Curl of N.x**2*N.y*N.z*N.i + N.x*N.y**2*N.z*N.j + N.x*N.y*N.z**2*N.k is

$$(-x_N y_N^2 + x_N z_N^2)\hat{i}_N + (x_N^2 y_N - y_N z_N^2)\hat{j}_N + (-x_N^2 z_N + y_N^2 z_N)\hat{k}_N$$

1.3 Method II:

To find gradient of $\phi = x^2yz$.

```
#To find gradient of a scalar point function x^2yz
from sympy.physics.vector import *
from sympy import var,pprint
var('x,y,z')
v=ReferenceFrame('v')
F=v[0]**2*v[1]*v[2]
G=gradient(F,v)
F=F.subs([(v[0],x),(v[1],y),(v[2],z)])
print("Given scalar function F=")
display(F)
G=G.subs([(v[0],x),(v[1],y),(v[2],z)])
print("\n Gradient of F=")
display(G)
```

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Given scalar function F=

x^2yz

Gradient of F=

$$2xyz\hat{\mathbf{v}}_{\mathbf{x}} + x^2z\hat{\mathbf{v}}_{\mathbf{y}} + x^2y\hat{\mathbf{v}}_{\mathbf{z}}$$

To find divergence of $\vec{F} = x^2y\hat{i} + yz^2\hat{j} + x^2z\hat{k}$.

```
#To find divergence of F=x^2yi+yz^2j+x^2zk
from sympy.physics.vector import *
from sympy import var
var('x,y,z')
v=ReferenceFrame('v')
F=v[0]**2*v[1]*v.x+v[1]*v[2]**2*v.y+v[0]**2*v[2]*v.z
G=divergence(F,v)
F=F.subs([(v[0],x),(v[1],y),(v[2],z)])
print("Given vector point function is ")
display(F)

G=G.subs([(v[0],x),(v[1],y),(v[2],z)])
print("Divergence of F=")
display(G)
```

Given vector point function is

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To find curl of $\vec{F} = xy^2\hat{i} + 2x^2yz\hat{j} - 3yz^2\hat{k}$

```
#To find curl of F=xy^2i+2x^2yzj-3yz^2k
from sympy.physics.vector import *
from sympy import var
var('x,y,z')
v=ReferenceFrame('v')
F=v[0]*v[1]**2*v.x+2*v[0]**2*v[1]*v[2]*v.y-3*v[1]*v[2]**2*v.z
G=curl(F,v)
F=F.subs([(v[0],x),(v[1],y),(v[2],z)])
print("Given vector point function is ")
display(F)

G=G.subs([(v[0],x),(v[1],y),(v[2],z)])
print("curl of F=")
display(G)
```

Given vector point function is

$$xy^2\hat{\mathbf{v}}_x + 2x^2yz\hat{\mathbf{v}}_y - 3yz^2\hat{\mathbf{v}}_z$$

curl of F=

$$(-2x^2y - 3z^2)\hat{\mathbf{v}}_x + (4xyz - 2xy)\hat{\mathbf{v}}_z$$

1.4 Exercise:

1. If $u = x + y + z$, $v = x^2 + y^2 + z^2$, $w = yz + zx + xy$, find grad$u$.
   Ans: $\hat{i} + \hat{j} + \hat{k}$, $2(x\hat{i} + y\hat{j} + z\hat{k})$, $(y + z)\hat{i} + (z + x)\hat{j} + (z + x)\hat{k}$.

2. Evaluate div$F$ and curl$F$ at the point (1,2,3), given that $\vec{F} = x^2y$