```
syms A
syms B
syms C
syms x
syms y
syms z

syms P
syms Q
syms R
```

Имеем поле $F(P(x,y),Q(x,y))$, где

```
P=3*x^3+A*x^2*y+B*x*y^2+C*y^3
```

P = $3x^3 + Ax^2y + Bxy^2 + Cy^3$

```
Q=2*x^3+4*x^2*y+9*x*y^2+4*y^3
```

Q = $2x^3 + 4x^2y + 9xy^2 + 4y^3$

```
%P = 8*x^3+A*x^2*y+B*x*y^2+C*y^3
%Q = (8/3)*x^3+5*x^2*y+27*x*y^2+4*y^3
%P=5*x*y+8*y
%Q=4*x^2+12*y^2
R = sym(0);
F=[P,Q,R]
```

F = $\left(3x^3 + Ax^2y + Bxy^2 + Cy^3 \quad 2x^3 + 4x^2y + 9xy^2 + 4y^3 \quad 0\right)$

Из выражения $\mathrm{rot}(F) = 0$ или $\frac{\partial Q}{\partial x} = \frac{\partial P}{\partial y}$ найдем коэффициенты A, B, C

```
rot = curl(F,[x,y,z]);
rot = rot(3)
```

rot = $8xy - Ax^2 - 3Cy^2 + 6x^2 + 9y^2 - 2Bxy$

```
symvar(rot);
vrs=[x,y];
coefs = coeffs(rot,vrs);
vec=sym([0,0,0]);
coefs==vec
```

ans = $\left(9 - 3C = 0 \quad 8 - 2B = 0 \quad 6 - A = 0\right)$

```
slv = solve(coefs==vec);
A=sym(slv.A)
```

A = 6

```
B=sym(slv.B)
```

B = 4

```
C=sym(slv.C)
```

C = 3

```
v=symvar(P);
P = subs(P,v(1),A);
P = subs(P,v(2),B);
P = subs(P,v(3),C);
P = simplify(P)
```

P = $3\,x^3 + 6\,x^2\,y + 4\,x\,y^2 + 3\,y^3$

```
syms x1
syms y1
iP = subs(P,x,x1);
```

iP = $3\,x_1{}^3 + 6\,x_1{}^2\,y + 4\,x_1\,y^2 + 3\,y^3$

```
iP = subs(iP,y,sym(0));
```

iP = $3\,x_1{}^3$

```
iQ = subs(Q,y,y1);
```

iQ = $2\,x^3 + 4\,x^2\,y_1 + 9\,x\,y_1{}^2 + 4\,y_1{}^3$

```
syms x1
syms y1
```

Восстановим потенциал

$$U(x,y) = U(0,0) + \int_0^x P(t,0)\mathrm{dt} + \int_0^y Q(x,t)\mathrm{dt}$$

Примем $U(0,0) = 0$

```
U = int(iP,x1,0,x) + int(iQ,y1,0,y)
```

U =

$$\frac{3\,x^4}{4} + 2\,x^3\,y + 2\,x^2\,y^2 + 3\,x\,y^3 + y^4$$

```
diff(U,x);
P;
```

```
diff(U,y);
Q;
```

Уравнение $U(x,y) = U(1,1)$ определяет неявную функцию $1 = f(1)$

```
f = U - subs(subs(U,x,1),y,1)%U(1,1)
```

```
f =
```

$$\frac{3\,x^4}{4} + 2\,x^3\,y + 2\,x^2\,y^2 + 3\,x\,y^3 + y^4 - \frac{35}{4}$$

Положим

```
x1 = 1
```

```
x1 = 1
```

```
y1 = 1
```

```
y1 = 1
```

сюда:

Проведем касательнуй в точке (*x1*,*y1*)

Найдем производную *ff1* в точке *x1*

Найдем аналитическое представление касательной *ty*

Пололжим новый x1 = x1 + eps, где

```
eps = .1
```

```
eps = 0.1000
```

Если x1 < gz

```
gz = 1.5
```

```
gz = 1.5000
```

goto туда^

```
gz = ((gz-1) / eps);

pts  =[];

for i=1:gz
    x1=double(x1)
    y1=double(y1)
    %x1
    pts=[pts;[x1,y1]];
    %tangent angle in point x1
    ff1 = -subs(subs(P,x,x1),y,y1)/subs(subs(Q,x,x1),y,y1) %  f'(1)
```

```
    %tangent in point x1
    ty = solve((y-y1)==(ff1*(x-x1)),y)
    x1=x1+eps;
    y1 = subs(ty,x,x1);
    'x1'
    double(x1)
    'y1'
    double(y1)
    "--------------------------------------------------------------------------"
end
```

```
x1 = 1
y1 = 1
ff1 =
```

$$-\frac{16}{19}$$

```
ty =
```

$$\frac{35}{19}-\frac{16\,x}{19}$$

```
ans =
'x1'
ans = 1.1000
ans =
'y1'
ans = 0.9158
ans =
"--------------------------------------------------------------------------"
x1 = 1.1000
y1 = 0.9158
ff1 =
```

$$-\frac{114105759}{126681886}$$

```
ty =
```

$$\frac{9178150359}{4813911668}-\frac{114105759\,x}{126681886}$$

```
ans =
'x1'
ans = 1.2000
ans =
'y1'
ans = 0.8257
ans =
"--------------------------------------------------------------------------"
x1 = 1.2000
y1 = 0.8257
ff1 =
```

$$-\frac{3082821879729173999726590609996814809423928680587}{3180546519732551518255799491471653777693804145508}$$

```
ty =
```

$$\frac{8902514428561619062237538263193680525445767521922176013180303777}{4476221287844389662734354277401946975839762221231664433190666240}-\frac{3082821879729173999}{318054651973255151}$$

```
ans =
'x1'
ans = 1.3000
ans =
'y1'
```

```
ans = 0.7288
ans =
"--------------------------------------------------------------------------"
x1 = 1.3000
y1 = 0.7288
ff1 =
```

$$\_\frac{399274218764283991791700546038458560425378089451}{380968594028608821929098413714204298807471552484}$$

```
ty =
```

$$\frac{560629437349972582346264768836077723260899565458215212629288737}{268082815329235071559690701646722720406028635073597859965173760}\_\frac{39927421876428399179}{380968594028608821}$$

```
ans =
'x1'
ans = 1.4000
ans =
'y1'
ans = 0.6240
ans =
"--------------------------------------------------------------------------"
x1 = 1.4000
y1 = 0.6240
ff1 =
```

$$\_\frac{16879713001308655914785416548551467862903791391822 37}{14850444466446839309212889529410928527121987982181 08}$$

```
ty =
```

$$\frac{37039903773553765325063680060401384196618613731640881925466581614977}{16720114041344057450335198781238350490889718958908445648475830353920}\_\frac{168797130013086}{14850444466446}$$

```
ans =
'x1'
ans = 1.5000
ans =
'y1'
ans = 0.5103
ans =
"--------------------------------------------------------------------------"
```

Получаем массив точек (x,y):

```
double(pts)
```

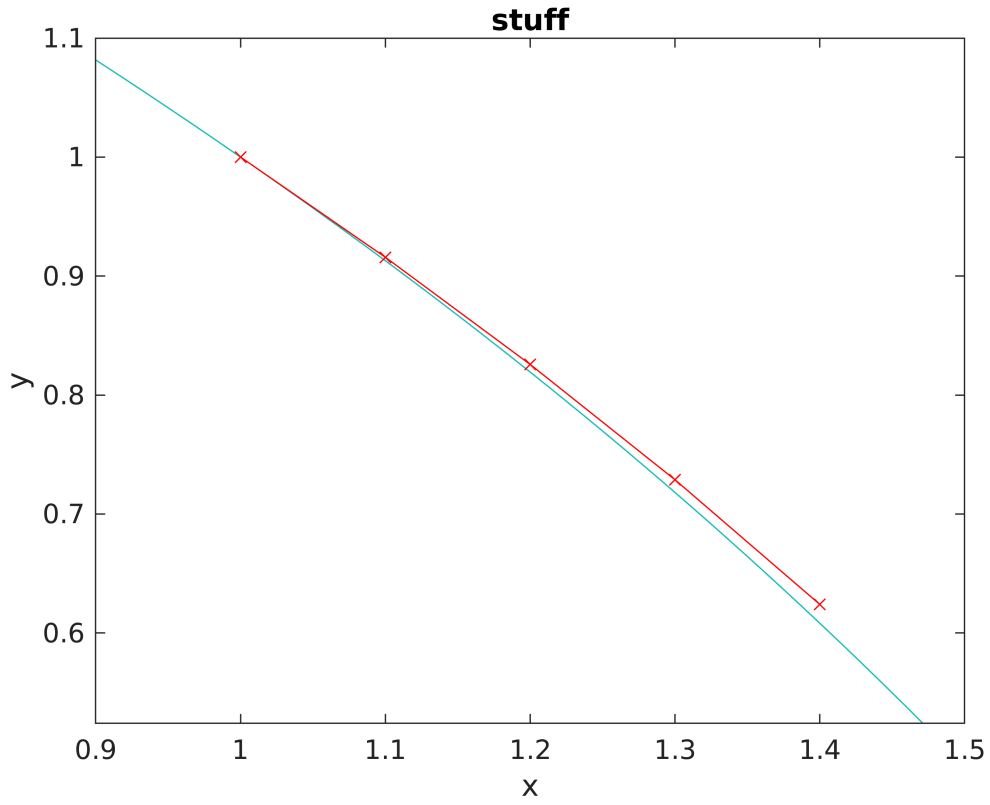
```
ans = 5×2
    1.0000    1.0000
    1.1000    0.9158
    1.2000    0.8257
    1.3000    0.7288
    1.4000    0.6240
```

```
pts;
mx=double(min(pts(:,1)));
my=double(min(pts(:,2)));
Mx=double(max(pts(:,1)));
My=double(max(pts(:,2)));
```

Представим на графике точке и аналитическую функцию $f(x)$:

```
ezplot(f,[mx-eps,Mx+eps,my-eps,My+eps])
hold on
```

```
title('stuff')
plot(pts(:,1)',pts(:,2)','-xr')
hold off
```




```
%f(1)=1; U(x,y)=U(1,1)
```