FORTRAN & MATHEMATICA

(PRACTICAL)

Subject Code: 243718

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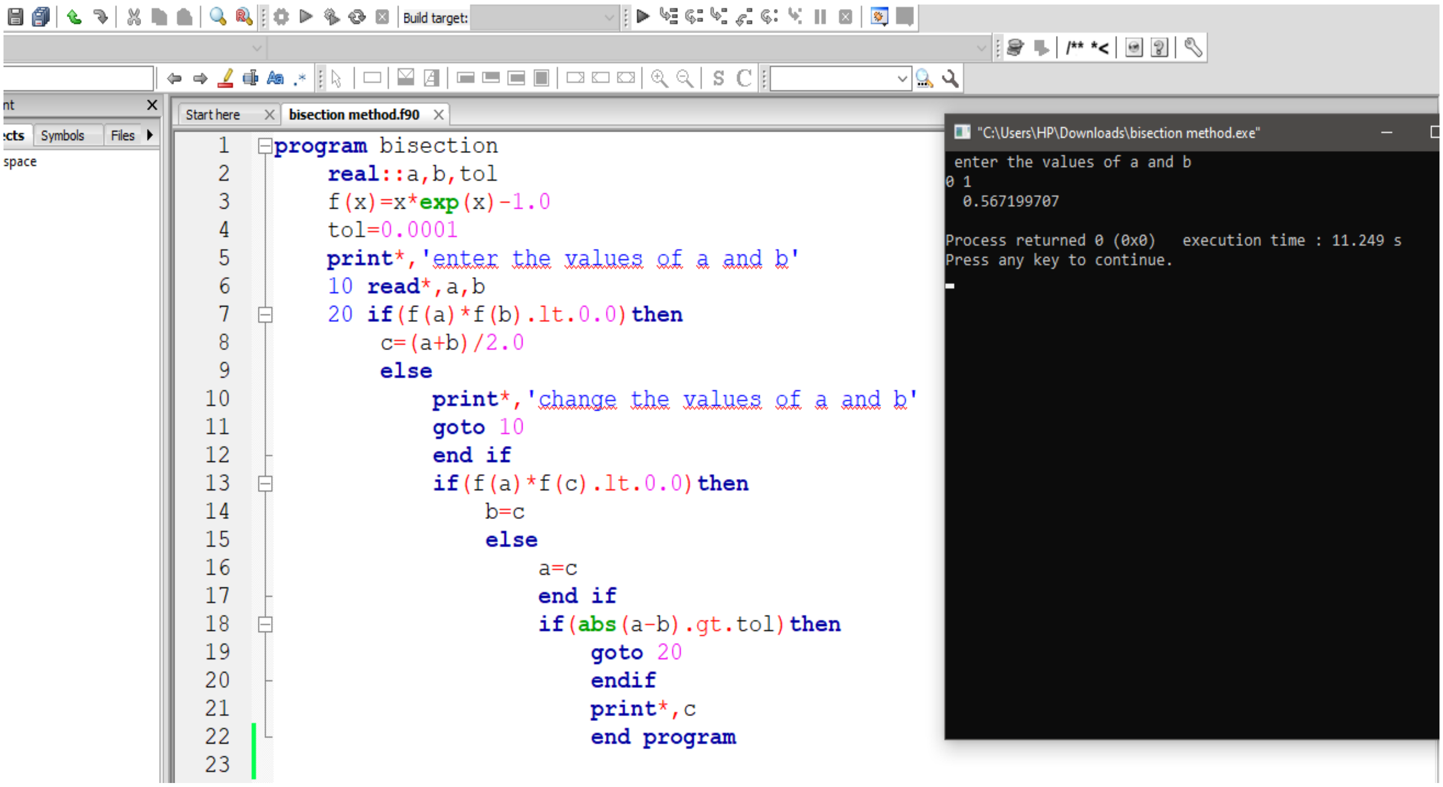
FORTRAN

PROBLEM-01

- Write a FORTRAN program to find a root, using bisection method, of the equation $xe^x = 1$.

Sol^n:

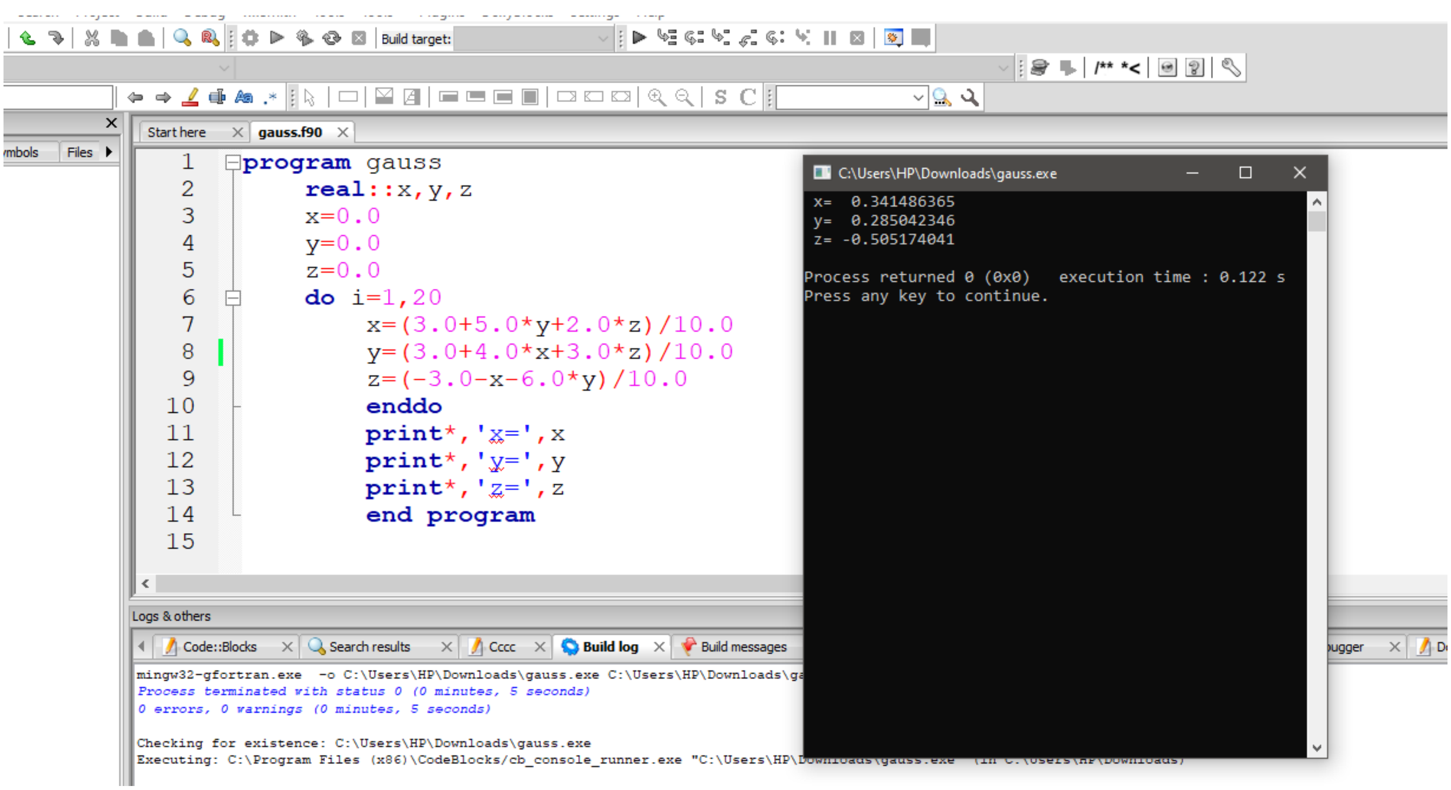


PROBLEM-02

- Write a FORTRAN program to solve the following system of linear equation by Gauss-Seidel method :

$$10x - 5y - 2z = 3$$
$$4x - 10y + 3z = -3$$
$$x + 6y + 10z = -3$$

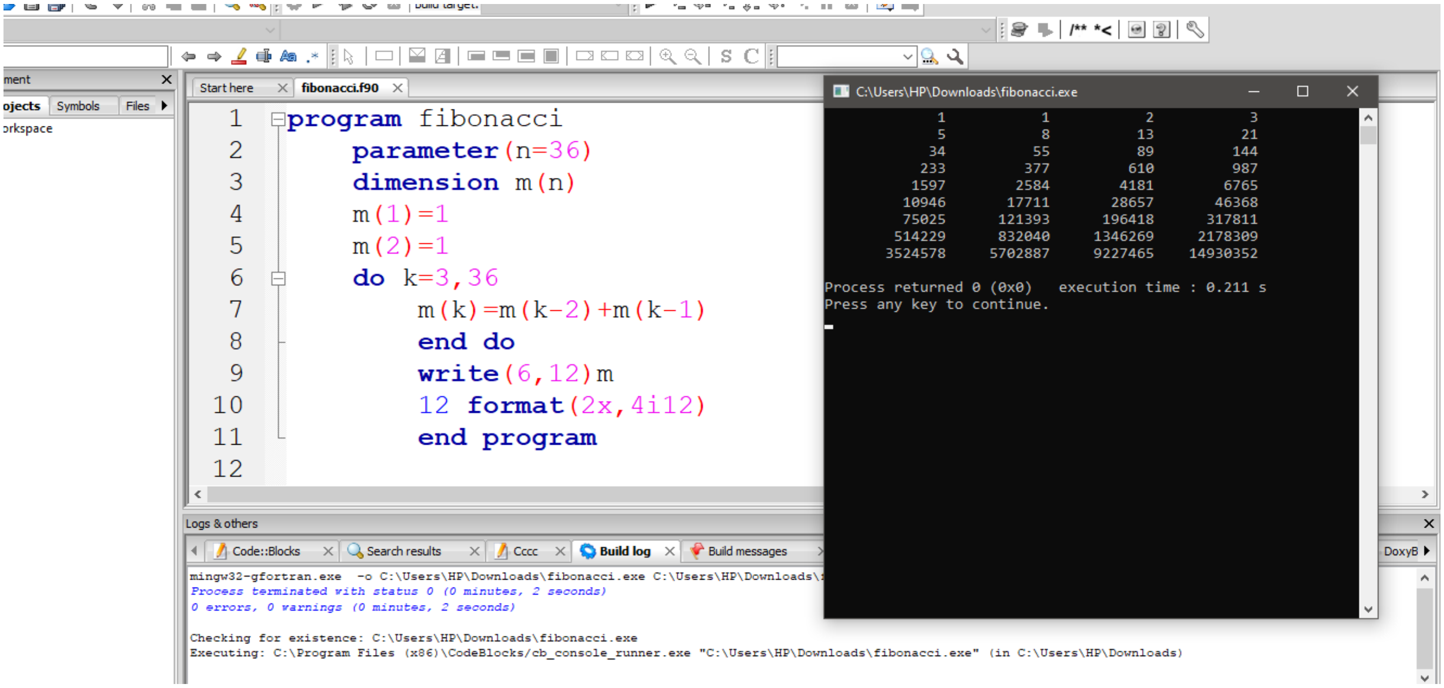
<u>Sol</u>



PROBLEM-03

- Write a FORTRAN program to find first 36 terms of Fibonacci sequence, the output should have four numbers in a line.

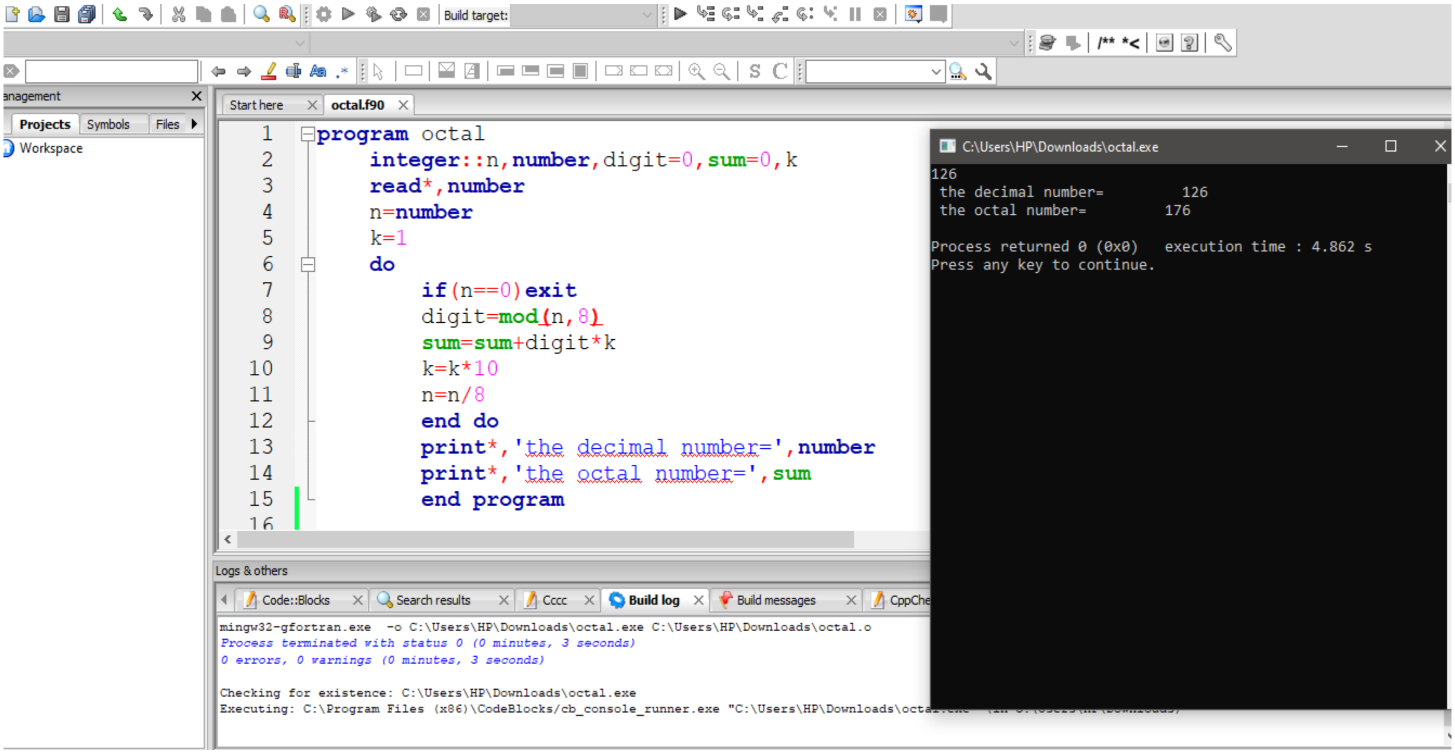
Sol^{n}:



PROBLEM-04

➢ Write a FORTRAN program to convert a decimal positive integer to octal number system.

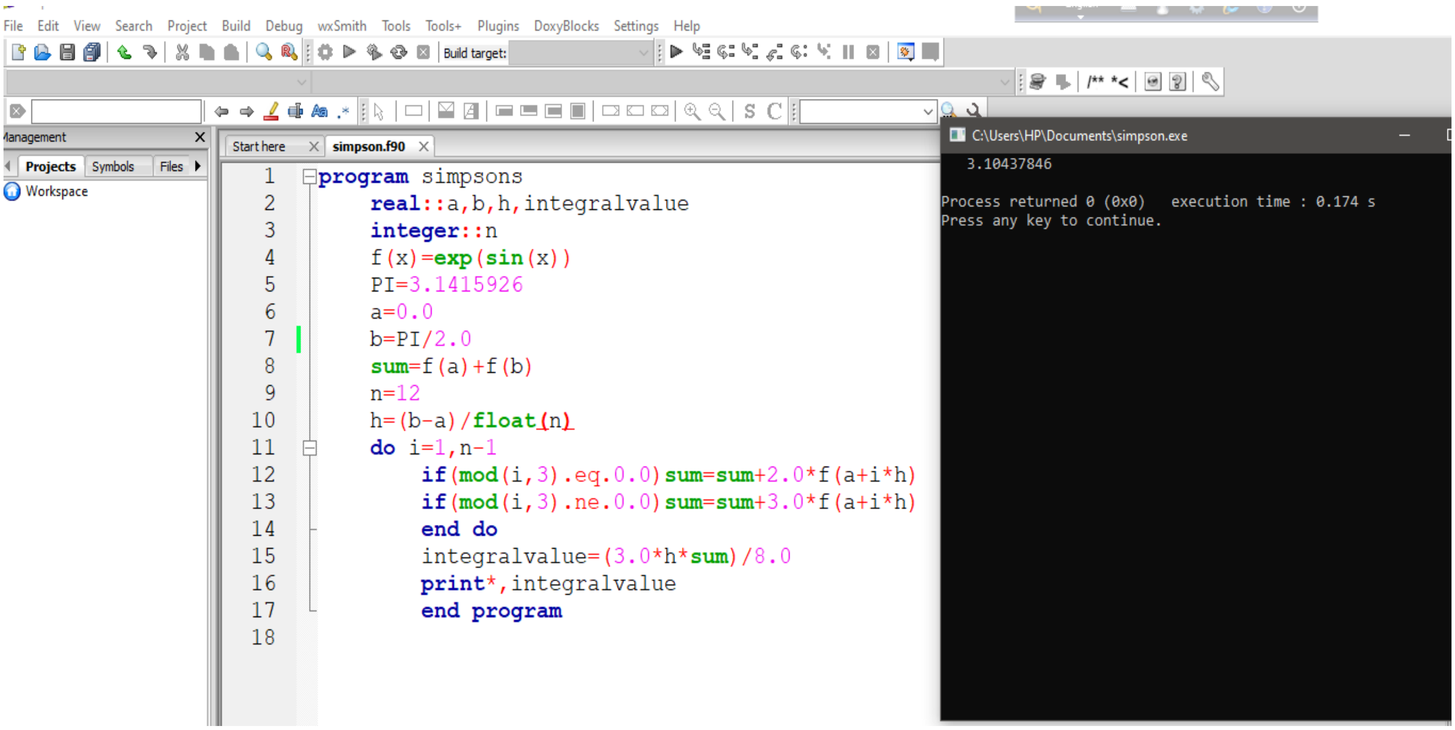
Sol^n:



PROBLEM-05

- Write a FORTRAN program for Simpson's $\frac{3}{8}$ rule to evaluate the integral $\int_0^{\frac{\pi}{2}} e^{\sin x}\, dx$.

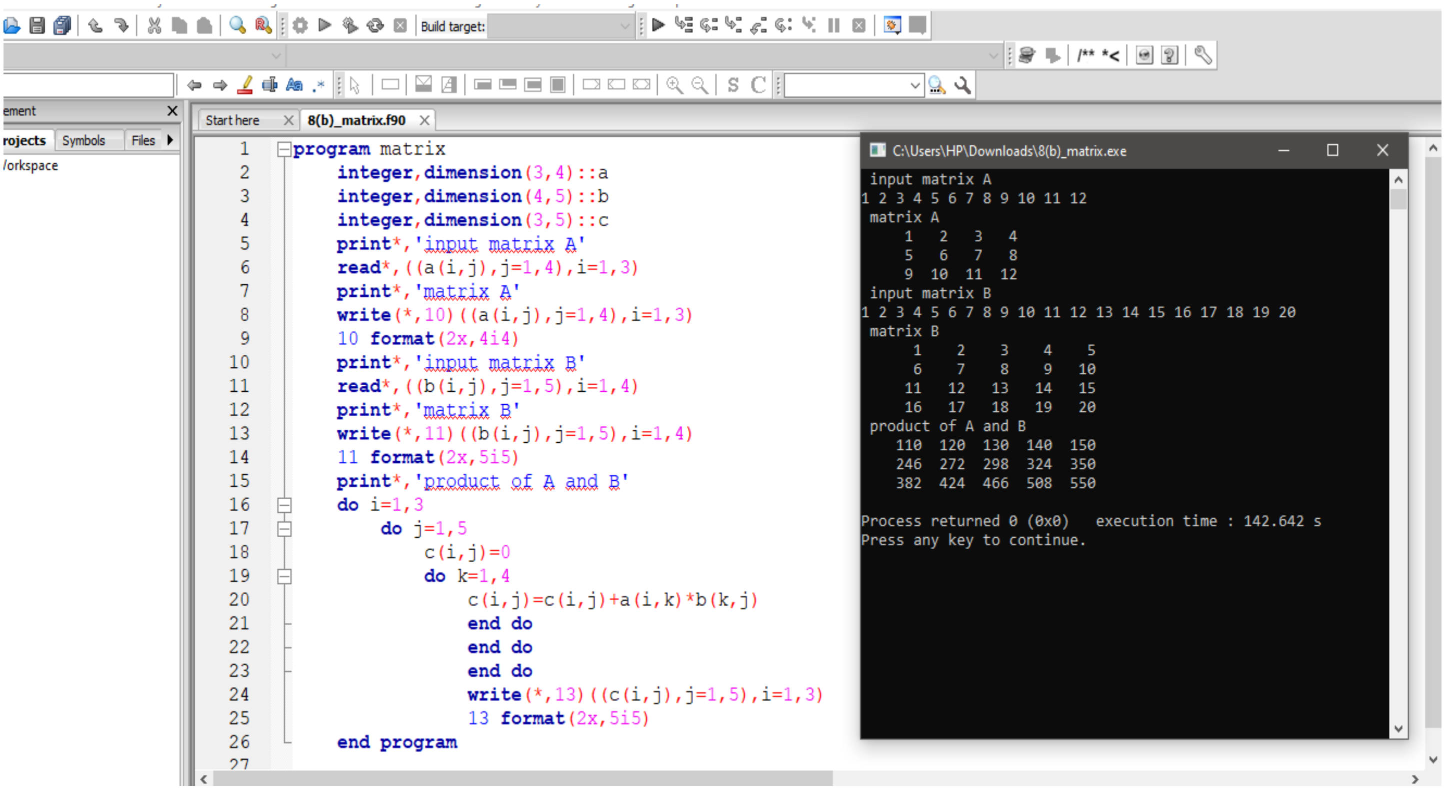
Sol^n:



PROBLEM-06

- Write a FORTRAN program to compute the product of two matrices.

Sol^n:



PROBLEM-07

- Write a FORTRAN program to find the solution of the differential equation $\frac{dy}{dx} + y + xy^2 = 0, y(0) = 1$ for $x \in [0,1]$ with $h = 0.1$ using Runge-Kutta fourth order method.

Sol^n:

runge.f90

```fortran
program runge
    real::x0=0.0,y0=1.0,x,x1,y1,k1,k2,k3,k4,k,f,h
    x1=x0
    y1=y0
    h=0.1
    x=1.0
    do while(x1.lt.x)
        k1=h*f(x1,y1)
        k2=h*f(x1+(h/2.0),y1+(k1/2.0))
        k3=h*f(x1+(h/2.0),y1+(k2/2.0))
        k4=h*f(x1+h,y1+k3)
        k=(k1+2.0*k2+2.0*k3+k4)/6.0
        y1=y1+k
        print*,x1+h,y1
        x1=x1+h
        end do
        end program

        real function f(x1,y1)
        real::x1,y1
        f=-y1-x1*y1**2
        return
        end function
```

C:\Users\HP\Downloads\runge.exe

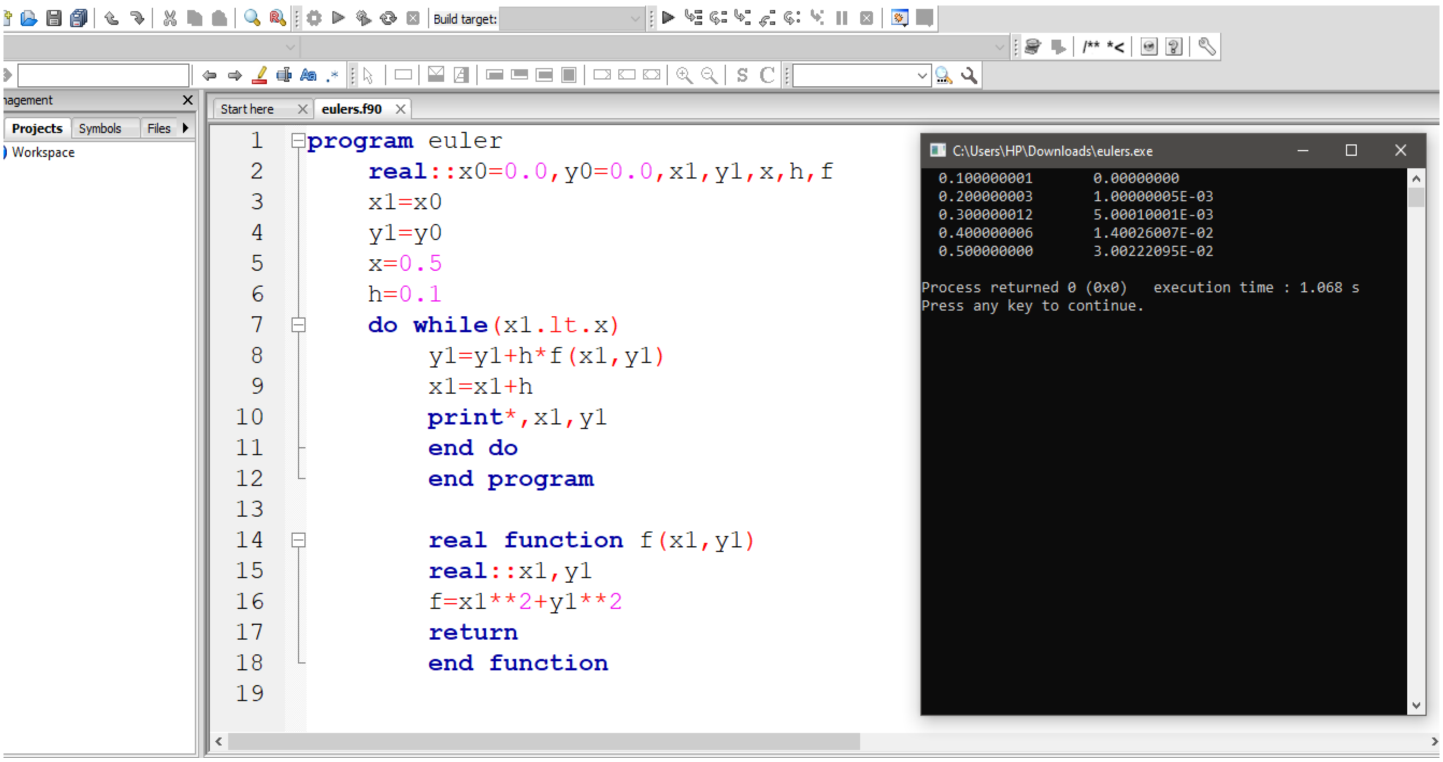
```
 0.100000001      0.900623679
 0.200000003      0.804631472
 0.300000012      0.714430392
 0.400000006      0.631453693
 0.500000000      0.556347013
 0.600000024      0.489181042
 0.700000048      0.429645717
 0.800000072      0.377205700
 0.900000095      0.331214100
  1.00000012      0.290989548

Process returned 0 (0x0)   execution time : 0.080 s
Press any key to continue.
```

PROBLEM-08

- Write a FORTRAN program to find the solution of $\frac{dy}{dx} = x^2 + y^2, y(0) = 0$ in the range $0 \le x \le 0.5$ with $h = 0.1$ using Euler's method.

Sol



MATHEMATICA

PROBLEM-01

➢ Show that, $f(x) = \begin{cases} x\cos\left(\frac{1}{x}\right) & if \;\; x \neq 0 \\ 0 & if \;\; x = 0 \end{cases}$ is continuous at $x = 0$ but not differentiable.

Sol^n:

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```
In[10]:= f[x_] := { x Cos[1/x]   x ≠ 0
                    0            x == 0

construct pure function

In[3]:= lhl = Limit[f[x], x → 0, Direction → "FromBelow"]

In[4]:= rhl = Limit[f[x], x → 0, Direction → "FromAbove"]

In[5]:= fv = f[0]

In[6]:= lhl == rhl == fv
```

f(x) is continuous at x=0

```
In[7]:= lhd = Limit[(f[0 + h] - f[0])/h, h → 0, Direction → "FromBelow"]

In[8]:= rhd = Limit[(f[0 + h] - f[0])/h, h → 0, Direction → "FromAbove"]

In[9]:= diff = Limit[(f[0 + h] - f[0])/h, h → 0]
```

f(x) is not differentiable at x=0

PROBLEM-02

- Given $f(x,y) = \begin{cases} \frac{xy(x^2-y^2)}{x^2+y^2} & if \ \ (x,\ y) \neq (0,0) \\ 0 & if \ \ (x,\ y) = (0,0) \end{cases}$ show that, $f_{xy}(0,0) \neq f_{yx}(0,0)$.

Sol^n:

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```
In[1]:= f[x_, y_] := Piecewise[{{(x * y * (x^2 - y^2))/(x^2 + y^2), x ≠ 0 || y ≠ 0}, {0, x == 0 && y == 0}}]

In[2]:= fx[x_, y_] := Limit[(f[x + h, y] - f[x, y])/h, h → 0]

In[3]:= fy[x_, y_] := Limit[(f[x, y + k] - f[x, y])/k, k → 0]

In[4]:= fxy = Limit[(fx[0, k] - fx[0, 0])/k, k → 0]

In[5]:= fyx = Limit[(fy[h, 0] - fy[0, 0])/h, h → 0]

In[6]:= fxy == fyx
```

PROBLEM-03

- Verify Roll's theorem with graph for the function $f(x) = (x-2)(x-3)(x-4)$ in the interval (2,3).

Sol^n:

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```
In[3]:= f[x_] = Expand[(x - 2) (x - 3) (x - 4)]
```

Since the function is a polynomial so the function is continuous and differentiable

```
In[4]:= a = 2; b = 3;

In[5]:= f[a] == f[b]

In[6]:= Plot[f[x], {x, 2, 3}]

In[7]:= NSolve[f'[c] == 0, c]
```

PROBLEM-04

- Find the intervals where the function $y = x^4 + 2x^3 - 3x^2 - 4x + 4$ is increasing and decreasing. Also find the maximum and minimum values of y.

Sol^n:

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```
In[1]:= f[x_] := x^4 + 2 x^3 - 3 x^2 - 4 x + 4

In[2]:= f'[x]

In[3]:= Solve[f'[x] == 0, x]

In[4]:= NumberLinePlot[{Interval[{-∞, -2}], Interval[{-2, -1/2}], Interval[{-1/2, 1}], Interval[{1, ∞}]}]

In[5]:= Plot[f[x], {x, -3, 2}, AxesOrigin → {0, 0}]

In[6]:= f'[x] /. x → -3

In[7]:= deint = Interval[{-∞, -2}]

In[8]:= f'[x] /. x → -1

In[9]:= inint = Interval[{-2, -1/2}]

In[10]:= f'[x] /. x → 0

In[11]:= deint = Interval[{-1/2, 1}]

In[12]:= f'[x] /. x → 2

In[13]:= inint = Interval[{1, ∞}]

In[14]:= f''[x]

In[15]:= f''[x] /. x → -2

In[16]:= min = f[x] /. x → -2

In[17]:= f''[x] /. x → -1/2

In[18]:= max = f[x] /. x → -1/2

In[19]:= f''[x] /. x → 1

In[20]:= min = f[x] /. x → 1
```

PROBLEM-05

- Find the equation of a sphere which passes through the points $(1,2,0)$, $(4,2,\ -3),(1,5,-3)$ and touches the plane $x + 2y + 2z = 8$. Draw the graph.

Sol^n:

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```
In[1]:= sphere = x^2 + y^2 + z^2 + 2*u*x + 2*v*y + 2*w*z + d == 0

In[2]:= eqn1 = sphere /. {x -> 1, y -> 2, z -> 0}

In[3]:= eqn2 = sphere /. {x -> 4, y -> 2, z -> -3}

In[4]:= eqn3 = sphere /. {x -> 1, y -> 5, z -> -3}

In[5]:= eqn4 = (-u - 2 v - 2 w + 8)/Sqrt[1 + 4 + 4] == Sqrt[u^2 + v^2 + w^2 - d]

In[6]:= sln = Solve[eqn1 && eqn2 && eqn3 && eqn4, {u, v, w, d}]

In[7]:= a1 = sphere /. sln[[1]]

In[8]:= a2 = sphere /. sln[[2]]

In[9]:= p1 = RegionPlot3D[191 - 18 Sqrt[105] + 2 × (-32 + 3 Sqrt[105]) x + x^2 + 6 × (-11 + Sqrt[105]) y + y^2 + 2 × (-28 + 3 Sqrt[105]) z + z^2 ≤ 0,
           {x, -5, 5}, {y, -5, 5}, {z, -8, 2}]

In[10]:= p2 = ContourPlot3D[x + 2 y + 2 z == 8, {x, -5, 5}, {y, -5, 5}, {z, -5, 5}, Mesh -> None,
           ContourStyle -> {Opacity[0.3], Lighter[Purple, 0.1]}]

In[11]:= Show[p1, p2]
```

PROBLEM-06

- Show that, $f(z) = f(x) = \begin{cases} \frac{x^3-3xy^2+i(y^3-3x^2y)}{x^2+y^2}, & z \neq 0 \\ 0 & , z = 0 \end{cases}$ is continuous at z=0 and the Cauchy-Riemann equations are satisfied but not differentiable at z=0.

Sol^n:

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```
f[z_] := { (x^3-3*x*y^2+i (y^3-3*x^2*y))/(x^2+y^2)   z ≠ 0
         { 0                                          z == 0

In[8]:=  u[x_, y_] = (x^3 - 3*x*y^2)/(x^2 + y^2)

In[9]:=  v[x_, y_] = (y^3 - 3*x^2*y)/(x^2 + y^2)

In[10]:= mux = Limit[u[x, y] /. y → m*x, x → 0]

In[11]:= mvx = Limit[v[x, y] /. y → m*x, x → 0]

In[12]:= mux + I*mvx

In[13]:= f[0]

In[14]:= mux + I*mvx == f[0]

         f(z) is continuous at z=0

In[15]:= u0 = u[x, 0] /. x → 0

In[16]:= v0 = v[x, 0] /. x → 0

In[17]:= ux = Limit[(u[0 + h, 0] - u0) / h, h → 0]

In[18]:= uy = Limit[(u[0, 0 + k] - u0) / k, k → 0]

In[19]:= vx = Limit[(v[0 + h, 0] - v0) / h, h → 0]

In[20]:= vy = Limit[(v[0, 0 + k] - v0) / k, k → 0]

In[21]:= ux == vy && vx == -uy

         f(z) satisfies Cauchy-Riemann equation.

In[22]:= Dfx = Limit[(u[x, y] + I*v[x, y] - 0)/(x + I*y) /. y → x, x → 0]

In[23]:= Df0 = Limit[(u[x, y] + I*v[x, y] - 0)/(x + I*y) /. y → 0, x → 0]

In[24]:= Dfx == Df0

         f(z) is not differentiable at z=0.
```

THE END