ДОДАТОК А

Код програми

Data preparation.

```
Clear["Global`*"]
```

Initial data.

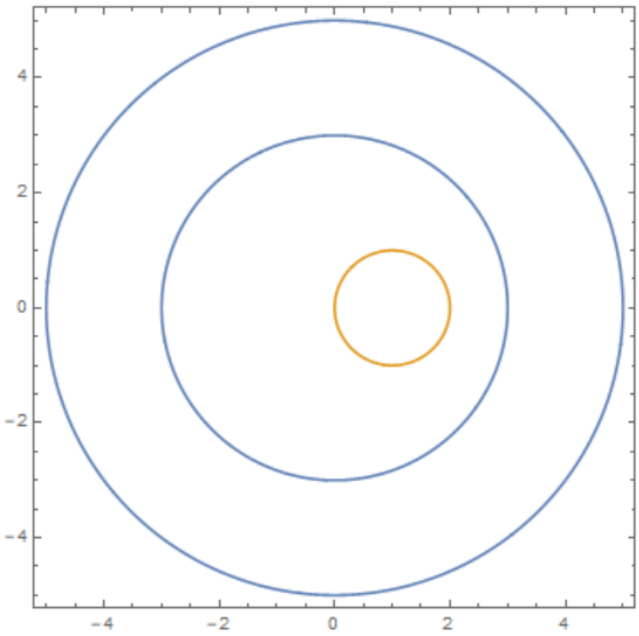
```
R0 = 10;

R = 5;

r = 3;

μ1 = 700;

μ0 = 4 Pi * 10^-7;

Ω0[x_, y_] = R0^2 - x^2 - y^2;

Ω1[x_, y_] = 1/(2 R) (R^2 - x^2 - y^2);

Ω2[x_, y_] = 1/(2 r) (r^2 - x^2 - y^2);
```

R – functions R_0.

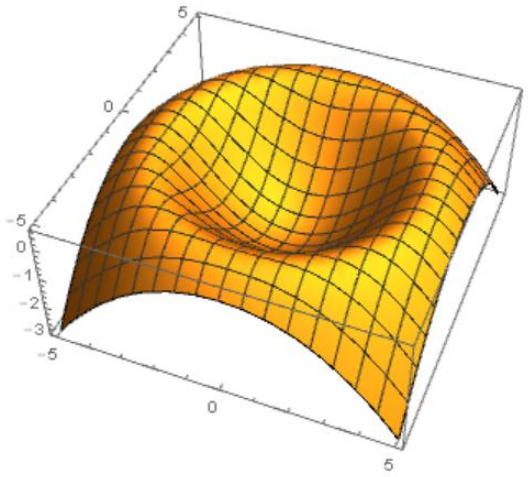
```
α = 0;

con[x_, y_] = 1/(1 + α) * (x + y - Sqrt[x^2 + y^2 - 2 * α * x * y]); (*Λα*)

Ωfv[x_, y_] = con[Ω1[x, y], -Ω2[x, y]];
```

Plot of a magnetic system.

```
G1=ContourPlot[{Ωfv[x,y] == 0,1-(x-1)^2-y^2==0},
{x, -R-.01, R+.01},{y, -R-.01, R+.01}, PlotPoints -> 200]
```



```
Plot3D[Ωfv[x, y], {x, -R, R}, {y, -R, R}]
```



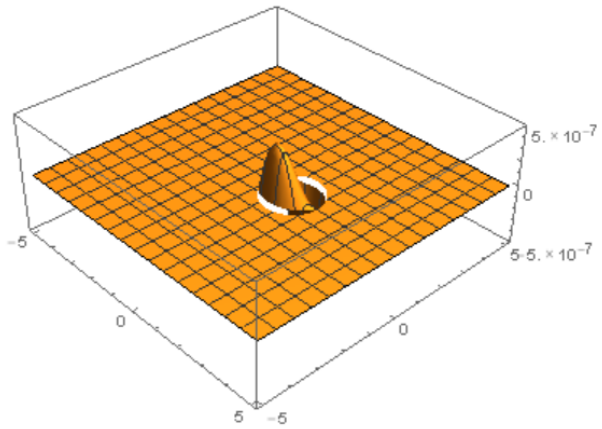
Function of magnetic permeability ferromagnetic :

```
μ[x_, y_] = Piecewise[{{μ1, Ωfv[x, y] ≥ 0}, {1, Ωfv[x, y] < 0}}];
```

Component of volumetric current density vector :

```
f[x_, y_] = -μ0 Piecewise[{{y (1 - (x - 1)^2 - y^2), 1 - (x - 1)^2 - y^2 ≥ 0}, {0, 1 - (x - 1)^2 - y^2 < 0}}];
```

```
Plot3D[f[x, y], {x, -R, R}, {y, -R, R}, PlotPoints → 100]
```



W

Coordinate sequences.

```
nn = 5;
NN = Quotient[(nn + 1) (nn + 2), 2];
array = {0, 1, 2, 3, 4, 5, 6, 7};
array2 = {10, 9, 8, 7, 6, 5, 4, 3, 2, 1, 0};
ka = {};
kb = {};
nn = 5;

For[i = 1, i ≤ nn + 1, i = i + 1,
 AppendTo[ka, Take[array, i]];
]
ka = Flatten[ka]

For[i = nn + 1, i > 0, i = i - 1,
 PrependTo[kb, Take[array2, -i]];
]
kb = Flatten[kb]

φ[m_, n_, x_, y_] := LegendreP[m, x / R0] LegendreP[n, y / R0];
rr1[i_, x_, y_] = Ω0[x, y] φ[ka[[i]], kb[[i]], x, y] - (1 - μ1) Ωfv[x, y] (D[Ωfv[x, y], x] D[Ω0[x, y] φ[ka[[i]],
          kb[[i]], x, y], x] + D[Ωfv[x, y], y] D[Ω0[x, y] φ[ka[[i]], kb[[i]], x, y], y]);
Φ[i_, x_, y_] := Piecewise[{{rr1[i, x, y], Ωfv[x, y] ≥ 0}, {Ω0[x, y] φ[ka[[i]], kb[[i]], x, y], Ωfv[x, y] < 0}}];
```

Calculation " Gauss nodes for integration."

Parameters.

```
a1 = 0;
b1 = R0;
c1 = 0;
d1 = 2 Pi;
NN1 = 10;
```

```
T = {-0.9739065285171716, -0.8650633666889844, -0.6794095682990247,
  -0.43339539412924705, -0.14887433898163122, 0.14887433898163122,
  0.43339539412924705, 0.6794095682990247, 0.8650633666889844, 0.9739065285171716}
```

```
CG = Array[0, NN1];
```

$$\text{Do}\left[\text{CG}[[i]] = \int_{-1}^{1} \frac{\left(\prod_{kk=1}^{i-1} (t - T[[kk]])\right)\left(\prod_{kk=i+1}^{NN1} (t - T[[kk]])\right)}{\left(\prod_{kk=1}^{i-1} (T[[i]] - T[[kk]])\right)\left(\prod_{kk=i+1}^{NN1} (T[[i]] - T[[kk]])\right)} \, dt, \{i, 1, NN1\}\right]$$

Compose Galerkin system.

```
A2 = Array[A, {NN, NN}];
```

```
B2 = Array[B, NN];
```

Calculation "Vector A".

$$\text{Do}\left[\left\{F1[x\_, y\_] = (1/\mu[x, y]\, \partial_{x,x}\, \Phi[i, x, y] + 1/\mu[x, y]\, \partial_{y,y}\, \Phi[i, x, y])\, \Phi[j, x, y];\right.\right.$$
$$FF1[\rho\_, \phi\_] = F1[\rho \text{Cos}[\phi], \rho \text{Sin}[\phi]]\, \rho;$$
$$\left.\left.A[i, j] = \frac{b1 - a1}{2} \frac{d1 - c1}{2} \sum_{ll=1}^{NN1} \sum_{kk=1}^{NN1} CG[[ll]]\, CG[[kk]]\, FF1\left[\frac{a1 + b1}{2} + \frac{b1 - a1}{2} T[[kk]], \frac{c1 + d1}{2} + \frac{d1 - c1}{2} T[[ll]]\right]\right\},$$
$$\left.\{i, 1, NN\}, \{j, 1, NN\}\right];$$

Calculation "Vector B".

$$\text{Do}\left[\left\{F2[x\_, y\_] = f[x, y] * \Phi[i, x, y];\right.\right.$$
$$FF2[\rho\_, \phi\_] = F2[\rho \text{Cos}[\phi], \rho \text{Sin}[\phi]]\, \rho;$$
$$\left.\left.B[i] = \frac{b1 - a1}{2} \frac{d1 - c1}{2} \sum_{ll=1}^{NN1} \sum_{kk=1}^{NN1} CG[[ll]]\, CG[[kk]]\, FF2\left[\frac{a1 + b1}{2} + \frac{b1 - a1}{2} T[[kk]], \frac{c1 + d1}{2} + \frac{d1 - c1}{2} T[[ll]]\right]\right\},$$
$$\left.\{i, 1, NN\}\right];$$

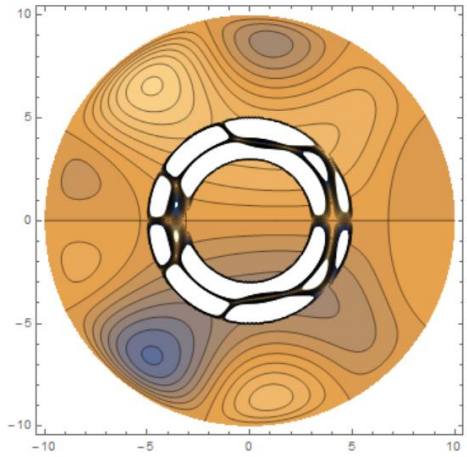
Find coefficients.

```
c = LinearSolve[A2, B2];
```

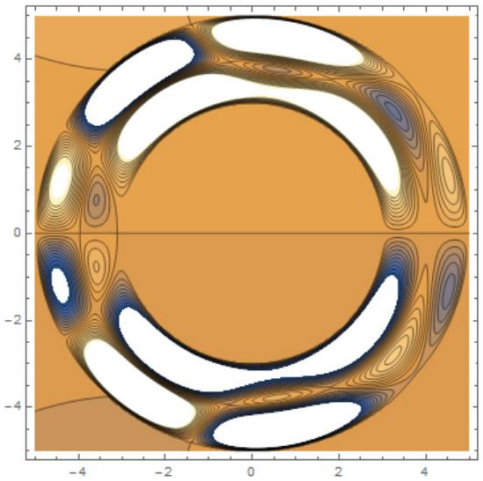
Output of result. Comparing with the exact solution

```
u[x_, y_] = Which[Ω0[x, y] ≥ 0, Sum[c[[k]] Φ[k, x, y], {k, 1, NN}]];
```

```
ContourPlot[u[x, y], {x, -R0, R0}, {y, -R0, R0}, AspectRatio -> Automatic, PlotPoints -> {100, 100}, Contours → 20]
```




```
ContourPlot[u[x, y], {x, -R, R}, {y, -R, R}, AspectRatio -> Automatic, PlotPoints -> {100, 100}, Contours → 20]
```




```
Plot3D[u[x , y], {x, -R0, R0}, {y, -R0, R0}, PlotRange → All, PlotPoints → 200]
```

```
Bx[x_, y_] := Which[Ω0[x, y] ≥ 0, Sum[CN[[k]] DΦy[k, x, y], {k, 1, NN}]];
```

условный оператор с множественными ветвями

```
Plot3D[Bx[x, y], {x, -R, R}, {y, -R, R}, PlotRange → All, PlotPoints → 50]
```

```
By[x_, y_] := Which[Ω0[x, y] ≥ 0, -Sum[CN[[k]] DΦx[k, x, y], {k, 1, NN}]];
```

условный оператор с множественными ветвями

```
Plot3D[By[x, y], {x, -R, R}, {y, -R, R}, PlotRange → All, PlotPoints → 50]
```

```
Do[Print[Plot[Bx[x, 0.05 * i], {x, -R, R}]], {i, 0, 30}]
```

о··· печат··· график функции

```
Do[Print[Plot[By[0.05 * i, y], {y, -R, R}]], {i, 0, 30}]
```

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ВІДОМІСТЬ АТЕСТАЦІЙНОЇ РОБОТИ

Позначення	Найменування	Дод. відомості
	Текстові документи	
1	Пояснювальна записка	65 с.
2	Презентаційний матеріал	25 с.
	Інші документи	
3	Роздруківки програм	4 с.
4	Рецензія	2 с.
5	Відгук керівника	1 с.

					Математичне моделювання магнітостатичних систем методом R-функцій			
Змін	**Арк.**	**Номер докум.**	**Підп.**	**Дата**				
Розроб.		**Заверуха О.І.**			**(Тема роботи) Відомість атестаційної роботи**		**Аркуш**	**Аркушів**
Перевір.		**Сидоров М.В.**						
Н. контр.		**Сидоров М.В.**				**ХНУРЕ Кафедра ПМ**		
Затв.		**Тевяшев А.Д.**						