 4}, {1, a}, {1, b},
 {1, c}, {1, d}, {2, 3}, {2, 4}, {2, a}, {2, b}, {2, c}, {2, d}, {3, 4}, {3, a},
 {3, b}, {3, c}, {3, d}, {4, a}, {4, b}, {4, c}, {4, d}, {a, b}, {a, c}, {a, d},
 {b, c}, {b, d}, {c, d}, {1, 2, 3}, {1, 2, 4}, {1, 2, a}, {1, 2, b}, {1, 2, c},
 {1, 2, d}, {1, 3, 4}, {1, 3, a}, {1, 3, b}, {1, 3, c}, {1, 3, d}, {1, 4, a}, {1, 4, b},
 {1, 4, c}, {1, 4, d}, {1, a, b}, {1, a, c}, {1, a, d}, {1, b, c}, {1, b, d}, {1, c, d},
 {2, 3, 4}, {2, 3, a}, {2, 3, b}, {2, 3, c}, {2, 3, d}, {2, 4, a}, {2, 4, b}, {2, 4, c},
 {2, 4, d}, {2, a, b}, {2, a, c}, {2, a, d}, {2, b, c}, {2, b, d}, {2, c, d},
 {3, 4, a}, {3, 4, b}, {3, 4, c}, {3, 4, d}, {3, a, b}, {3, a, c}, {3, a, d},
 {3, b, c}, {3, b, d}, {3, c, d}, {4, a, b}, {4, a, c}, {4, a, d}, {4, b, c},
 {4, b, d}, {4, c, d}, {a, b, c}, {a, b, d}, {a, c, d}, {b, c, d}, {1, 2, 3, 4},
 {1, 2, 3, a}, {1, 2, 3, b}, {1, 2, 3, c}, {1, 2, 3, d}, {1, 2, 4, a}, {1, 2, 4, b},
 {1, 2, 4, c}, {1, 2, 4, d}, {1, 2, a, b}, {1, 2, a, c}, {1, 2, a, d}, {1, 2, b, c},
 {1, 2, b, d}, {1, 2, c, d}, {1, 3, 4, a}, {1, 3, 4, b}, {1, 3, 4, c}, {1, 3, 4, d},
 {1, 3, a, b}, {1, 3, a, c}, {1, 3, a, d}, {1, 3, b, c}, {1, 3, b, d}, {1, 3, c, d},
 {1, 4, a, b}, {1, 4, a, c}, {1, 4, a, d}, {1, 4, b, c}, {1, 4, b, d}, {1, 4, c, d},
 {1, a, b, c}, {1, a, b, d}, {1, a, c, d}, {1, b, c, d}, {2, 3, 4, a}, {2, 3, 4, b},
 {2, 3, 4, c}, {2, 3, 4, d}, {2, 3, a, b}, {2, 3, a, c}, {2, 3, a, d}, {2, 3, b, c},
```

```
{2, 3, b, d}, {2, 3, c, d}, {2, 4, a, b}, {2, 4, a, c}, {2, 4, a, d}, {2, 4, b, c},
{2, 4, b, d}, {2, 4, c, d}, {2, a, b, c}, {2, a, b, d}, {2, a, c, d}, {2, b, c, d},
{3, 4, a, b}, {3, 4, a, c}, {3, 4, a, d}, {3, 4, b, c}, {3, 4, b, d}, {3, 4, c, d},
{3, a, b, c}, {3, a, b, d}, {3, a, c, d}, {3, b, c, d}, {4, a, b, c}, {4, a, b, d},
{4, a, c, d}, {4, b, c, d}, {a, b, c, d}, {1, 2, 3, 4, a}, {1, 2, 3, 4, b},
{1, 2, 3, 4, c}, {1, 2, 3, 4, d}, {1, 2, 3, a, b}, {1, 2, 3, a, c}, {1, 2, 3, a, d},
{1, 2, 3, b, c}, {1, 2, 3, b, d}, {1, 2, 3, c, d}, {1, 2, 4, a, b}, {1, 2, 4, a, c},
{1, 2, 4, a, d}, {1, 2, 4, b, c}, {1, 2, 4, b, d}, {1, 2, 4, c, d}, {1, 2, a, b, c},
{1, 2, a, b, d}, {1, 2, a, c, d}, {1, 2, b, c, d}, {1, 3, 4, a, b}, {1, 3, 4, a, c},
{1, 3, 4, a, d}, {1, 3, 4, b, c}, {1, 3, 4, b, d}, {1, 3, 4, c, d}, {1, 3, a, b, c},
{1, 3, a, b, d}, {1, 3, a, c, d}, {1, 3, b, c, d}, {1, 4, a, b, c}, {1, 4, a, b, d},
{1, 4, a, c, d}, {1, 4, b, c, d}, {1, a, b, c, d}, {2, 3, 4, a, b}, {2, 3, 4, a, c},
{2, 3, 4, a, d}, {2, 3, 4, b, c}, {2, 3, 4, b, d}, {2, 3, 4, c, d}, {2, 3, a, b, c},
{2, 3, a, b, d}, {2, 3, a, c, d}, {2, 3, b, c, d}, {2, 4, a, b, c}, {2, 4, a, b, d},
{2, 4, a, c, d}, {2, 4, b, c, d}, {2, a, b, c, d}, {3, 4, a, b, c}, {3, 4, a, b, d},
{3, 4, a, c, d}, {3, 4, b, c, d}, {3, a, b, c, d}, {4, a, b, c, d}, {1, 2, 3, 4, a, b},
{1, 2, 3, 4, a, c}, {1, 2, 3, 4, a, d}, {1, 2, 3, 4, b, c}, {1, 2, 3, 4, b, d},
{1, 2, 3, 4, c, d}, {1, 2, 3, a, b, c}, {1, 2, 3, a, b, d}, {1, 2, 3, a, c, d},
{1, 2, 3, b, c, d}, {1, 2, 4, a, b, c}, {1, 2, 4, a, b, d}, {1, 2, 4, a, c, d},
{1, 2, 4, b, c, d}, {1, 2, a, b, c, d}, {1, 3, 4, a, b, c}, {1, 3, 4, a, b, d},
{1, 3, 4, a, c, d}, {1, 3, 4, b, c, d}, {1, 3, a, b, c, d}, {1, 4, a, b, c, d},
{2, 3, 4, a, b, c}, {2, 3, 4, a, b, d}, {2, 3, 4, a, c, d}, {2, 3, 4, b, c, d},
{2, 3, a, b, c, d}, {2, 4, a, b, c, d}, {3, 4, a, b, c, d}, {1, 2, 3, 4, a, b, c},
{1, 2, 3, 4, a, b, d}, {1, 2, 3, 4, a, c, d}, {1, 2, 3, 4, b, c, d}, {1, 2, 3, a, b, c, d},
{1, 2, 4, a, b, c, d}, {1, 3, 4, a, b, c, d}, {2, 3, 4, a, b, c, d}, {1, 2, 3, 4, a, b, c, d}}
```

Length[PSA]

```
256
```

A − B

Thread::tdlen : Objects of unequal length in {1, 2, 3, 4, a, b, c, d} + {−2, −5, −9} cannot be combined. ≫

```
{-2, -5, -9} + {1, 2, 3, 4, a, b, c, d}
```

A = {1, 2, 3};
B = {3, 4, 5};
A + B

```
{4, 6, 8}
```

A B

```
{3, 8, 15}
```

A.B

```
26
```

```
(A) (B)
{3, 8, 15}

A = {1, 3, 7, a};

MatrixForm[A]
```

$$\begin{pmatrix} 1 \\ 3 \\ 7 \\ a \end{pmatrix}$$

```
A[[4]]
a

A[[2 ;; 4]]
{3, 7, a}

A[[2, 4]]
Part::partd : Part specification {1, 3, 7, a}⟦2, 4⟧ is longer than depth of object. >>
{1, 3, 7, a}⟦2, 4⟧

A = {{1, 2}, {3, 4}, {5, 6}};

MatrixForm[A]
```

$$\begin{pmatrix} 1 & 2 \\ 3 & 4 \\ 5 & 6 \end{pmatrix}$$

```
A[[2]]
{3, 4}

A[[2 ;; 3]]
{{3, 4}, {5, 6}}


A[[3, 2]]
6

A[[2 ;; 3, 2]]
{4, 6}

A[[1 ;; 3, 2]]

{2, 4, 6}

A[[All, 2]]
{2, 4, 6}
```

```
A[[3, All]]
{5, 6}
```

NEWTON RAPHSON METHOD

BY USING "DO COMMAND"

- With Stopping Criteria: $| f(x_n)-0| < \epsilon$

Question: f(x) = x - cosx with initial guess $x_0 = 0$

```
f[x_] := x - Cos[x]
```

```
x0 = 0.;
```

```
ϵ = 10^-6;
```

```
n = 0;
```

```
? If
```

If[*condition*, *t*, *f*] gives *t* if *condition* evaluates to True, and *f* if it evaluates to False.

If[*condition*, *t*, *f*, *u*] gives *u* if *condition* evaluates to neither True nor False. >>

```
If[Abs[f[xn] - 0] > ϵ, xn+1 = xn - f[xn] / (D[f[x], x] /. x → xn), Print[xn+1]]
```

1.

```
? Do
```

Do[*expr*, *n*] evaluates *expr* *n* times.

Do[*expr*, {*i*, i_{max}}] evaluates *expr* with the variable *i* successively taking on the values 1 through i_{max} (in steps of 1).

Do[*expr*, {*i*, i_{min}, i_{max}}] starts with $i = i_{min}$.

Do[*expr*, {*i*, i_{min}, i_{max}, *di*}] uses steps *di*.

Do[*expr*, {*i*, {i_1, i_2, …}}] uses the successive values i_1, i_2, ….

Do[*expr*, {*i*, i_{min}, i_{max}}, {*j*, j_{min}, j_{max}}, …] evaluates *expr* looping over different values of *j* etc. for each *i*. >>

```
Do[If[Abs[f[xn] - 0] > ϵ, xn+1 = xn - f[xn] / (D[f[x], x] /. x → xn), Print[xn+1]], {n, n++}]
```

```
n
```

3

```
x_n
```

0.739113

```
s = Table[x_i, {i, 0, n}]
```

{0., 1., 0.750364, 0.739113}

```
z = Table[n, {n, 1, 4}]
```

{1, 2, 3, 4}

```
TableForm[{{z, s, f[s]}}, TableHeadings → {None, {"n", "x_n", "|f(x_n)|"}}]
```

n	x_n	$\|f(x_n)\|$
1	0.	-1.
2	1.	0.459698
3	0.750364	0.0189231
4	0.739113	0.0000464559

Question: f(x) = $x^3 - 2x^2 - 5$,where x ∈ [0,4]

```
f[x_] := x^3 - 2 x^2 - 5
```

```
x_0 = 2.;
```

```
ϵ = 10^-6;
```

```
n = 1;
```

$$x_1 = x_0 - \frac{f[x_0]}{D[f[x], x] /. x \to x_0}$$

3.25

$$\text{If}\left[\text{Abs}[f[x_n] - f[x_{n-1}]] > \epsilon,\ x_{n+1} = x_n - \frac{f[x_n]}{D[f[x], x] /. x \to x_n},\ \text{Print}[x_{n+1}]\right]$$

2.81104

$$\text{Do}\left[\text{If}\left[\text{Abs}[f[x_n] - f[x_{n-1}]] > \epsilon,\ x_{n+1} = x_n - \frac{f[x_n]}{D[f[x], x] /. x \to x_n},\ \text{Print}[x_{n+1}]\right],\ \{n, n{+}{+}\}\right]$$

```
n
```

2

Age Calculator

In[1]:=
```
A = {15, 04, 2022};
```

In[2]:=
```
B = {17, 07, 2000};
```

In[3]:=
```
LeapYearQ[{A[[3]]}]
```

Out[3]= False

In[4]:=
```
Day = If[A[[1]] < B[[1]],
  If[A[[2]] == 2, A[[1]] + 28, A[[1]] + 30] - B[[1]], A[[1]] - B[[1]]]
```

Out[4]= 28

In[5]:=
```
Month = If[A[[2]] < B[[2]], ((A[[2]] - 1) + 10) - B[[2]], ((A[[2]] - 1) - B[[2]])]
```

Out[5]= 6

In[6]:=
```
Year = (A[[3]] - 1) - B[[3]]
```

Out[6]= 21

In[7]:=
```
{Day, Month, Year}
```

Out[7]= {28, 6, 21}

```
A = {1, 2, 3, 4};
MatrixForm[A]
```

$$\begin{pmatrix} 1 \\ 2 \\ 3 \\ 4 \end{pmatrix}$$

```
B = {{2, 3, 4}, {4, 5, 6}};
MatrixForm[B]
```

$$\begin{pmatrix} 2 & 3 & 4 \\ 4 & 5 & 6 \end{pmatrix}$$

```
%
{{2, 3, 4}, {4, 5, 6}}
```

to call previous input.

```
B[[1]]
{2, 3, 4}

B[[1 ;; 2, 2]]
{3, 5}

B[[2, 3]]
6

B1 = {{2, 3, 7}, {1, 1, 1}};

B + B1
{{4, 6, 11}, {5, 6, 7}}

MatrixForm[%]
```

$$\begin{pmatrix} 4 & 6 & 11 \\ 5 & 6 & 7 \end{pmatrix}$$

```
2 * B
{{4, 6, 8}, {8, 10, 12}}

B * B1
{{4, 9, 28}, {4, 5, 6}}

/ * +
```

the above mentioned symbols are used for point dividsion , multiplication and addition.and the dimensions of two lists must be same.

Matrix multiplication is nothing but the dot produt of the row of first matrix with the coloumn of second matrix.

```
B = {1, 3, 5};
```

```
B.B
35

5 + B
{6, 8, 10}
```

ALT+Shift+} = { }

Alt+] = [ ]

```
? Table
```

Table[*expr*, *n*] generates a list of *n* copies of *expr*.

Table[*expr*, {*i*, i_{max}}] generates a list of the values of *expr* when *i* runs from 1 to i_{max}.

Table[*expr*, {*i*, i_{min}, i_{max}}] starts with $i = i_{min}$.

Table[*expr*, {*i*, i_{min}, i_{max}, *di*}] uses steps *di*.

Table[*expr*, {*i*, {i_1, i_2, …}}] uses the successive values i_1, i_2, ….

Table[*expr*, {*i*, i_{min}, i_{max}}, {*j*, j_{min}, j_{max}}, …] gives a nested list. The list associated with *i* is outermost. >>

```
Table[y, 10]
{y, y, y, y, y, y, y, y, y, y}

Table[0, 5]
{0, 0, 0, 0, 0}

Table[, 6]
{Null, Null, Null, Null, Null, Null}
```

Table[x^2, {x, 1, 5}]

{1, 4, 9, 16, 25}

Table[x^3, {x, 6}]

{1, 8, 27, 64, 125, 216}

Table[x_i, {i, 1, 10}]

{x_1, x_2, x_3, x_4, x_5, x_6, x_7, x_8, x_9, x_{10}}

```
Table[i + 1, {i, 4}]
{2, 3, 4, 5}

Table[i + 1, {i, -5, 5}]
{-4, -3, -2, -1, 0, 1, 2, 3, 4, 5, 6}
```

Table[x_j, {j, -5, 0}]

{x_{-5}, x_{-4}, x_{-3}, x_{-2}, x_{-1}, x_0}

```
Table[x_i, {i, -1, 5, 2}]
```

$\{x_{-1}, x_1, x_3, x_5\}$

```
Table[x^2, {x, 10, 2}]
```

{}

$\left(\begin{pmatrix} \square & \square & \square \\ \square & \square & \square \\ \square & \square & \square \end{pmatrix}\right)$

A two dimensional matrix is infact the list of lists

$\begin{pmatrix} \square \\ \square \end{pmatrix}$

Ctrl+Enter gives row.

Alt+shift+) gives ( )

$(\square \quad \square \quad \square)$

Ctrl+, gives columns

```
x = 3;
```

x_2

3_2

```
Array[y, 5]
```

{y[1], y[2], y[3], y[4], y[5]}

Array command is used to put index to some variables.

```
? Array
```

Array[*f*, *n*] generates a list of length *n*, with elements *f*[*i*].

Array[*f*, *n*, *r*] generates a list using the index origin *r*.

Array[*f*, *n*, {*a*, *b*}] generates a list using *n* values from *a* to *b*.

Array[*f*, {n_1, n_2, …}] generates an $n_1 \times n_2 \times \ldots$ array of nested lists, with elements *f*[i_1, i_2, …].

Array[*f*, {n_1, n_2, …}, {r_1, r_2, …}] generates a list using the index origins r_i (default 1).

Array[*f*, {n_1, n_2, …}, {{a_1, b_1}, {a_2, b_2}, …}] generates a list using n_i values from a_i to b_i.

Array[*f*, *dims*, *origin*, *h*] uses head *h*, rather than List, for each level of the array. >>

```
Array[y, 5, 3]
```

{y[3], y[4], y[5], y[6], y[7]}

```
Array[x, 5, {1, 5}]
```

{3[1], 3[2], 3[3], 3[4], 3[5]}

```
Array[y, {2, 3}]
```

{{y[1, 1], y[1, 2], y[1, 3]}, {y[2, 1], y[2, 2], y[2, 3]}}

```
MatrixForm[%]
```

$$\begin{pmatrix} y[1,1] & y[1,2] & y[1,3] \\ y[2,1] & y[2,2] & y[2,3] \end{pmatrix}$$

```
DiagonalMatrix[{2, 0, 3, 5, 6}] // MatrixForm
```

$$\begin{pmatrix} 2 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 3 & 0 & 0 \\ 0 & 0 & 0 & 5 & 0 \\ 0 & 0 & 0 & 0 & 6 \end{pmatrix}$$

```
A = MatrixForm[%]
```

$$\begin{pmatrix} 2 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 3 & 0 & 0 \\ 0 & 0 & 0 & 5 & 0 \\ 0 & 0 & 0 & 0 & 6 \end{pmatrix}$$

```
A
```

$$\begin{pmatrix} 2 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 3 & 0 & 0 \\ 0 & 0 & 0 & 5 & 0 \\ 0 & 0 & 0 & 0 & 6 \end{pmatrix}$$

```
A[[1]]
```

```
{{2, 0, 0, 0, 0}, {0, 0, 0, 0, 0}, {0, 0, 3, 0, 0}, {0, 0, 0, 5, 0}, {0, 0, 0, 0, 6}}
```

```
A // Normal
```

$$\begin{pmatrix} 2 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 3 & 0 & 0 \\ 0 & 0 & 0 & 5 & 0 \\ 0 & 0 & 0 & 0 & 6 \end{pmatrix}$$

```
B = {{1, 2}, {3, 4}} // MatrixForm
```

$$\begin{pmatrix} 1 & 2 \\ 3 & 4 \end{pmatrix}$$

```
Diagonal[B]
```

Diagonal::list : List expected at position 1 in Diagonal$\left[\begin{pmatrix} 1 & 2 \\ 3 & 4 \end{pmatrix}\right]$. ≫

Diagonal$\left[\begin{pmatrix} 1 & 2 \\ 3 & 4 \end{pmatrix}\right]$

```
C1 = {{1, 2, 3}, {2, 3, 4}};
```

```
UpperTriangularize[C1]
```

```
{{1, 2, 3}, {0, 3, 4}} // MatrixForm
```

$$\begin{pmatrix} 1 & 2 & 3 \\ 0 & 3 & 4 \end{pmatrix}$$

```
LowerTriangularize[C1]
```

```
{{1, 0, 0}, {2, 3, 0}} // MatrixForm
```

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

```
A = Table[Table[0, {i, 1, 2}, {i, 2, 3}]]
```

```
{{0, 0}, {0, 0}}
```

```
Solve[a x^2 + b x + c == 0, x]
```

$$\left\{\left\{x \to \frac{-b - \sqrt{b^2 - 4 a c}}{2 a}\right\}, \left\{x \to \frac{-b + \sqrt{b^2 - 4 a c}}{2 a}\right\}\right\}$$

for assignment we use singal ''is equal to'' or ''=''

for equation we use double is equal to ''==''

```
Solve [3 x^2 + 5 x - 2 == 0, x]
```

$$\left\{\{x \to -2\}, \left\{x \to \frac{1}{3}\right\}\right\}$$

```
eq1 = 2 x^2 + 5 x - 6 == 0;
Solve[eq1, x]
```

$$\left\{\left\{x \to \frac{1}{4}\left(-5 - \sqrt{73}\right)\right\}, \left\{x \to \frac{1}{4}\left(-5 + \sqrt{73}\right)\right\}\right\}$$

```
Solve[x - Cos[x] == 0, x]
```

Solve::nsmet : This system cannot be solved with the methods available to Solve. >>

```
Solve[x - Cos[x] == 0, x]
```

we use ''Solve command '' only for equations that has known exact solution. We cannot use Solve command for numerical solution.

For numerical solution we use newton raphson method and use command ''FindRoot''.

```
FindRoot[x - Cos[x] == 0, {x, 0}]
{x → 0.739085}
```

in the above example we use the initial guess x_o=0

```
Solve[x^2 - x - 6 == 0, x]
{{x → -2}, {x → 3}}
Values[%]
{{-2}, {3}}
```

in the output no.11 to get the values from keys we use the command ''Values''

```
Solve[a x + b == 0, a]
```

$$\left\{\left\{a \to -\frac{b}{x}\right\}\right\}$$

```
Solve[x^10 - 100 == 0, x] // Values
```

$$\left\{\left\{-(-10)^{1/5}\right\}, \left\{(-10)^{1/5}\right\}, \left\{-10^{1/5}\right\}, \left\{10^{1/5}\right\}, \left\{-(-1)^{2/5}\,10^{1/5}\right\}, \left\{(-1)^{2/5}\,10^{1/5}\right\}, \left\{-(-1)^{3/5}\,10^{1/5}\right\}, \left\{(-1)^{3/5}\,10^{1/5}\right\}, \left\{-(-1)^{4/5}\,10^{1/5}\right\}, \left\{(-1)^{4/5}\,10^{1/5}\right\}\right\}$$

```
eq1 = x - Cos[x] == 0;
```

```
FindRoot[eq1, {x, 0}]
{x → 0.739085}

y == 0;

y = 3
3
```

here the input no.19 is an equation and input no. 20 is assignment.

the command ‘’FindRoot’’ is also used for matrix equations. In using ‘FindRoot’’ command we have give the correct initial guess.If we give some wrong initial guess may be the solution diverge.

```
eq1 = 2 x - y + z == 3;

eq2 = x + y == -1;

eq3 = 3 x - y - 2 z == 7;

Solve[{eq1, eq2, eq3}, {x, y, z}]
```

```
{{x → 1, y → -2, z → -1}}
```

```
D[Exp[2 x], x]
```

$2\, e^{2 x}$

```
eq4 = 3 x - y + 4 z == 2;

eq5 = 17 x + 2 + z == 14;

eq6 = x + 12 y - 77 z == 54;

Solve[{eq4, eq5, eq6}, {x, y, z}]
```

$\left\{\left\{x \to \frac{213}{265}, y \to -\frac{331}{53}, z \to -\frac{441}{265}\right\}\right\}$ `// N`

```
{{x → 0.8037735849056604`, y → -6.245283018867925`, z → -1.6641509433962265`}} //
 Values
```

```
{{0.803774, -6.24528, -1.66415}}
```

```
eq7 = c^2 + d^2 == 42;

eq8 = 2 √c == 4 d - 5;

Solve[{eq7, eq8}, {c, d}]
```

```
{{c → 1/4 (-1/2 -
    5 √(3/(-2 - 7763/(24 643 + 6 √13 012 167 261)^(1/3) + (24 643 + 6 √13 012 167 261)^(1/3))) -
    2 √(1/3 (-2 - 7763/(24 643 + 6 √13 012 167 261)^(1/3) + (24 643 + 6 √13 012 167 261)^(1/3))
       (-1/12 + 7763/(48 (24 643 + 6 √13 012 167 261)^(1/3)) -
        1/48 (24 643 + 6 √13 012 167 261)^(1/3) - 5/4 √(3/(-2 - 7763/
              (24 643 + 6 √13 012 167 261)^(1/3) + (24 643 + 6 √13 012 167 261)^(1/3)))))),
  d → 5/4 + 1/(8 √(3/(-2 - 7763/(24 643 + 6 √13 012 167 261)^(1/3) +
            (24 643 + 6 √13 012 167 261)^(1/3)))) -
    1/2 √(-1/12 + 7763/(48 (24 643 + 6 √13 012 167 261)^(1/3)) -
       1/48 (24 643 + 6 √13 012 167 261)^(1/3) - 5/4 √(3/(-2 -
```

$$7763 / (24643 + 6\sqrt{13012167261})^{1/3} + (24643 + 6\sqrt{13012167261})^{1/3}))) \},$$

$$\{c \to \frac{1}{4} (-\frac{1}{2} - 5\sqrt{(3/(-2 - 7763/(24643 + 6\sqrt{13012167261})^{1/3} +}$$

$$(24643 + 6\sqrt{13012167261})^{1/3})) +$$

$$2\sqrt{((\frac{1}{3}(-2 - 7763/(24643 + 6\sqrt{13012167261})^{1/3} + (24643 + 6\sqrt{13012167261})^{1/3})}$$

$$(-\frac{1}{12} + 7763/(48(24643 + 6\sqrt{13012167261})^{1/3}) -$$

$$\frac{1}{48}(24643 + 6\sqrt{13012167261})^{1/3} - \frac{5}{4}\sqrt{(3/(-2 - 7763/}$$

$$(24643 + 6\sqrt{13012167261})^{1/3} + (24643 + 6\sqrt{13012167261})^{1/3}))))),$$

$$d \to \frac{5}{4} + 1/(8\sqrt{(3/(-2 - 7763/(24643 + 6\sqrt{13012167261})^{1/3} +}$$

$$(24643 + 6\sqrt{13012167261})^{1/3}))) +$$

$$\frac{1}{2}\sqrt{(-\frac{1}{12} + 7763/(48(24643 + 6\sqrt{13012167261})^{1/3}) -}$$

$$\frac{1}{48}(24643 + 6\sqrt{13012167261})^{1/3} - \frac{5}{4}\sqrt{(3/(-2 -}$$

$$7763/(24643 + 6\sqrt{13012167261})^{1/3} + (24643 + 6\sqrt{13012167261})^{1/3}))) \},$$

$$\{c \to \frac{1}{4}(-\frac{1}{2} + 5\sqrt{(3/(-2 - 7763/(24643 + 6\sqrt{13012167261})^{1/3} +}$$

$$(24643 + 6\sqrt{13012167261})^{1/3})) - 2/$$

$$(\sqrt{(3/((-2 - 7763/(24643 + 6\sqrt{13012167261})^{1/3} + (24643 + 6\sqrt{13012167261})^{1/3})}$$

$$(-\frac{1}{12} + 7763/(48(24643 + 6\sqrt{13012167261})^{1/3}) - \frac{1}{48}$$

$$(24643 + 6\sqrt{13012167261})^{1/3} + \frac{5}{4}\sqrt{(3/(-2 - 7763/(24643 +}$$

$$6\sqrt{13012167261})^{1/3} + (24643 + 6\sqrt{13012167261})^{1/3}))))))),$$

$$d \to \frac{5}{4} - 1/(8\sqrt{(3/(-2 - 7763/(24643 + 6\sqrt{13012167261})^{1/3} +}$$

$$(24643 + 6\sqrt{13012167261})^{1/3}))) +$$

$$\frac{1}{2}\sqrt{(-\frac{1}{12} + 7763/(48(24643 + 6\sqrt{13012167261})^{1/3}) -}$$

$$\frac{1}{48}(24643 + 6\sqrt{13012167261})^{1/3} + \frac{5}{4}\sqrt{(3/(-2 -}$$

$$7763/(24643 + 6\sqrt{13012167261})^{1/3} + (24643 + 6\sqrt{13012167261})^{1/3}))) \}\}$$

N[%]

```
{{c → -6.48537 - 0.250291 ⅈ, d → 1.27457 - 1.27356 ⅈ},
 {c → -6.48537 + 0.250291 ⅈ, d → 1.27457 + 1.27356 ⅈ}, {c → 5.99005, d → 2.47373}}
```

Values[%]

```
{{-6.48537 - 0.250291 ⅈ, 1.27457 - 1.27356 ⅈ},
 {-6.48537 + 0.250291 ⅈ, 1.27457 + 1.27356 ⅈ}, {5.99005, 2.47373}}
```

eq1 = 16 x + 16 y + 17 z == 10;

eq2 = -14 x + 17 y - 3 z == 75;

eq3 = -5 x - 11 y - 18 z == 43;

Solve[{eq1, eq2, eq3}, {x, y, z}]

{{x → 2, y → 5, z → -6}} // Values

```
{{2, 5, -6}}
```

eq1 = x + y + z == 3;

eq2 = $x^2 + y^2 + z^2$ == 5;

eq3 = e^x + xy - xz == 1;

FindRoot[{eq1, eq2, eq3}, {{x, 0}, {y, 1}, {z, 1}}]

FindRoot::nlnum : The function value {eq1, eq2, eq3} is not a list of numbers with dimensions {3} at {x, y, z} = {0., 1., 1.}. >>

```
FindRoot[{eq1, eq2, eq3}, {{x, 0}, {y, 1}, {z, 1}}]
```

? FindRoot

FindRoot[f, {x, x_0}] searches for a numerical root of f, starting from the point $x = x_0$.

FindRoot[lhs == rhs, {x, x_0}] searches for a numerical solution to the equation lhs == rhs.

FindRoot[{f_1, f_2, …}, {{x, x_0}, {y, y_0}, …}] searches for a simultaneous numerical root of all the f_i.

FindRoot[{eqn_1, eqn_2, …}, {{x, x_0}, {y, y_0}, …}] searches for a numerical solution to the simultaneous equations eqn_i. >>

N[%]

```
{{x → Log[1. - 1. xy + xz], y → 0.5
    (3. - 1. Log[1. - 1. xy + xz] + √(1. + 6. Log[1. - 1. xy + xz] - 3. Log[1. - 1. xy + xz]^2)),
  z → 0.5 (3. - 1. Log[1. - 1. xy + xz] -
      1. √(1. + 6. Log[1. - 1. xy + xz] - 3. Log[1. - 1. xy + xz]^2))},
 {x → Log[1. - 1. xy + xz], y → 0.5 (3. - 1. Log[1. - 1. xy + xz] -
      1. √(1. + 6. Log[1. - 1. xy + xz] - 3. Log[1. - 1. xy + xz]^2)), z → 0.5
    (3. - 1. Log[1. - 1. xy + xz] + √(1. + 6. Log[1. - 1. xy + xz] - 3. Log[1. - 1. xy + xz]^2))}}
```

```
Values[%]
```

{{Log[1. - 1. xy + xz],
0.5 (3. - 1. Log[1. - 1. xy + xz] + √(1. + 6. Log[1. - 1. xy + xz] - 3. Log[1. - 1. xy + xz]^2)),
0.5 (3. - 1. Log[1. - 1. xy + xz] -
1. √(1. + 6. Log[1. - 1. xy + xz] - 3. Log[1. - 1. xy + xz]^2))},
{Log[1. - 1. xy + xz], 0.5 (3. - 1. Log[1. - 1. xy + xz] -
1. √(1. + 6. Log[1. - 1. xy + xz] - 3. Log[1. - 1. xy + xz]^2)), 0.5
(3. - 1. Log[1. - 1. xy + xz] + √(1. + 6. Log[1. - 1. xy + xz] - 3. Log[1. - 1. xy + xz]^2))}}

eq1 = $(x-2)^2 + (y-1)^2 == 1$;

Solve[eq1, {x, y}]

Solve::svars : Equations may not give solutions for all "solve" variables. ≫

$\{\{y \to 1 - \sqrt{-3 + 4x - x^2}\}, \{y \to 1 + \sqrt{-3 + 4x - x^2}\}\}$

eq1 = $3x^2 + 3y^2 == 27$;

eq2 = $3x^2 + 2y^2 == 23$;

Solve[{eq1, eq2}, {x, y}]

$\{\{x \to -\sqrt{5}, y \to -2\}, \{x \to -\sqrt{5}, y \to 2\}, \{x \to \sqrt{5}, y \to -2\}, \{x \to \sqrt{5}, y \to 2\}\}$ // Values

$\{\{-\sqrt{5}, -2\}, \{-\sqrt{5}, 2\}, \{\sqrt{5}, -2\}, \{\sqrt{5}, 2\}\}$

eq1 = $y^4 + 6x^4 == 6x^4 y^4$;

eq2 = $2y^4 + 12x^4 == 12x^4 y^4$;

Solve[{eq1, eq2}, {x, y}]

Solve::svars : Equations may not give solutions for all "solve" variables. ≫

$\left\{\left\{y \to -\frac{6^{1/4} x}{(-1 + 6x^4)^{1/4}}\right\}, \left\{y \to -\frac{i\, 6^{1/4} x}{(-1 + 6x^4)^{1/4}}\right\}, \left\{y \to \frac{i\, 6^{1/4} x}{(-1 + 6x^4)^{1/4}}\right\}, \left\{y \to \frac{6^{1/4} x}{(-1 + 6x^4)^{1/4}}\right\}\right\}$

```
f[x_] := x - Cos[x]

x0 = 0.;

ϵ = 10^-4;

n = 0;

While[Abs[f[xn] - 0] > ϵ,
 n++;
 xn = xn-1 - f[xn-1] / (D[f[x], x] /. x → xn-1)]

s = Table[xi, {i, 0, n}]
```

{0., 1., 0.750364, 0.739113}

```
z = Table[n, {n, 1, 5}]
```

{1, 2, 3, 4, 5}

```
TableForm[{{z, s, Abs[f[s]]}}]
```

1	0.	1.
2	1.	0.459698
3	0.750364	0.0189231
4	0.739113	0.0000464559
5		

```
TableForm[{{z, s, Abs[f[s]]}}, TableHeadings → {None, {"n", "xn", "|f(xn)|"}}]
```

n	x_n	$\|f(x_n)\|$
1	0.	1.
2	1.	0.459698
3	0.750364	0.0189231
4	0.739113	0.0000464559
5		

```
?If
```

If[*condition*, *t*, *f*] gives *t* if *condition* evaluates to True, and *f* if it evaluates to False.

If[*condition*, *t*, *f*, *u*] gives *u* if *condition* evaluates to neither True nor False. >>

if command is used for decision making.

```
n = 15;

If[n < 10, Print["A"], Print["B"]]
```

B

```
If[n < 20, n = n + 1, n = n/2]
```

18

```
TableForm[{{1, 2}, {3, 4}}]
```

1	2
3	4

```
TableForm[{{1, 2}, {3, 4}}, TableHeadings → {None, {"x", "y"}}]
```

x	y
1	2
3	4

```
TableForm[{{1, 2}, {3, 4}}, TableHeadings → {{"x", "y"}, None}]
```

x	1	2
y	3	4

```
TableForm[{{1, 2}, {3, 4}}, TableHeadings → {None, {"xi", "y"}}]
```

x_i	y
1	2
3	4

```
TableForm[{{1, 2}, {3, 4}}, TableHeadings → {{a, b}, {"x", "y"}}]
```

	x	y
a	1	2
b	3	4

```
f[x_] := x - Cos[x]
x0 = 0.;
```

$$\text{Do}\left[x_{i+1} = x_i - \frac{f[x_i]}{D[f[x], x] \; /. \; x \to x_i}, \{i, 0, 10\}\right]$$

```
Table[xi, {i, 0, 10}]
```

{0., 1., 0.750364, 0.739113, 0.739085, 0.739085,
 0.739085, 0.739085, 0.739085, 0.739085, 0.739085}

```
Print[5]
```

5

```
"Uziii Gujjar"
```

Uziii Gujjar

```
Print[Uziii Gujjar]
```

Gujjar Uziii

```
Print["uziii Gujjar"]
```

uziii Gujjar

```
Do[Print[i], {i, 0, 5}]
```

```
0
1
2
3
4
5
```

$$\text{Do}\left[x_{i+1} = x_i - \frac{f[x_i]}{D[f[x], x] \text{ /. } x \to x_i}; \text{Print}[x_{i+1}], \{i, 0, 10\}\right]$$

```
1.
0.750364
0.739113
0.739085
0.739085
0.739085
0.739085
0.739085
0.739085
0.739085
0.739085
```

to use more than two commands in single step we use Do command and separate each command by ;

$$\text{Table}\left[x_{i+1} = x_i - \frac{f[x_i]}{D[f[x], x] \text{ /. } x \to x_i}; \text{Print}[x_{i+1}], \{i, 0, 10\}\right]$$

```
1.
0.750364
0.739113
0.739085
0.739085
0.739085
0.739085
0.739085
0.739085
0.739085
0.739085
{Null, Null, Null, Null, Null, Null, Null, Null, Null, Null, Null}
```

```
TableForm[x_{i+1} = x_i - f[x_i] / (D[f[x], x] /. x → x_i); Print[x_{i+1}], {i, 0, 10}]
```

$x_i - \frac{-\mathrm{Cos}[x_i] + x_i}{1 + \mathrm{Sin}[x_i]}$

ReplaceAll::rmix : Elements of
{{i, 0, 10}, TableAlignments → Automatic, TableDepth → ∞, TableDirections → Column, TableHeadings → None, TableSpacing → Automatic} are a mixture of lists and nonlists. ≫

TableForm::tfal : Value of option TableAlignments –> TableAlignments /.
{{i, 0, 10}, TableAlignments → Automatic, TableDepth → ∞, TableDirections → Column, TableHeadings → None, TableSpacing → Automatic} should be a list of alignment specifications (Top,
Bottom, and Center for row dimensions, or Left, Right, and Center for column dimensions). ≫

ReplaceAll::rmix : Elements of
{{i, 0, 10}, TableAlignments → Automatic, TableDepth → ∞, TableDirections → Column, TableHeadings → None, TableSpacing → Automatic} are a mixture of lists and nonlists. ≫

TableForm::iopnf : Value of option TableDepth –> TableDepth /.
{{i, 0, 10}, TableAlignments → Automatic, TableDepth → ∞, TableDirections → Column, TableHeadings → None, TableSpacing → Automatic} should be a non–negative integer or Infinity. ≫

ReplaceAll::rmix : Elements of
{{i, 0, 10}, TableAlignments → Automatic, TableDepth → ∞, TableDirections → Column, TableHeadings → None, TableSpacing → Automatic} are a mixture of lists and nonlists. ≫

General::stop : Further output of ReplaceAll::rmix will be suppressed during this calculation. ≫

TableForm::tfh : TableHeadings option contained TableHeadings /.
{{i, 0, 10}, TableAlignments → Automatic, TableDepth → ∞, TableDirections → Column, TableHeadings → None, TableSpacing → Automatic}, which is not Automatic, None, or a list of labels. ≫

TableForm::tfdir : Value of option TableDirections –> TableDirections /.
{{i, 0, 10}, TableAlignments → Automatic, TableDepth → ∞, TableDirections → Column, TableHeadings → None, TableSpacing → Automatic} should be Row, Column, or a non–empty list of these values. ≫

```
Null
```

```
Do[Print[i], {i, 5}] *
 (if we donot give any initial point the command automatically start from 1) *
```

```
1
2
3
4
5
```

BISECTION METHOD

Q: f(x) = x-cosx , x ∈ [0,1]

- With Stopping Criteria: $| f(x_n)-0| < \epsilon$

```
f[x_] := x - Cos[x]

a0 = 0.; b0 = 1.;

ϵ = 10^-8;

c0 = (a0 + b0)/2;

n = 0;

While[Abs[f[cn]] > ϵ,
 If[f[an] f[cn] < 0,
  an+1 = an; bn+1 = cn,
  an+1 = cn; bn+1 = bn];
 n++;
 cn = (an + bn)/2
]

TV = Table[{i, ai, bi, ci, f[ai], f[bi], f[ci]}, {i, 0, n}];
```

```
TableForm[TV,
 TableHeadings → {None, {"n", "an", "bn", "cn", "f(an)", "f(bn)", "f(cn)"}}]
```

n	a_n	b_n	c_n	$f(a_n)$	$f(b_n)$	$f(c_n)$
0	0.	1.	0.5	-1.	0.459698	-0.377583
1	0.5	1.	0.75	-0.377583	0.459698	0.0183111
2	0.5	0.75	0.625	-0.377583	0.0183111	-0.185963
3	0.625	0.75	0.6875	-0.185963	0.0183111	-0.0853349
4	0.6875	0.75	0.71875	-0.0853349	0.0183111	-0.0338794
5	0.71875	0.75	0.734375	-0.0338794	0.0183111	-0.0078747
6	0.734375	0.75	0.742188	-0.00787473	0.0183111	0.00519571
7	0.734375	0.742188	0.738281	-0.00787473	0.00519571	-0.0013451
8	0.738281	0.742188	0.740234	-0.00134515	0.00519571	0.00192387
9	0.738281	0.740234	0.739258	-0.00134515	0.00192387	0.00028900
10	0.738281	0.739258	0.73877	-0.00134515	0.000289009	-0.0005281
11	0.73877	0.739258	0.739014	-0.000528158	0.000289009	-0.0001195
12	0.739014	0.739258	0.739136	-0.000119597	0.000289009	0.00008470
13	0.739014	0.739136	0.739075	-0.000119597	0.0000847007	-0.0000174
14	0.739075	0.739136	0.739105	-0.0000174493	0.0000847007	0.00003362
15	0.739075	0.739105	0.73909	-0.0000174493	0.0000336253	8.08791 × 1
16	0.739075	0.73909	0.739082	-0.0000174493	8.08791×10^{-6}	-4.68074 ×
17	0.739082	0.73909	0.739086	-4.68074×10^{-6}	8.08791×10^{-6}	1.70358 × 1
18	0.739082	0.739086	0.739084	-4.68074×10^{-6}	1.70358×10^{-6}	-1.48858 ×
19	0.739084	0.739086	0.739085	-1.48858×10^{-6}	1.70358×10^{-6}	1.07502 × 1
20	0.739084	0.739085	0.739085	-1.48858×10^{-6}	1.07502×10^{-7}	-6.90538 ×
21	0.739085	0.739085	0.739085	-6.90538×10^{-7}	1.07502×10^{-7}	-2.91518 ×
22	0.739085	0.739085	0.739085	-2.91518×10^{-7}	1.07502×10^{-7}	-9.2008 × 1
23	0.739085	0.739085	0.739085	-9.2008×10^{-8}	1.07502×10^{-7}	7.74702 × 1

With Stopping Criteria: $|f(x_n) - f(x_{n-1})| < \epsilon$

```
f[x_] := x - Cos[x]

a0 = 0.; b0 = 1.;

eps = 10^-8;

c0 = (a0 + b0)/2;

n = 1;

If[f[a0] f[c0] < 0, a1 = a0; b1 = c0, a1 = c0; b1 = b0];

c1 = (a1 + b1)/2;

While[Abs[f[cn] - f[c(n-1)]] > eps,
 If[f[an] f[cn] < 0,
  a(n+1) = an; b(n+1) = cn,
  a(n+1) = cn; b(n+1) = bn];
 n++;
 cn = (an + bn)/2
]
```

s = Table[{i, a_i, b_i, c_i, f[a_i], f[b_i], f[c_i]}, {i, 0, n}];

TableForm[s, TableHeadings → {None, {"n", "a_n", "b_n", "c_n", "f(a_n)", "f(b_n)", "f(c_n)"}}]

n	a_n	b_n	c_n	f(a_n)	f(b_n)	f(c_n)
0	0.	1.	0.5	-1.	0.459698	-0.377583
1	0.5	1.	0.75	-0.377583	0.459698	0.0183111
2	0.5	0.75	0.625	-0.377583	0.0183111	-0.185963
3	0.625	0.75	0.6875	-0.185963	0.0183111	-0.0853349
4	0.6875	0.75	0.71875	-0.0853349	0.0183111	-0.0338794
5	0.71875	0.75	0.734375	-0.0338794	0.0183111	-0.0078747
6	0.734375	0.75	0.742188	-0.00787473	0.0183111	0.00519571
7	0.734375	0.742188	0.738281	-0.00787473	0.00519571	-0.0013451
8	0.738281	0.742188	0.740234	-0.00134515	0.00519571	0.00192387
9	0.738281	0.740234	0.739258	-0.00134515	0.00192387	0.00028900
10	0.738281	0.739258	0.73877	-0.00134515	0.000289009	-0.0005281
11	0.73877	0.739258	0.739014	-0.000528158	0.000289009	-0.0001195
12	0.739014	0.739258	0.739136	-0.000119597	0.000289009	0.00008470
13	0.739014	0.739136	0.739075	-0.000119597	0.0000847007	-0.0000174
14	0.739075	0.739136	0.739105	-0.0000174493	0.0000847007	0.00003362
15	0.739075	0.739105	0.73909	-0.0000174493	0.0000336253	8.08791×1
16	0.739075	0.73909	0.739082	-0.0000174493	8.08791×10^{-6}	$-4.68074 \times$
17	0.739082	0.73909	0.739086	-4.68074×10^{-6}	8.08791×10^{-6}	1.70358×1
18	0.739082	0.739086	0.739084	-4.68074×10^{-6}	1.70358×10^{-6}	$-1.48858 \times$
19	0.739084	0.739086	0.739085	-1.48858×10^{-6}	1.70358×10^{-6}	1.07502×1
20	0.739084	0.739085	0.739085	-1.48858×10^{-6}	1.07502×10^{-7}	$-6.90538 \times$
21	0.739085	0.739085	0.739085	-6.90538×10^{-7}	1.07502×10^{-7}	$-2.91518 \times$
22	0.739085	0.739085	0.739085	-2.91518×10^{-7}	1.07502×10^{-7}	-9.2008×1
23	0.739085	0.739085	0.739085	-9.2008×10^{-8}	1.07502×10^{-7}	7.74702×1
24	0.739085	0.739085	0.739085	-9.2008×10^{-8}	7.74702×10^{-9}	$-4.21305 \times$
25	0.739085	0.739085	0.739085	-4.21305×10^{-8}	7.74702×10^{-9}	$-1.71917 \times$
26	0.739085	0.739085	0.739085	-1.71917×10^{-8}	7.74702×10^{-9}	$-4.72236 \times$
27	0.739085	0.739085	0.739085	-4.72236×10^{-9}	7.74702×10^{-9}	1.51233×1

SECANT METHOD

Q-1: $f(x) = x^3 - 9x + 1$, where $x \in [3,4]$

With Stopping Criteria: $|f(x_n) - 0| < \epsilon$

```
In[27]:= f[x_] := x^3 - 9 x + 1

In[28]:= a0 = 3.; b0 = 4.;

In[29]:= ϵ = 10^-8;

In[30]:= n = 0;

In[32]:= c0 = (a0 f[b0] - b0 f[a0]) / (f[b0] - f[a0]);

In[33]:= While[Abs[f[cn] - 0] > ϵ,
          an+1 = bn; bn+1 = cn;
          n++;
          cn = (an f[bn] - bn f[an]) / (f[bn] - f[an])]

In[35]:= s = Table[{i, ai, bi, ci, f[ai], f[bi], f[ci]}, {i, 0, n}];

In[36]:= TableForm[s,
          TableHeadings → {None, {"n", "an", "bn", "cn", "f(an)", "f(bn)", "f(cn)"}}]
```

Out[36]//TableForm=

n	a_n	b_n	c_n	$f(a_n)$	$f(b_n)$	$f(c_n)$
0	3.	4.	2.96429	1.	29.	0.368577
1	4.	2.96429	2.95095	29.	0.368577	0.138683
2	2.96429	2.95095	2.94291	0.368577	0.138683	0.00152296
3	2.95095	2.94291	2.94282	0.138683	0.00152296	6.41785×10^{-6}
4	2.94291	2.94282	2.94282	0.00152296	6.41785×10^{-6}	2.99242×10^{-10}

Q-2: $f(x) = \sin x - 5x + 2$, where $x \in [0.4, 0.5]$

With Stopping Criteria: $|f(x_n) - f(x_{n-1})| < \epsilon$

```
In[37]:= f[x_] := Sin[x] - 5 x + 2

In[38]:= ao = 0.4; b0 = 0.5;
```

In[39]:= $\epsilon = 10^{-8};$

In[40]:= $n = 1;$

In[42]:= $$c_0 = \frac{a_0\, f[b_0] - b_0\, f[a_0]}{f[b_0] - f[a_0]};$$

In[44]:= $a_1 = b_0;\ b_1 = c_0;$

In[46]:= $$c_1 = \frac{a_1\, f[b_1] - b_1\, f[a_1]}{f[b_1] - f[a_1]};$$

In[47]:= $\text{While}\Big[\text{Abs}[f[c_n] - f[c_{n-1}]] > \epsilon;$

$a_{n+1} = b_n;\ b_{n+1} = c_n;$

$n{+}{+};$

$$c_n = \frac{a_n\, f[b_n] - b_n\, f[a_n]}{f[b_n] - f[a_n]}\Big]$$

In[49]:= $s = \text{Table}[\{i, a_i, b_i, c_i, f[a_i], f[b_i], f[c_i]\}, \{i, 0, n\}];$

In[50]:= TableForm[s,
TableHeadings → {None, {"n", "a_n", "b_n", "c_n", "f(a_n)", "f(b_n)", "f(c_n)"}}]

Out[50]//TableForm=

n	a_n	b_n	c_n	$f(a_n)$	$f(b_n)$	$f(c_n)$
0	3.	0.5	0.495994	-12.8589	-0.0205745	-0.004062
1	0.5	0.495994	0.495008	-0.0205745	-0.004062	-1.17291×10^{-6}
2	0.495994	0.495008	0.495008	-0.004062	-1.17291×10^{-6}	-6.66991×10^{-1}

Q-3: f(x) = x^3-5 , where x $\in$ [0,3]

■ With Stopping Criteria: $\frac{|f(x_n) - f(x_{n-1})|}{|f(x_n)|} < \epsilon$

In[51]:= $f[x\_] := x^3 - 5$

In[52]:= $a_0 = 0.;\ b_0 = 3.;$

In[53]:= $\epsilon = 10^{-8};$

In[54]:= $n = 1;$

In[56]:= $$c_0 = \frac{a_0\, f[b_0] - b_0\, f[a_0]}{f[b_0] - f[a_0]};$$

In[58]:= $a_1 = b_0;\ b_1 = c_0;$

In[60]:= $$c_1 = \frac{a_1\, f[b_1] - b_1\, f[a_1]}{f[b_1] - f[a_1]};$$

In[61]:=
```
While[Abs[f[c_n] - f[c_(n-1)]] / Abs[f[c_n]] > ϵ,
  a_(n+1) = b_n; b_(n+1) = c_n;
  n++;
  c_n = (a_n f[b_n] - b_n f[a_n]) / (f[b_n] - f[a_n])]
```

$$\text{While}\left[\frac{\text{Abs}[f[c_n]-f[c_{n-1}]]}{\text{Abs}[f[c_n]]} > \epsilon,\ a_{n+1} = b_n;\ b_{n+1} = c_n;\ n{+}{+};\ c_n = \frac{a_n f[b_n] - b_n f[a_n]}{f[b_n] - f[a_n]}\right]$$

In[62]:=
```
s = Table[{i, a_i, b_i, c_i, f[a_i], f[b_i], f[c_i]}, {i, 0, n}];
```

In[63]:=
```
TableForm[s,
  TableHeadings → {None, {"n", "a_n", "b_n", "c_n", "f(a_n)", "f(b_n)", "f(c_n)"}}]
```

Out[63]//TableForm=

n	a_n	b_n	c_n	$f(a_n)$	$f(b_n)$	$f(c_n)$
0	0.	3.	0.555556	-5.	22.	-4.82853
1	3.	0.555556	0.995501	22.	-4.82853	-4.01344
2	0.555556	0.995501	3.16174	-4.82853	-4.01344	26.6067
3	0.995501	3.16174	1.27943	-4.01344	26.6067	-2.90563
4	3.16174	1.27943	1.46476	26.6067	-2.90563	-1.85735
5	1.27943	1.46476	1.79311	-2.90563	-1.85735	0.765304
6	1.46476	1.79311	1.6973	-1.85735	0.765304	-0.110406
7	1.79311	1.6973	1.70938	0.765304	-0.110406	-0.005259
8	1.6973	1.70938	1.70998	-0.110406	-0.00525978	0.0000392
9	1.70938	1.70998	1.70998	-0.00525978	0.0000392192	$-1.37603\times$
10	1.70998	1.70998	1.70998	0.0000392192	-1.37603×10^{-8}	$-3.4639\times$
11	1.70998	1.70998	1.70998	-1.37603×10^{-8}	-3.4639×10^{-14}	$8.88178\times$
12	1.70998	1.70998	1.70998	-3.4639×10^{-14}	8.88178×10^{-16}	$8.88178\times$

```
f[x_] := e^-x - x
x0 = 0.;
Do[x_{i+1} = x_i + f[x_i] / (D[f[x], x] /. x → x_i); Print[x_{i+1}], {i, 0, 5}]
```

$$f[x\_] := e^{-x} - x$$

$$x_0 = 0.;$$

$$\text{Do}\left[x_{i+1} = x_i + \frac{f[x_i]}{D[f[x], x] \;/.\; x \to x_i}; \text{Print}[x_{i+1}], \{i, 0, 5\}\right]$$

```
-0.5
-1.31123
-2.3773
-3.49426
-4.56778
-5.60444
```

Coding for Newton Raphson Method

first of all we give a function to read,

```
f[x_] := x - Cos[x]
```

here we use the colon : sign to delay the output

```
xo = 0;
```

```
f'[x]
```

```
1 + Sin[x]
```

```
f'''[x]
```

```
-Sin[x]
```

```
f[π]
```

```
1 + π
```

```
f[x] /. x → 7
```

```
7 - Cos[7]
```

to give value to some function we use /. x->7

```
D[f[x], x]
```

```
1 + Sin[x]
```

```
D[f[x], {x, 5}]
```

```
Sin[x]
```

$$x_1 = x_o - \frac{f[x_o]}{D[f[x], x] \ /. \ x \to x_o} \ (*\text{First approximatiom}*)$$

```
1
```

$$x_2 = x_1 - \frac{f[x_1]}{D[f[x], x] \ /. \ x \to x_1} \ (*\text{second approximation}*)$$

$$1 - \frac{1 - \text{Cos}[1]}{1 + \text{Sin}[1]} \ // \ N$$

```
0.750364
```

$$x_3 = x_2 - \frac{f[x_2]}{D[f[x], x] \ /. \ x \to x_2} \ (*\text{Third approximation}*)$$

$$1 - \frac{1 - \text{Cos}[1]}{1 + \text{Sin}[1]} - \frac{1 - \text{Cos}\left[1 - \frac{1-\text{Cos}[1]}{1+\text{Sin}[1]}\right] - \frac{1-\text{Cos}[1]}{1+\text{Sin}[1]}}{1 + \text{Sin}\left[1 - \frac{1-\text{Cos}[1]}{1+\text{Sin}[1]}\right]} \text{ // N}$$

0.739113

REGULA FALSI METHOD

Q-1: f(x)= x^2-2 where x ϵ [1,2]

With Stopping Criteria: | $f(x_n)$-0| < ϵ

```
In[1]:= f[x_] := x^2 - 2

In[2]:= a0 = 1.; b0 = 2.;

In[3]:= ϵ = 10^-4;

In[4]:= n = 0;

In[5]:= c0 = (a0 f[b0] - b0 f[a0]) / (f[b0] - f[a0]);

In[6]:= While[Abs[f[cn] - 0] > ϵ,
         If[f[an] f[cn] < 0,
          an+1 = an; bn+1 = cn, an+1 = cn; bn+1 = bn];
         n++;
         cn = (an f[bn] - bn f[an]) / (f[bn] - f[an])
        ]

In[9]:= s = Table[{i, ai, bi, ci, f[ai], f[bi], f[ci]}, {i, 0, n}];

In[8]:= TableForm[s,
         TableHeadings → {None, {"n", "an", "bn", "cn", "f(an)", "f(bn)", "f(cn)"}}]
```

Out[8]//TableForm=

n	a_n	b_n	c_n	$f(a_n)$	$f(b_n)$	$f(c_n)$
0	1.	2.	1.33333	-1.	2.	-0.222222
1	1.33333	2.	1.4	-0.222222	2.	-0.04
2	1.4	2.	1.41176	-0.04	2.	-0.00692042
3	1.41176	2.	1.41379	-0.00692042	2.	-0.00118906
4	1.41379	2.	1.41414	-0.00118906	2.	-0.000204061
5	1.41414	2.	1.4142	-0.000204061	2.	-0.0000350128

Q-2: $f(x) = x^6$-x-1 where x ∈ [1,1.2]

With Stopping Criteria: $|f(x_n) - f(x_{n-1})| < \epsilon$

In[8]:=
```
f[x_] := x^6 - x - 1
```

In[9]:=
```
a0 = 1.; b0 = 1.2;
```

In[10]:=
```
ϵ = 10^-8;
```

In[11]:=
```
n = 1;
```

In[13]:=
```
c0 = (a0 f[b0] - b0 f[a0]) / (f[b0] - f[a0]);
```

In[18]:=
```
If[f[a0] f[c0] < 0, a1 = a0; b1 = c0, a1 = c0; b1 = b0];
```

In[19]:=
```
c1 = (a1 f[b1] - b1 f[a1]) / (f[b1] - f[a1]);
```

In[20]:=
```
While[Abs[f[cn] - f[cn-1]] > ϵ,
 If[f[an] f[cn] < 0,
  an+1 = an; bn+1 = cn,
  an+1 = cn; bn+1 = bn];
 n++;
 cn = (an f[bn] - bn f[an]) / (f[bn] - f[an])]
```

In[22]:=
```
s = Table[{i, ai, bi, ci, f[ai], f[bi], f[ci]}, {i, 0, n}];
```

In[23]:=
```
TableForm[s,
 TableHeadings → {None, {"n", "an", "bn", "cn", "f(an)", "f(bn)", "f(cn)"}}]
```

Out[23]//TableForm=

n	a_n	b_n	c_n	$f(a_n)$	$f(b_n)$	$f(c_n)$
0	1.	1.2	1.11198	-1.	0.785984	-0.221429
1	1.11198	1.2	1.13133	-0.221429	0.785984	-0.0346406
2	1.13133	1.2	1.13423	-0.0346406	0.785984	-0.00509855
3	1.13423	1.2	1.13465	-0.00509855	0.785984	-0.000743584
4	1.13465	1.2	1.13471	-0.000743584	0.785984	-0.000108301
5	1.13471	1.2	1.13472	-0.000108301	0.785984	-0.0000157706
6	1.13472	1.2	1.13472	-0.0000157706	0.785984	-2.29643×10^{-6}
7	1.13472	1.2	1.13472	-2.29643×10^{-6}	0.785984	-3.34393×10^{-7}
8	1.13472	1.2	1.13472	-3.34393×10^{-7}	0.785984	-4.86923×10^{-8}
9	1.13472	1.2	1.13472	-4.86923×10^{-8}	0.785984	-7.09027×10^{-9}
10	1.13472	1.2	1.13472	-7.09027×10^{-9}	0.785984	-1.03244×10^{-9}

Q-3: f(x)= xSinx-1, where x ϵ [0,2]

▪ With Stopping Criteria: $\frac{|f(x_n)-f(x_{n-1})|}{|f(x_n)|} < \epsilon$

In[7]:=
```
f[x_] := x Sin[x] - 1
```

In[8]:=
```
a_0 = 0.; b_0 = 2.;
```

In[9]:=
```
ϵ = 10^-8;
```

In[10]:=
```
n = 1;
```

In[12]:=
```
c_0 = (a_0 f[b_0] - b_0 f[a_0]) / (f[b_0] - f[a_0]);
```

In[14]:=
```
If[f[a_0] f[c_0] < 0, a_1 = a_0; b_1 = c_0, a_1 = c_0; b_1 = b_0];
```

In[16]:=
```
c_1 = (a_1 f[b_1] - b_1 f[a_1]) / (f[b_1] - f[a_1]);
```

In[17]:=
```
While[Abs[f[c_n] - f[c_{n-1}]] / Abs[f[c_n]] > ϵ,
  If[f[a_n] f[c_n] < 0,
   a_{n+1} = a_n; b_{n+1} = c_n,
   a_{n+1} = c_n; b_{n+1} = b_n];
  n++;
  c_n = (a_n f[b_n] - b_n f[a_n]) / (f[b_n] - f[a_n])]
```

In[20]:=
```
s = Table[{i, a_i, b_i, c_i, f[a_i], f[b_i], f[c_i]}, {i, 0, n}];
```

In[21]:=
```
TableForm[s,
  TableHeadings → {None, {"n", "a_n", "b_n", "c_n", "f(a_n)", "f(b_n)", "f(c_n)"}}]
```

Out[21]//TableForm=

n	a_n	b_n	c_n	$f(a_n)$	$f(b_n)$	$f(c_n)$
0	0.	2.	1.09975	-1.	0.818595	-0.0200192
1	1.09975	2.	1.12124	-0.0200192	0.818595	0.00983461
2	1.09975	1.12124	1.11416	-0.0200192	0.00983461	5.63036×10^{-6}
3	1.09975	1.11416	1.11416	-0.0200192	5.63036×10^{-6}	3.00226×10^{-9}
4	1.09975	1.11416	1.11416	-0.0200192	3.00226×10^{-9}	1.60094×10^{-12}
5	1.09975	1.11416	1.11416	-0.0200192	1.60094×10^{-12}	8.88178×10^{-16}
6	1.09975	1.11416	1.11416	-0.0200192	8.88178×10^{-16}	$-2.22045\times10^{-}$
7	1.11416	1.11416	1.11416	-2.22045×10^{-16}	8.88178×10^{-16}	2.22045×10^{-16}
8	1.11416	1.11416	1.11416	-2.22045×10^{-16}	2.22045×10^{-16}	2.22045×10^{-16}

NEWTON RAPHSON METHOD

- For f(x)= x - cosx with initial guess x_0=0

With Stopping Criteria: $|f(x_n) - f(x_{n-1})| > \epsilon$

```
f[x_] := x - Cos[x]

x₀ = 0.;

ϵ = 10^-8;
n = 1;

x₁ = x₀ - f[x₀] / (D[f[x], x] /. x → x₀)

1.

While[Abs[f[xₙ] - f[xₙ₋₁]] > ϵ,
 n++;
 xₙ = xₙ₋₁ - f[xₙ₋₁] / (D[f[x], x] /. x → xₙ₋₁)
]

n

5

xₙ

0.739085

f[xₙ]

0.

s = Table[xᵢ, {i, 0, n}]
{0., 1., 0.750364, 0.739113, 0.739085, 0.739085}

f[s]
{-1., 0.459698, 0.0189231, 0.0000464559, 2.84721×10^-10, 0.}

Abs[f[s]]
{1., 0.459698, 0.0189231, 0.0000464559, 2.84721×10^-10, 0.}
```

```
TableForm[s]
```

```
0.
1.
0.750364
0.739113
0.739085
0.739085
```

```
z = Table[n, {n, 1, 6}]
```

```
{1, 2, 3, 4, 5, 6}
```

```
TableForm[{{z, s, Abs[f[s]]}}, TableHeadings -> {None, {"n", "xn", "|f(xn)|"}}]
```

n	x_n	$\lvert f(x_n)\rvert$
1	0.	1.
2	1.	0.459698
3	0.750364	0.0189231
4	0.739113	0.0000464559
5	0.739085	2.84721×10^{-10}
6	0.739085	0.

With Stopping Criteria: $\lvert f(x_n)-0\rvert > \epsilon$

```
f[x_] := x - Cos[x]
```

```
x0 = 0.;
```

```
ϵ = 10^-4;
```

```
n = 0;
```

```
While[Abs[f[xn] - 0] > ϵ,
 n++;
 xn = xn-1 - f[xn-1] / (D[f[x], x] /. x → xn-1)]
```

```
s = Table[xi, {i, 0, n}]
```

```
{0., 1., 0.750364, 0.739113}
```

```
z = Table[n, {n, 1, 5}]
```

```
{1, 2, 3, 4, 5}
```

```
TableForm[{{z, s, Abs[f[s]]}}]
```

1	0.	1.
2	1.	0.459698
3	0.750364	0.0189231
4	0.739113	0.0000464559
5		

```
TableForm[{{z, s, Abs[f[s]]}}, TableHeadings → {None, {"n", "xn", "|f(xn)|"}}]
```

n	x_n	$\lvert f(x_n)\rvert$
1	0.	1.
2	1.	0.459698
3	0.750364	0.0189231
4	0.739113	0.0000464559
5		

Jacobi's method

```
In[1]:= A = {{10, -1, 2, 0},
            {-1, 11, -1, 3},
            {2, -1, 10, -1},
            {0, 3, -1, 8}};

In[2]:= b = {6, 25, -11, 15};

In[3]:= D1 = DiagonalMatrix[Diagonal[A]];

In[4]:= L = LowerTriangularize[A, -1];

In[5]:= U = UpperTriangularize[A, 1];

In[6]:= X0 = {0, 0, 0, 0};

In[7]:= lhs = D1;

In[8]:= rhs = -(L + U).X0 + b;
        X1 = LinearSolve[N[lhs], N[rhs]];

In[10]:= n = 1;

In[11]:= ϵ = 10^-8;

In[12]:= While[Norm[Xn - Xn-1] / Norm[Xn] > ϵ,
          n++;
          lhs = D1;
          rhs = -(L + U).Xn-1 + b;
         Xn = LinearSolve[N[lhs], N[rhs]]]

In[13]:= s = Table[Xi, {i, 0, n}];
```

In[14]:=
```
TableForm[s, TableHeadings → {Automatic, {"x1", "x2", "x3", "x4"}}]
```

Out[14]//TableForm=

	x_1	x_2	x_3	x_4
1	0	0	0	0
2	0.6	2.27273	-1.1	1.875
3	1.04727	1.71591	-0.805227	0.885227
4	0.932636	2.05331	-1.04934	1.13088
5	1.0152	1.9537	-0.968109	0.973843
6	0.988991	2.01141	-1.01029	1.02135
7	1.0032	1.99224	-0.994522	0.994434
8	0.998128	2.00231	-1.00197	1.00359
9	1.00063	1.99867	-0.999036	0.998888
10	0.999674	2.00045	-1.00037	1.00062
11	1.00012	1.99977	-0.999828	0.999786
12	0.999942	2.00008	-1.00007	1.00011
13	1.00002	1.99996	-0.999969	0.99996
14	0.99999	2.00002	-1.00001	1.00002
15	1.	1.99999	-0.999994	0.999992
16	0.999998	2.	-1.	1.
17	1.	2.	-0.999999	0.999999
18	1.	2.	-1.	1.
19	1.	2.	-1.	1.
20	1.	2.	-1.	1.
21	1.	2.	-1.	1.
22	1.	2.	-1.	1.
23	1.	2.	-1.	1.
24	1.	2.	-1.	1.

In[15]:=
```
Print["Required solution is", Xn]
```

Required solution is{1., 2., -1., 1.}

Today

Mon 11 Apr 2022

CHOLESKY'S FACTORIZATION METHOD

For cholesky's factorization method the matrix A must be positive definite.

Positive Definite:

For positive definite the determinent of the submatrices on leading diagonals are positive.(pg:414 from Burten's Book)

A matirx A is positive definite if A is symmetric and if $x^t Ax > 0$ for every n-dimensional vector x (x is non zero).

Also x must be conformable for multiplication with A.

In choleskeys factorization method the diagonal elements of both lower and upper triangular matrix are same.In other words upper triangular matrix is the transpose of lower triangular matrix.

Suppose we have system of equation

$AX = B \to 1$

$LUX = B \to 2$

Let $UX = Y \to 3$

This implies $LY = B \to 4$

This implies $Y = L^{-1}B$

Put is eq. 3 and we get X by using cramers rule, inverse method or any other method

Today

Wed 13 Apr 2022

Q:

```
A = {{10, -1, 2, 0},
    {-1, 11, -1, 3},
    {2, -1, 10, -1},
    {0, 3, -1, 8}};
```

```
B = {6, 25, -11, 15};
```

First of all we check wether A is symmetric and positive definite matrix.

```
SymmetricMatrixQ[A]
```

```
True
```

```
PositiveSemidefiniteMatrixQ[A]
```

```
True
```

```
U = CholeskyDecomposition[A];(*this command gives only one matrix
 lower or upper the other one is the tranpose of the first one*)
```

```
MatrixForm[U]
```

$$\begin{pmatrix} \sqrt{10} & -\frac{1}{\sqrt{10}} & \sqrt{\frac{2}{5}} & 0 \\ 0 & \sqrt{\frac{109}{10}} & -4\sqrt{\frac{2}{545}} & 3\sqrt{\frac{10}{109}} \\ 0 & 0 & 4\sqrt{\frac{65}{109}} & -\frac{17\sqrt{\frac{5}{1417}}}{4} \\ 0 & 0 & 0 & \frac{\sqrt{\frac{1479}{13}}}{4} \end{pmatrix}$$

```
L = Transpose[U];
```

```
A == L.U
```

```
True
```

```
y = LinearSolve[N[L], N[B]];
```

```
X = LinearSolve[N [U], N[y]]
```

```
{1., 2., -1., 1.}
```

Task:

Make code for doolittle, crouts , and relaxation method

```
LUDecomposition[A]
```

$$\left\{\left\{\{-1, 11, -1, 3\}, \{0, 3, -1, 8\}, \{-2, 7, 15, -51\}, \left\{-10, \frac{109}{3}, \frac{17}{9}, -\frac{493}{3}\right\}\right\}, \{2, 4, 3, 1\}, 0\right\}$$

```
MatrixForm[%]
```

$$\begin{pmatrix} \left\{\{-1, 11, -1, 3\}, \{0, 3, -1, 8\}, \{-2, 7, 15, -51\}, \left\{-10, \frac{109}{3}, \frac{17}{9}, -\frac{493}{3}\right\}\right\} \\ \{2, 4, 3, 1\} \\ 0 \end{pmatrix}$$

```
{a, b, c} = LUDecomposition[A];
```

```
MatrixForm[a]
```

$$\begin{pmatrix} -1 & 11 & -1 & 3 \\ 0 & 3 & -1 & 8 \\ -2 & 7 & 15 & -51 \\ -10 & \frac{109}{3} & \frac{17}{9} & -\frac{493}{3} \end{pmatrix}$$

```
MatrixForm[b]
```

$$\begin{pmatrix} 2 \\ 4 \\ 3 \\ 1 \end{pmatrix}$$

```
MatrixForm[c]
```

0

Approximation: If we find a polynomial and then draw its curve , that curve may not pass through the points of the given data.

Interpolation: If we find a polynomial and then draw its curve, that curve must pass through the points of the given data.

Gauss-Seidel Method

```
A = {{10, -1, 2, 0},
    {-1, 11, -1, 3},
    {2, -1, 10, -1},
    {0, 3, -1, 8}};

B = {6, 25, -11, 8};

D1 = DiagonalMatrix[Diagonal[A]];

MatrixForm[D1];

L = LowerTriangularize[A, -1];

MatrixForm[L];

U = UpperTriangularize[A, 1];

MatrixForm[U];

X0 = {0, 0, 0, 0};

ϵ = 10^-4;

lhs = (L + D1);

rsh = -U.X0 + B;

X1 = LinearSolve[N[lhs], N[rhs]];

n = 1;

While[Norm[Xn - Xn-1] / Norm[Xn] > ϵ,
 n++;
 lhs = (L + D1);
 rhs = -U.Xn-1 + B;
 Xn = LinearSolve[N[lhs], N[rhs]]
]

TV = Table[Xi, {i, 0, n}];

TableForm[TV, TableHeadings → {Automatic, {"X1", "X2", "X3", "X4"}}]
```

	X_1	X_2	X_3	X_4
1	0	0	0	0
2	1.00002	2.09087	-0.990887	0.0920226
3	1.00726	2.24912	-1.06734	0.023163
4	1.03838	2.26378	-1.07898	0.0162107
5	1.04217	2.26496	-1.08032	0.0156003
6	1.04256	2.26504	-1.08045	0.015554
7	1.04259	2.26504	-1.08046	0.0155511

RELAXATION METHOD

For Relaxation Method:

$$(D - \omega L)\, X_{n+1} = ((1-\omega)D + \omega U)\, X_n + \omega B$$

- Successive Under Relaxation (SUR) Method:

For SUR Method $0 < \omega < 1$

```
In[1]:= e1 = 3 x + y + z == 3;

In[2]:= e2 = 2 x - 8 y + z == -5;

In[3]:= e3 = x - 2 y + 9 z == 8;

In[4]:= A = {{3, 1, 1},
            {2, -8, 1},
            {1, -2, 9}};

In[5]:= B = {3, -5, 8};

In[6]:= X0 = {0, 0, 0};

In[7]:= ω = 0.45;

In[8]:= D1 = DiagonalMatrix[Diagonal[A]];

In[9]:= L = LowerTriangularize[A, -1];

In[10]:= U = UpperTriangularize[A, 1];

In[11]:= L + D1 + U == A

Out[11]= True

In[12]:= lhs = (D1 - ω L);

In[13]:= rhs = ((1 - ω) D1 + ω U).X0 + ω B;

In[14]:= X1 = LinearSolve[N[lhs], N[rhs]];

In[15]:= ϵ = 10^-6;

In[16]:= n = 0;
```

```
In[17]:= While[Norm[X_{n+1} - X_n] / Norm[X_{n+1}] > ϵ,
  n++;
  lhs = (D1 - ω L);
  rhs = ((1 - ω) D1 + ω U).X_n + ω B;
  X_{n+1} = LinearSolve[N[lhs], N[rhs]]]

In[18]:= s = Table[X_i, {i, 0, n}];

In[19]:= TableForm[s, TableHeadings → {Automatic, {"n", "x", "y", "z"}}]
```

Out[19]//TableForm=

	n	x	y
1	0	0	0
2	0.45	0.230625	0.399438
3	0.792009	0.296524	0.629639
4	1.02453	0.293662	0.768162
5	1.17276	0.267619	0.854365
6	1.26332	0.238259	0.909241
7	1.31695	0.212991	0.944631
8	1.34797	0.193613	0.967584
9	1.36556	0.179685	0.982481
10	1.37538	0.170082	0.992125
11	1.38079	0.163649	0.998344
12	1.38373	0.15943	1.00233
13	1.38532	0.156707	1.00488
14	1.38616	0.154971	1.00649
15	1.38661	0.153875	1.00751
16	1.38684	0.153189	1.00816
17	1.38697	0.152761	1.00856
18	1.38703	0.152497	1.00881
19	1.38706	0.152333	1.00896
20	1.38708	0.152233	1.00906
21	1.38709	0.152171	1.00912
22	1.38709	0.152133	1.00916
23	1.38709	0.15211	1.00918
24	1.3871	0.152096	1.00919
25	1.3871	0.152087	1.0092
26	1.3871	0.152082	1.00921
27	1.3871	0.152079	1.00921
28	1.3871	0.152077	1.00921

```
In[20]:= Print["Required solution is" , X_n]

Required solution is{1.3871, 0.152077, 1.00921}
```

Successive Over Relaxation Method

For SOR Method 1 < ω < 2

```
In[1]:= e1 = 4 x_1 + 3 x_2 == 24;

In[2]:= e2 = 3 x_1 + 4 x_2 - x_3 == 30;

In[3]:= e3 = -x_2 + 4 x_3 == -24;
```

```
In[4]:= A = {{4, 3, 0},
            {3, 4, -1},
            {0, -1, 4}};

In[5]:= B = {24, 30, -24};

In[6]:= D1 = DiagonalMatrix[Diagonal[A]];

In[7]:= L = LowerTriangularize[A, -1];

In[8]:= U = UpperTriangularize[A, 1];

In[9]:= L + D1 + U == A

Out[9]= True

In[11]:= X0 = {1, 1, 1};

In[12]:= ω = 1.25;

In[13]:= lhs = (D1 - ω L);

In[14]:= rhs = ((1 - ω) D1 + ω U) .X0 + ω B;

In[15]:= X1 = LinearSolve[N[lhs], N[rhs]]

Out[15]= {8.1875, 16.4883, -12.9026}

In[16]:= ϵ = 10^-8;

In[17]:= n = 0;

In[18]:= While[Norm[Xn+1 - Xn] / Norm[Xn+1] > ϵ,
          n++;
          lhs = (D1 - ω L);
          rhs = ((1 - ω) D1 + ω U) .Xn + ω B;
          Xn+1 = LinearSolve[N[lhs], N[rhs]]]

In[21]:= s = Table[Xi, {i, 0, n}];
```

In[20]:=
```
TableForm[s, TableHeadings → {Automatic, {"n", "x1", "x2", "x3"}}]
```

Out[20]//TableForm=

	n	x_1	x_2
1	1	1	1
2	8.1875	16.4883	-12.9026
3	20.9109	28.8889	-13.3021
4	29.3557	33.8306	-14.7465
5	31.8773	35.4106	-14.8792
6	32.7281	35.8547	-14.9848
7	32.9318	35.9676	-14.9937
8	32.9867	35.9936	-14.9996
9	32.9974	35.999	-14.9998
10	32.9997	35.9999	-15.
11	33.	36.	-15.
12	33.	36.	-15.
13	33.	36.	-15.
14	33.	36.	-15.
15	33.	36.	-15.
16	33.	36.	-15.

f_x Shift, enter

1) Which command can solve the Linear matric system for ax=b for x

(LinearSolve [A,b])

What is the output of the command if [5<6, Print ["well done"]. Print "try again"]]

(Well done)

Which expression return's the numerical value of P_i with 20 digit precision

(N[Pi_20)

Which expression has no syntax error

(Solve [x^2 - x - 6 = 0, (x)]])

Which expression has no syntax error

(Solve [x^2 - x - 6 = 0, (x)]])

Which is the Product of x & y

(None)

If $x=5$ then 25 will be written as

(5x)

In Mathematica % symbol is used for

(Last output)

5+4; then output will be

(None)

List = {a,b,c} then List [[1]] will show

(a)

N[Sin[8.4]]

(0.11)

Command of factorial is

(Factorial [4])

1,4,9,16 its command will be

Table[i^2 , {i,4}]

Function is defined as

(f[x_] := 1/(1+x^2))

Plotting of a curve command

(Plot[f{x}, {x,-3,3}])

Answer of GCD [24,15] will be.

(3)

Answer of LCM [24,15] will be

(120)

Product of GCD and LCD always equal.

(to product of the numbers)

Sqrt [49]

($\sqrt{7}$)

N[Pi, 46]

(3.1456)

Simpson's rule assumes that boundary between the ordinate are (True)

Which of the following shaps is generally preferred in case of applications of Simpson's rule?

(Traperaid)

All the built in function start with the letters

upper case

which test read as a comment

(* don't worry *)

which expression has no syntax error

(cos[x])

which expression has return the very last generated

(%)

which command is print the matrix form of list A

(MatrixForm[A])

The command table [2.4] gives

(Error)

Which Keyboard key's combination is used to insert function

(Cntrl.)

The expression sign [-3.5] gives

((-1))

The command Head [3.5] gives

(Real)

which Keyboard Key's combination is used to insert subscript

(Cntrl)

which expression is a list

([1,2,3,4])

If we put the semicolon at the end of the input line, the output is

(Suppressed)

which expression has return the imaginary part of the complex number Z.

(Im (z))

The command Appends [{a}. (1,2,3) give

([a, 1. 2,3])

which expression gives the 3rd order derivative f [x,y] w.r.t y

(D[f[x,y], {x,3}])

The command flatten [(1,2.3), {4, {5}}] returns

([1.2.3.4, {5}])

If A- {1,2,3,{4,5},6,7} then A [[1.4]] returns

(4)

which command return's the transpose of matrix 'A'

(Transpose [A])

which expression returns the real part of a complex number z.

(Re [z])

The command Take [{1.2.3.4.3.6}.3]
gives

([1, 2. 3])

To execute an input, which keyboard keys combination is used for

(Shift, enter)

which command returns, the additive inverse of a non-singular square matrix A

(Inverse [A])

For a loop is of the form

(For [start, condition, increment, body])

which command gives the number of elements present in one dimentional list 'A'.

(length [A])

which keyboard key's combination is used to insert a squar root

(Cntrl, 2)

The input Log2[x] returns

(logari of x to base 2)

If f[x] = x+5 which comand evaluates f at x=a

(F[a])

which command construct a list {v[1], V[2], V[3]}

(Arrav fv[[i], (I 1 3)]]

which command can solve the linear matrix system for ax=b for x

(LinearSolve[A,b])

what's the output of the command if [5<6, print["well done"], print["try again"]]

(well done)

MATHEMATICA

EHSAN ULLAH.

1- A = {{1,2,3},{4,5,6},{7,8,9}} then Diagonal[A,-1]
⇒ {4,8}

2- The Input a = 3 is
⇒ An assignment

3- If A = {1,3,5,7} then Drop[A,2]
⇒ {5,7}

4- The arguments of functions in Mathematica are given in
⇒ Box brackets

5- Which command automatically displays the output
⇒ Table

6- In Mathematica, the input command divide[a,b]
→ Contain Syntax Error

7- The input D[f,x] givens
→ Gradient

8- The input Sign[-3.5] returns
→ -1

9- In Mathematica, the expression x+y<6 && x-y<2 means
→ x+y and x-y < 2

10- Which expression retuns the real part of a Complex
→ Re[z]

11- Which built-in function is used to solve diff. equations
→ DSolve

12- If A = {1,3,5,7} then which Mathematica input gives Mean
→ Mean[A]

13- Which command gives the list of main Diagonal
→ Diagonal[A]

14- If a = {1,2} & b = {3,4} then command for addition of a&b
→ Plus[a,b]

15. The input command Dt[f,x] gives the
→ Total derivative of f w.r.t x

16. The input D[f,{x,2}] gives
→ Second derivative of f w.r.t x

17. In Mathematica, the input command Abs[4+3i] gives output
→ 5

18. The input command for union of two sets A and B is
→ Union[A,B]

19. The input command Max[1,2,3,5] returns
→ 5

20. Which Expression returns the vary last generated output
→ %

21. The command Append[{a},{1,2,3}]
→ {a, {1,2,3}}

22. The input command command to construct unit vector
→ UnitVector[3,2]

23. The command Prepend[{1,2,3},a}] returns
→ {a,1,2,3}

24. The Mathematic input Graphics3D[Cylinder[]]
→ Cylinder

25. In Matheamatica, the input command Re[2+3i] gives
→ 2

26. If A = {1, x, 3,5,7}, then the input command A/.x→4
→ {1,4,3,5,7}

27. Which input expression returns the imaginary part
→ Im[Z]

28. Which text is read as a comment in Mathematica
→ (*Don't Worry*)

29. The input command for intersection of A & B
→ Intersection[A,B]

30. The input Table[0,2,2] returns
→ {{0,0},{0,0}}

31. If A= {{1,2,3},{4,5,6},{7,8,9}} then A[[2]][2;;3]]
→ {5,6}

32. If f[x_]:=x+5 then which command gives at x=a.
→ f[a]

33. In Mathematica, command to evaluate logrithm of a base 10
→ Log10[a]

34. The input command for Diagonal matrix having 1,2,3,4
→ DiagonalMatrix[{1,2,3,4}]

35. In Mathematica, the input command Divide[a,b]
→ Divides a by b

36. Which Mathematica Command will give partial fractions
→ Apart[P]

37. Which input Command is converts a matrix A into echelon
→ RowReduce[A]

38. To execute an input line in Mathematica, Which Key
→ Shift, Enter

39. Which command returns absolute value of x
→ Abs[x]

40. Which input command give the Rank of a square matrix
→ MatrixRank[A]

41. The input command Minimize[f,x]
→ Minimize f w.r.t x

42. The input Log2[x] returns
→ Logarithm of x to base 2

43. Which keyboard keys combination is used to insert Subscript
→ Cntrl, -

44. The mathematica command to evaluate logarithm of a base b
→ Log[a,b]

45. Which command returns the transpose of matrix A
→ Transpose[A]

46. := is used for
→ Delayed output

47. If A = {1,3,5,7}, then the input command A[[4]]
→ 7

48. Which command gives the number of elements ——
→ Length[A]

49. In Mathematica, the input command for order of Group
→ GroupOrder[G]

50. Which keyboard keys combination is used for Square root
→ Ctrl, 2

51. The input command GCD[2,4,8] gives
→ Greatest common divison of 2,4,8

52. Which command constructs the list [y[1], y[2], y[3]]
→ Array[y, 3]

53. Which command Can Solve the linear system Ax = b for x
→ LinearSolve[A, b]

54. Which command constructs the identity matrix of order 3
→ IdentityMatrix[3]

55. The command Table[2,4} gives
→ {2,2,2,2}

56. Which command returns the additive inverse of a Matrix
→ -A

57. If $A = \{1,3,5,7\}$ then the input command Take[A, 2]

→ $\{1, 3\}$

58. Let n be an integer. The input Command Divisors[n]

→ List of all positive divisor of n

59. The input command N[E, 5] gives

→ 2.7183

60. In Mathematica, the input command Im[2+3i] gives

→ 3

7831*.

Sign[-3.5] = -1

1 The expression Sign[-3,5] gives

a)* Error b) -3 c) -1 d) -2

2 If f[x_]= x+5 then which command evaluates f at x=a

a) f(a) b) F(a) c)* f[a] d) f/@a

3 Which command returns the determinant of nonsingular square matrix A

a) |A| b)* Det[A] c) Det(A) d) det[A]

4 The command Flatten[{{1,2,3},{4,{5}}}] returns

a) {{1,2,3,4,5}} b) {1,2,3,4,{5}} c)* {1,2,3,4,5} d) {1,2,3,{4,5}}

5 If we put a semicolon at the end of an input the output is

a) Displayed b)* suppressed c) Delayed d) Printed

6 which expression returns The imaginary part of a complex number

a) Img[Z] b) img[Z] c)* Im[Z] d) I[Z]

7 which command gives the no-of elements present in one dimensional List A

a) Elements[A,1] b) Length[A,1] c)* Length[A] d) Elements[A]

8 which keyboard keys combination is used to insert a square root

a) Cntrl,r b) Cntrl.square c) Cntrl,s d)* cntrl 2

9 The arguments of functions are given in

a) angle Brackets b) Round brackets c)* Box Brackets d) Curly Brackets

10- which expression gives 3rd order derivative of f[x,y] w.r.t y

a) D[f[x,y], {x,3}]   b) D[f[x_, y_], {y,3}]

* c) D[f[x,y], {y,3}]   d) D[f[x,y]; {y,3}]

11- The Command Table[2,{4}] gives

a) {2,4}   b) {4,4}   * c) {2,2,2,2}   d) error

12- what's The output of the command

if[5<6, Print["well done"], Print["try again"]]

* a) well done   b) Try again   c) false   d) True.

13- which expression constructs identity matrix of order 3

a) Imatrix[3]   b) identitymatrix[3]   * c) IdentityMatrix[3]   d) identity[3]

14- which command construct the list {y[1], y[2], y[3]}

a) Array[y, {1,{1}}]   b) Array[y, {1,2,3}]   c) Array[y[i], {i,1,3}]   * d) Array[y,3]

15- The input Table[{0,2},{2}] returns

* a) {{0,2},{0,2}}   b) {{0,0},{2,2}}   c) {0,2,2}   d) {{0,0},{0,0}}

16- The input a=3 is

a) a function   * b) an assignment   c) an identity   d) an equation

17- which expression is a list

* a) {1,2,3,4}   b) <1,2,3,4>   c) [1,2,3,4]   d) (1,2,3,4)

18- The Command Take[{1,2,3,4,3,6},3] gives   [{--}, -3] ↓ last element → {4,3,6}.

a) {3,3,6}   b) 3   * c) {1,2,3}   d) {3,3}

19- The Command has free of syntax error.

a) Do[Print[j]; {j,1,3}]   b) do[Print[j], {j,1,3}]

c) Do[Print[i], {j,1,3}]   * d) Do[Print[j], {j,1,3}]

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20- which text is read as comment

a) (don't worry) *b) (* don't worry *) c) *don't worry* d) *(don't worry)*

21- which keyboard keys combination is used to insert a fraction

a) Cntrl,l *b) Cntrl,/ c) Cntrl,- d) Cntrl,\

22- which expression has no syntax error

a) Cos(x) b) cos[x] *c) Cos[x] d) Cos(x)

23- If A={1,2,3,{4,5},6,7} then A[[1;;4]] returns

*a) {1, 2,3,{4,5}} b) {1,2,3,4} c) 4 d) {1,2,3,4,5}

24- which Command prints the matrix form of a list A

a) matrixform[A] b) Matrixform[A] *c) MatrixForm[A] d) MatrixForm(A)

25- The Command Append[{a},{1,2,3}] gives

*a) {a,{1,2,3}} b) {1,2,3,a} c) {{1,2,3},a} d) {a,1,2,3}

26- The Command Head[3.5] gives

a) Irrational b) integer *c) Real d) Even

27- which expression returns the very last generated

a) $ *b) % c) Ans d) #

28- All the built-in function start with the letters

*a) upper case b) Greek c) lower Case d) Latin

29- The input Log2[x] returns

*a) Error b) common logarithm of 2x c) natural log of 2x

d) Logarithm of x to base 2

30- := used for

a) suppressed input *b) delayed input c) delayed out d) suppressed output

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31- which command returns the multiplicative inverse of a nonsingular matrix A.

*a) Inverse[A] b) Multiplicative inverse[A] c) Inv[A]

32- which expression returns the real part of a complex

a) real[z] b) Real[z] c) R[z] *d) Re[z]

33- To execute an input line, which keyboard keys combination is used.

a) esc, enter *b) shift, enter c) esc, enter, esc d) esc, shift, esc

34- which command returns absolute value of x.

a) |x| b) Mod[3] *c) Abs[x] d) A[x]

35 which command returns Transpose of matrix A

a) {A}^T b) T[A] c) A^T *d) Transpose[A]

36- which command can solve the L.matrix.S for ax=b form

*a) LinearSolve[A, b] b) LinearSolve[A; b]

c) LinearSolve[Ax, b] d) Linear solve[A, b]

37- The command Prepend[{1,2,3}, a] returns

a) {{a},1,2,3} b) {1,2,3,a} c) {1,2,3,{a}} *d) {a,1,2,3}

38- which expression has no syntax error

a) Solve[x^2-x-6=0, x] b) Solve[x^2-x-6==0, {x}]

*c) Solve[x^2-x-6==0, x] d) Solve[x^2-x-6=0 ; x]

39- which keyboard keys combination is used to insert superscript ↓subscript

a) Cntrl, 6 b) Cntrl, + *c) Cntrl, - d) Control, enter

40- which command automatically prints the generated out

a) While b) For c) DO (*)? d) Table

41- Which expression return the numerical value of Pi with 20-digit precision

a) Numerical[Pi,20] b) N[Pi,{20}] * c) N[Pi,20] d) Pi|N[20]

42- which command returns the additive inverse of a nonsingular square matrix

* a) -A b) Inverse[A] c) inverse[A] d) inverse (A)

43- which function is helpful to exit the Do, for or while loop

a) End[] b) close[] c) Exit[] (*)? d) Break[]

44- which command gives the list of main diagonal elements of a square matrix A

a) Diagonal[A,1] b) MainDiagonal[A] c) Diagonal Element [A]

* d) Diagonal [A]

45- For loop is of the form

* a) For[start, condition, increment, body]

b) For [start, condition, increment ; body]

c) For [start, condition ; increment, body]

d) For[start ; condition ; increment, body]

* While[test (condition), body] * Do[expr, {imax}] Do[expr, {i, imin, imax}] * If [condition, t (true), f (false), u (neither true nor false)]

MATHEMATICA MCQS BY SIR ALI RAZA

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1 The expression sign[-3.5] = -1 gives

a) Error | b)-3
c)-3 | d)-2

2 If f[x_]=x+5 then which command evaluate f at x = a

a)f(a) | b)F(a)
c)f[a] | d)f/@a

3 Which command returns the determinat of non-singular square matrix A

a)|A| | b)Det[A]
c)Det(A) | d)det[A]

4 The Command Flatten[{{1,2,3},{4,{5}}}] returns

a){{1,2,3,4,5}} | b){1,2,3,4,{5}}
c){1,2,3,4,5} | d){1,2,3,{4,5,}}

5 If we put a semicolon at the end of an input then output is

a)Displayed | b)suppressed
c)Delayed | d)Printed

6 Which expression returns the imaginary part of a complex number

a)Img[z] | b)img[z]
c)Im[z] | d)I[z]

7 Which command gives the no. of elemetns present in one dimensional list A

a)Element[A,1] | b)Length[A,1]
c)Length[A] | d)Elements[A]

8 Which key board keys combination is used to insert a square root

a)Ctrl,r | b)Ctrl.square
c)Ctrl,s | d)Ctrl2

9 The arguments of functions are given in

a)Angle Brackets | b)Round Brackets
c)Box Brackets | d)Curly Brackets

10 Which expression gives 3rd order derivative of f[x,y] w.r.t y

a)D[f[x,y],{x,3}] | b)D[f[x_,y_],{y,3}]
c)D[f[x,y],{y,3}] | d)D[f[x,y];[y,3]]

11 The Command lable [2,{4}] gives

a){2,4} | b){4,4}
c){2,2,2,2} | d)error

12 What is the output of command if [5<6,Print[" well done "], Print ["try again"]]

a)well done | b)Try again
c)false | d) true

13 Which expression constructs idenity matrix of order3

a)Imatrix | b)identity matrix[3]
C)Identity Matrix[3] | d)identity[3]

14 which command constructs the list {y[1],y[2], y[3]}

a)array[,{1,{1}] | b)Array[y,{1,2,3}]
c)Array[y[i],{i,1,3}] | d)Array[y,3]

15 The input Table {{0,2},[2]} returns

a){{0,2},{0,2}} | b){{0,0},{2,2}}
c){0,2,2} | d){0,0},{0,0}}

16 The input a=3 is

a)a function | b)an assignement

c)an identity
d)an equation

17 Which expression is a list

a){1,2,3,4}
b)<1,2,3,4>
c)[1,2,3,4]
d)(1,2,3,4)

18 The command take [{1,2,3,4,3,6},3} gives

a){3,3,6}
b)3
c){1,2,3}
d){3,3}

19 The command has five free of syntax error.

a)Do[Print[j];{j,1,3}]
b)do[Print[j],[j],{j,1,3}]
c)Do[Print[j],{j,1,3}]
d)Do[Print[j],{j,1,3}]

20 Which text is read as comment

a)(don't worry)
b)(*don't worry*)
c)*don't worry*
d)*(don't worry)*

21 Which key board keys combination is used to insert a function

a)Ctrl,l
b)Ctrl,/
c)Ctrl,-
Cntrl,\

22 Which expression has no syntax error

a)cos(x)
b)cos[x]
c)Cos[x]
d)Cos(x)

23 If A={1,2,3,{4,5,6,7} then A[[1;;4]] returns

a){1,2,3,{4,5}}
b){1,2,3,4}
c)4
d){1,2,3,4,5}

24 Which command prints:- the matrix form of a list A

a)matrixform[A]
b)Matrixform[A]
c)MatrixForm[A]
d)MatrixForm(A)

25 The command Append[{a},{1,2,3}] gives

a){a,{1,2,3}}
b){1,2,3,a}
c){{1,2,3},a}
d){a,1,2,3}

26 The command Heat[3,5] gives

a)irrational
b)integer
c)Real
d)Even

27 Which expression returns the very last generated

a)$
b)%
c)Ans
d)#

28 All the built-in function start with the letter

a)Upper Case
b)Greek
c)Lower Case
d)Latin

29 The input Log2[x] returns

a)Error
b)common logarithm of 2x
c)natural logarithm of 2x
d)Logarithm of x to base 2

30 := is used for

a) Suspended
b)delayed input
c)delayed output
d)suppressed output

31 Which command returns the multiplication inverse of a nonsingular matrix A

a)Inverse[A]
b)multiplication inverse[A]
c)Inv[A]
d)none

32 Which expression returns the real part of a complex number

a)real[z]
b)Real[Z]

c)R[z] d)**Re[z]**

33 To execute an input line, which keyboard keys combination is used

a)esc, enter b)**shift, enter**

c)esc,enter, esc d)esc, shift, txsc

34 Which command returns absolute value of x.

a) [x] b)Med[3]

c)**Abs[x]** d)A[x]

35 Which command returns the Transpose of matrix A

a){A}^T b)T[A]

c)A^T d)**Transpose[A]**

36 which command can solve the L.matrix.S for ax=b for x,

a)**LinearSolve[A,b]** b)LinearSolve[A;b]

c)LinearSolve[ax,b] d)Linearsolve[A,b]

37 The command Prepend[{1,2,3},a] returns

a){{a},1,2,3} b){1,2,3,a}

c){1,2,3,{a}} d)**{a,1,2,3}**

38 Which expression has no syntax error

a)Solve[x^2 - x - 6 = 0, x] b)Solve[x^2 - x - 6 = 0, {x}]

c)**Solve[x^2 - x - 6 == 0, x]** d)Solve[x^2 - x - 6 = 0; x]

39 Which keyboard keys combination is used to insert supersript and subscript respectively

a)**Ctrl6,Ctrl-** b)Ctrl-,Ctrl6

c)Ctrl6,Ctrl+ d)Ctrl+,Ctrl=

40 Which command automatically prints the generated out

a)While b)For

c)Do d)**Table**

41 Which expression returns the numerical value of Pi with 20 digits precision

a)Numerical[Pi,20] b)N[Pi,{20}]

c)**N[Pi,20]** d)Pi|N[20]

42 Which command returns the additive inverse of a non-singular square matrix

a)**-A** b)Inverse[A]

c)inverse[A] d)Inverse(A)

43 Which function is helpful to exist the Do, For or while loop

a)End[ ] b)Close[ ]

c)Exit[ ] d)**Break[ ]**

44 Which command gives the list of main diagnol elements of a square matrix A

a)Diagonal[A,1] b)Main Diagonal[A]

c)Diagonal Element[A] d)**Diagonal[A]**

45 For loop is of the form

a)**For[start, condition, increment, body]** b)For[start, condition, increment; body]

c)For[start, condition; increment, body] d)For[start; condition; increment, body]