

1. 2-

[1]

$$F_1(x, y; m, k) = \rho + 10^m \left[(x - \rho \cos(k\rho))^2 + (y - \rho \sin(k\rho))^2 \right] \quad (1)$$

$$F_2(x, y; m, k) = \rho + 10^m \left[(x - \rho \cos(k\rho))^2 + (y - \rho \sin(k\rho))^2 \right]^{1/2} \quad (2)$$

$\rho = \sqrt{x^2 + y^2}$. m - , k - .

$$\frac{\partial F_1}{\partial x} = \frac{x}{\rho} + 2L \left[(x - \rho \cos k\rho) \left(1 - \frac{x}{\rho} \cos k\rho + kx \sin k\rho \right) - (y - \rho \sin k\rho) \left(\frac{x}{\rho} \sin k\rho + kx \cos k\rho \right) \right]$$

$$\frac{\partial F_1}{\partial y} = \frac{y}{\rho} + 2L \left[(y - \rho \sin k\rho) \left(1 - \frac{y}{\rho} \sin k\rho - ky \cos k\rho \right) + (x - \rho \cos k\rho) \left(-\frac{y}{\rho} \cos k\rho + ky \sin k\rho \right) \right]$$

$$\frac{\partial F_2}{\partial x} = \frac{x}{\rho} + \frac{L}{\phi} \left[(x - \rho \cos k\rho) \left(1 - \frac{x}{\rho} \cos k\rho + kx \sin k\rho \right) - (y - \rho \sin k\rho) \left(\frac{x}{\rho} \sin k\rho + kx \cos k\rho \right) \right]$$

$$\frac{\partial F_2}{\partial y} = \frac{y}{\rho} + \frac{L}{\phi} \left[(y - \rho \sin k\rho) \left(1 - \frac{y}{\rho} \sin k\rho - ky \cos k\rho \right) + (x - \rho \cos k\rho) \left(-\frac{y}{\rho} \cos k\rho + ky \sin k\rho \right) \right]$$

$$\phi = \left[(x - \rho \cos(k\rho))^2 + (y - \rho \sin(k\rho))^2 \right]^{1/2}, L = 10^m$$

(0.,0.), - (0.,0.)

XOY

$\rho = \frac{1}{k} \varphi$ (), φ -

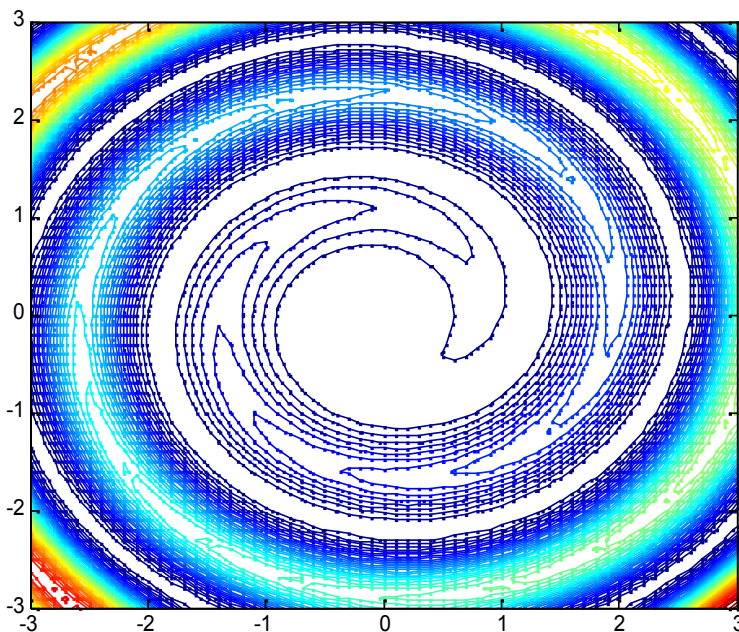
OX.

$1 \leq m \leq 4, 0 < k \leq 10.$

$(x; y) - [-5., 5.]^2$.

: $x^* = y^* = 0., F_1^* = F_2^* = 0.,$

$\|grad F_1^*\|_E = 1.$



(
 – Mathematica, Matlab. m, k)

Mathematica :

```
ro=Sqrt[x*x+y*y] k=5. m=3 x0=2 y0=2
F1=ro+10^m*((x-ro*Cos[k*ro])^2+(y-ro*Sin[k*ro])^2)
FindMinimum[F1,{x,x0},{y,y0}]
F2=ro+10^m*Sqrt[((x-ro*Cos[k*ro])^2+(y-ro*Sin[k*ro])^2)]
FindMinimum[F2,{x,x0},{y,y0}]
:
```

F1(x,y)=1.29025, x=1.27229, y=0.209141. F2(x,y)=1.42687, x=0.940475, y=1.07306

Mathlab:

```
x0 = [2,2];
[x,fval] = fminunc(@myfun,x0)
function f = myfun(x)
ro = sqrt(x(1)^2+x(2)^2);
k=5;
C=1000;
A=(x(1)-ro*cos(k*ro))^2+(x(2)-ro*sin(k*ro))^2;
f=ro+C*A;
( F1): x = 1.1633 0.7187 fval = 1.3680
( F2): x = -0.0698 0.3469 fval = 0.3539
```

1. $[-5.,5.]^2$
2. $1 \leq m \leq 4, 0 < k \leq 10. (m = 1,2,3,4; k =$
3. : [1.e-10., 1.e-1]
4. : [1.e-10., 1.e-1]

Output.dat

[2].

(1,2).

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Mathlab
 NAG (Numerical

Algorithms Group, <http://www.nag.co.uk/>).

2.

(1):

$$F_1(x_1, x_2, \dots, x_n) = \rho + 10^m \sum_{i=1}^n (x_i - R_i)^2, \quad x_i \in [-5, 5] \quad (3)$$

$$F_2(x_1, x_2, \dots, x_n) = \rho + 10^m \sqrt{\sum_{i=1}^n (x_i - R_i)^2}, \quad x_i \in [-5, 5], \quad (4)$$

$$\rho = \|x\|$$

$$R_1 = \rho \cos k\rho,$$

$$R_2 = \rho \sin k\rho \cdot \cos(k+1)\rho,$$

$$R_3 = \rho \sin k\rho \cdot \sin(k+1)\rho \cdot \cos(k+2)\rho,$$

$$R_{n-1} = \rho \sin k\rho \cdot \sin(k+1)\rho \cdot \dots \cdot \sin((k+n-2)\rho) \cdot \cos((k+n-1)\rho),$$

$$R_n = \rho \sin k\rho \cdot \sin(k+1)\rho \cdot \dots \cdot \sin((k+n-2)\rho) \cdot \sin((k+n-1)\rho).$$

$$\|x\| = \sqrt{\sum_{i=1}^n R_i^2}$$

$$(x_i^* = 0., i = 1, \dots, n; F_1^* = F_2^* = 0.$$

$$10- [3,4] : x_i = -10., i = 1, \dots, 10.$$

$$F(x^*) = 0.2273E-01.$$

<http://math-lab.ru/>

1. 2003-27, 2003, . 1-72
2. 1966
3. 30, .: - .46-54, 2008.
4. Deyanov R. A SUCCESSIVE DESCENT ALGORITHM OVER A SYSTEM OF LOCAL MINIMA. Computational Mathematics and Modeling, Vol. 20, No. 3, pp.278-285, 2009; -author - B. M. Shchedrin.