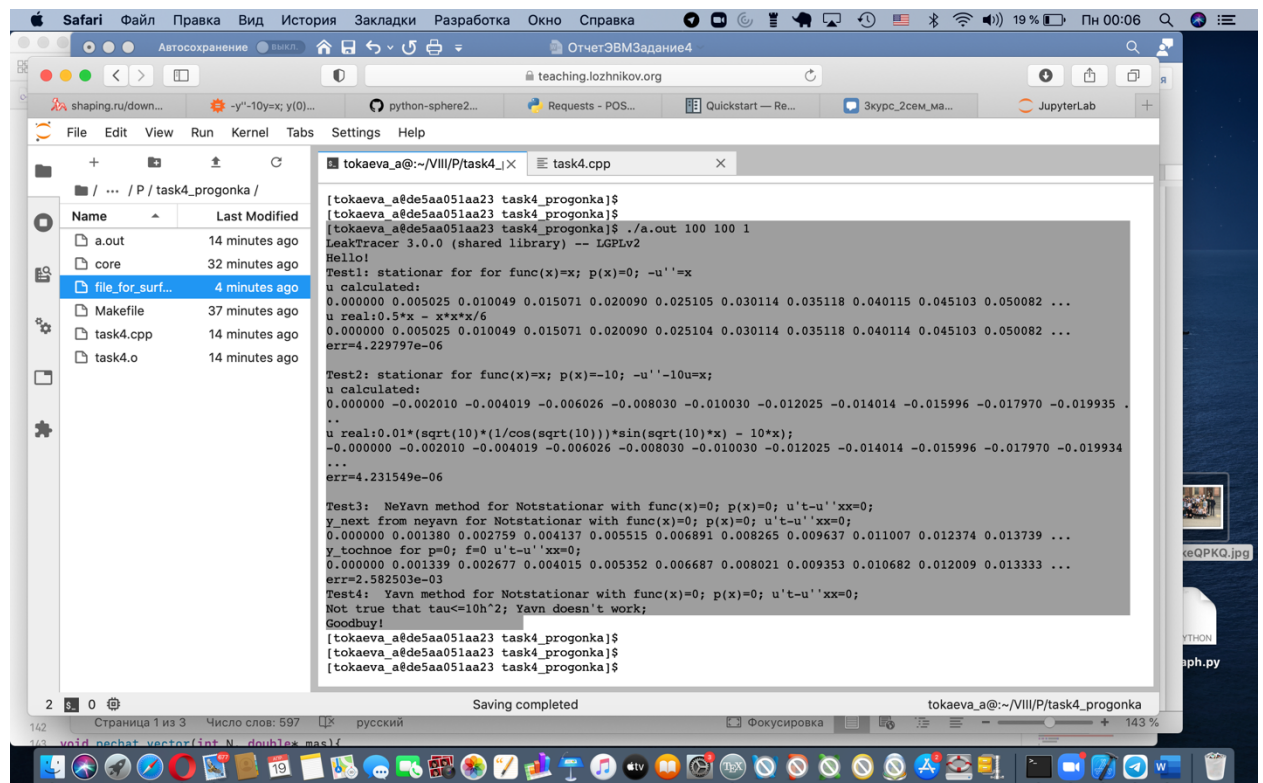


Проверяем численно:

1) Запускаем ./a.out 100 100 1



```
[tokaeva_a@e5aa051aa23 task4_progonka]$ ./a.out 100 100 1
LeakTracer 3.0.0 (shared library) -- LGPLv2
Hello!
Test1: stationar for func(x)=x; p(x)=0; -u''=x
u calculated:
0.000000 0.005025 0.010049 0.015071 0.020090 0.025105 0.030114 0.035118 0.040115 0.045103 0.050082 ...
u real:0.5*x - x*x*x/6
0.000000 0.005025 0.010049 0.015071 0.020090 0.025104 0.030114 0.035118 0.040114 0.045103 0.050082 ...
err=4.229797e-06

Test2: stationar for func(x)=x; p(x)=-10; -u''-10u=x;
u calculated:
0.000000 -0.002010 -0.004019 -0.006026 -0.008030 -0.010030 -0.012025 -0.014014 -0.015996 -0.017970 -0.019935 ...
u real:0.01*(sqrt(10)*(1/cos(sqrt(10))))*sin(sqrt(10)*x) - 10*x;
-0.000000 -0.002010 -0.004019 -0.006026 -0.008030 -0.010030 -0.012025 -0.014014 -0.015996 -0.017970 -0.019934 ...
err=4.231549e-06

Test3: NeYavn method for Notstationar with func(x)=0; p(x)=0; u't-u''xx=0;
y next from neyavn for Notstationar with func(x)=0; p(x)=0; u't-u''xx=0;
0.000000 0.001380 0.002759 0.004137 0.005515 0.006891 0.008265 0.009637 0.011007 0.012374 0.013739 ...
y tochnoe for p=0; f=0 u't-u''xx=0;
0.000000 0.001339 0.002677 0.004015 0.005352 0.006687 0.008021 0.009353 0.010682 0.012009 0.013333 ...
err=2.582503e-03

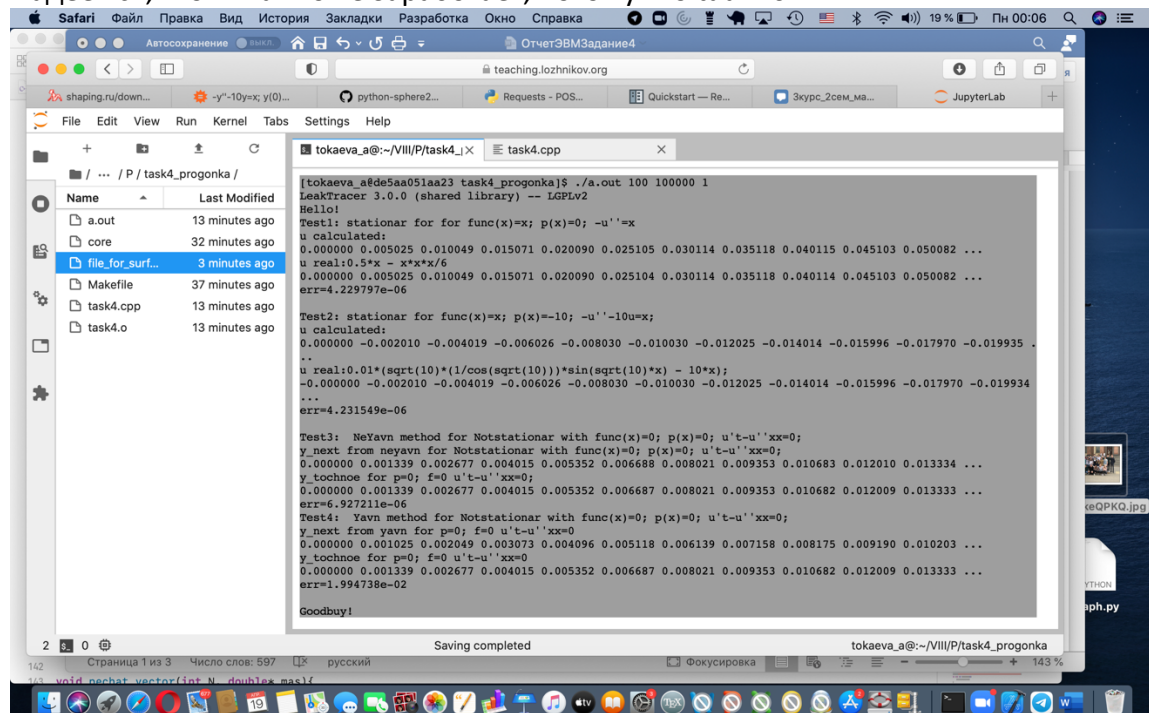
Test4: Yavn method for Notstationar with func(x)=0; p(x)=0; u't-u''xx=0;
Not true that tau<=10h^2; Yavn doesn't work;
Goodbuy!

[tokaeva_a@e5aa051aa23 task4_progonka]$
```

Видим, что все, кроме явной схемы - работает хорошо. Явная и не должна работать, потому что у нас тут $\tau = h$, а она работает (в смысле не разбалтывается) только при $\tau \leq C \cdot h^2$;

2) Запускаем ./a.out 100 100000 1

Надеемся, что явная тоже заработает, потому что $\tau = 10h^2$.



```
[tokaeva_a@e5aa051aa23 task4_progonka]$ ./a.out 100 100000 1
LeakTracer 3.0.0 (shared library) -- LGPLv2
Hello!
Test1: stationar for func(x)=x; p(x)=0; -u''=x
u calculated:
0.000000 0.005025 0.010049 0.015071 0.020090 0.025105 0.030114 0.035118 0.040115 0.045103 0.050082 ...
u real:0.5*x - x*x*x/6
0.000000 0.005025 0.010049 0.015071 0.020090 0.025104 0.030114 0.035118 0.040114 0.045103 0.050082 ...
err=4.229797e-06

Test2: stationar for func(x)=x; p(x)=-10; -u''-10u=x;
u calculated:
0.000000 -0.002010 -0.004019 -0.006026 -0.008030 -0.010030 -0.012025 -0.014014 -0.015996 -0.017970 -0.019935 ...
u real:0.01*(sqrt(10)*(1/cos(sqrt(10))))*sin(sqrt(10)*x) - 10*x;
-0.000000 -0.002010 -0.004019 -0.006026 -0.008030 -0.010030 -0.012025 -0.014014 -0.015996 -0.017970 -0.019934 ...
err=4.231549e-06

Test3: NeYavn method for Notstationar with func(x)=0; p(x)=0; u't-u''xx=0;
y next from neyavn for Notstationar with func(x)=0; p(x)=0; u't-u''xx=0;
0.000000 0.001339 0.002677 0.004015 0.005352 0.006687 0.008021 0.009353 0.010682 0.012009 0.013333 ...
y tochnoe for p=0; f=0 u't-u''xx=0;
0.000000 0.001339 0.002677 0.004015 0.005352 0.006687 0.008021 0.009353 0.010682 0.012009 0.013333 ...
err=6.927211e-06

Test4: Yavn method for Notstationar with func(x)=0; p(x)=0; u't-u''xx=0;
y next from yavn for p=0; f=0 u't-u''xx=0
0.000000 0.001025 0.002049 0.003073 0.004096 0.005118 0.006139 0.007158 0.008175 0.009190 0.010203 ...
y tochnoe for p=0; f=0 u't-u''xx=0
0.000000 0.001339 0.002677 0.004015 0.005352 0.006687 0.008021 0.009353 0.010682 0.012009 0.013333 ...
err=1.994738e-02

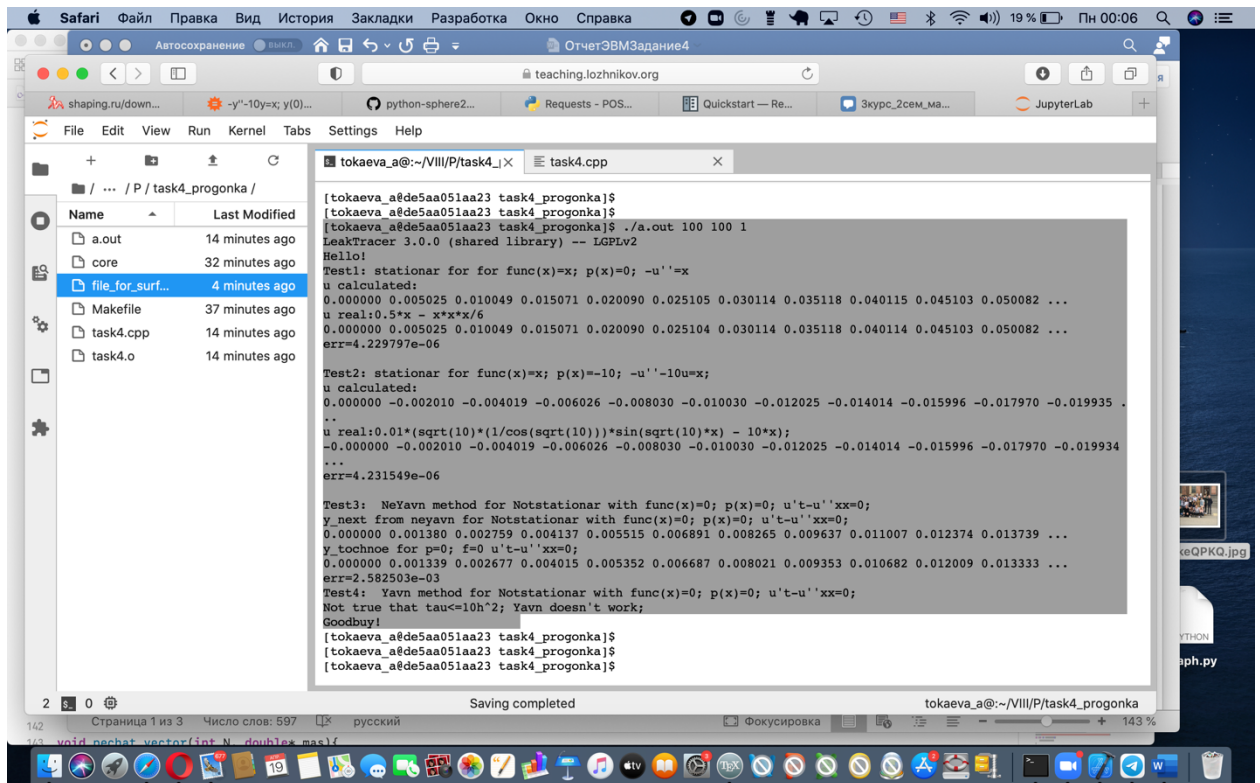
Goodbuy!
```

Заработала, но с маленькой точностью. Чтобы точность росла, надо увеличить M.

3) Проверим, что схема порядка $O(\tau + h^2)$;

Для этого запустим 100 100 1 (см выше)

Точность у неявного метода $\text{err}=2.582503\text{e-}03$

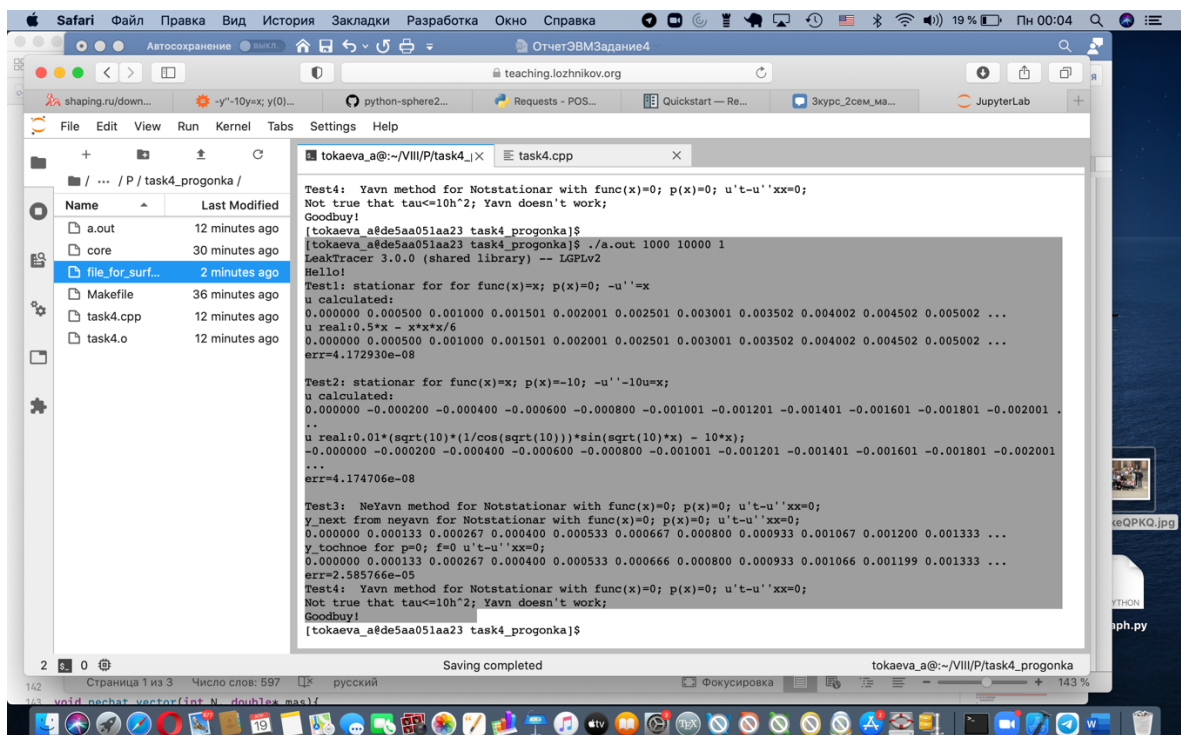


```
[tokaeva_a@de5aa051aa23 task4_progonka]$
[tokaeva_a@de5aa051aa23 task4_progonka]$
[tokaeva_a@de5aa051aa23 task4_progonka]$ ./a.out 100 100 1
LeakTracer 3.0.0 (shared library) -- LGPLv2
Hello!
Test1: stationar for func(x)=x; p(x)=0; -u'='x
u calculated:
0.000000 0.005025 0.010049 0.015071 0.020090 0.025105 0.030114 0.035118 0.040115 0.045103 0.050082 ...
u real: 0.5*x - x*x*x/6
0.000000 0.005025 0.010049 0.015071 0.020090 0.025104 0.030114 0.035118 0.040114 0.045103 0.050082 ...
err=4.229797e-06

Test2: stationar for func(x)=x; p(x)=-10; -u'=-10u=x;
u calculated:
0.000000 -0.002010 -0.004019 -0.006026 -0.008030 -0.010030 -0.012025 -0.014014 -0.015996 -0.017970 -0.019935 ...
u real: 0.01*(sqrt(10)*(1/cos(sqrt(10))))*sin(sqrt(10)*x) - 10*x;
-0.000000 -0.002010 -0.004019 -0.006026 -0.008030 -0.010030 -0.012025 -0.014014 -0.015996 -0.017970 -0.019934 ...
err=4.231549e-06

Test3: NeYavn method for Notstationar with func(x)=0; p(x)=0; u't-u'xx=0;
y_next from neyavn for Notstationar with func(x)=0; p(x)=0; u't-u'xx=0;
0.000000 0.001380 0.002759 0.004137 0.005515 0.006891 0.008265 0.009637 0.011007 0.012374 0.013739 ...
y_tochnoe for p=0; f=0 u't-u'xx=0;
0.000000 0.001339 0.002677 0.004015 0.005352 0.006687 0.008021 0.009353 0.010682 0.012009 0.013333 ...
err=2.582503e-03
Test4: Yavn method for Notstationar with func(x)=0; p(x)=0; u't-u'xx=0;
Not true that tau<=10h^2; Yavn doesn't work;
Goodbuy!
[tokaeva_a@de5aa051aa23 task4_progonka]$
[tokaeva_a@de5aa051aa23 task4_progonka]$
[tokaeva_a@de5aa051aa23 task4_progonka]$
```

И запустим 1000 10000 1



```
Test4: Yavn method for Notstationar with func(x)=0; p(x)=0; u't-u'xx=0;
Not true that tau<=10h^2; Yavn doesn't work;
Goodbuy!
[tokaeva_a@de5aa051aa23 task4_progonka]$
[tokaeva_a@de5aa051aa23 task4_progonka]$
[tokaeva_a@de5aa051aa23 task4_progonka]$ ./a.out 1000 10000 1
LeakTracer 3.0.0 (shared library) -- LGPLv2
Hello!
Test1: stationar for func(x)=x; p(x)=0; -u'='x
u calculated:
0.000000 0.000500 0.001000 0.001501 0.002001 0.002501 0.003001 0.003502 0.004002 0.004502 0.005002 ...
u real: 0.5*x - x*x*x/6
0.000000 0.000500 0.001000 0.001501 0.002001 0.002501 0.003001 0.003502 0.004002 0.004502 0.005002 ...
err=4.172930e-08

Test2: stationar for func(x)=x; p(x)=-10; -u'=-10u=x;
u calculated:
0.000000 -0.000200 -0.000400 -0.000600 -0.000800 -0.001001 -0.001201 -0.001401 -0.001601 -0.001801 -0.002001 ...
u real: 0.01*(sqrt(10)*(1/cos(sqrt(10))))*sin(sqrt(10)*x) - 10*x;
-0.000000 -0.000200 -0.000400 -0.000600 -0.000800 -0.001001 -0.001201 -0.001401 -0.001601 -0.001801 -0.002001 ...
err=4.174706e-08

Test3: NeYavn method for Notstationar with func(x)=0; p(x)=0; u't-u'xx=0;
y_next from neyavn for Notstationar with func(x)=0; p(x)=0; u't-u'xx=0;
0.000000 0.000133 0.000267 0.000400 0.000533 0.000666 0.000800 0.000933 0.001067 0.001200 0.001333 ...
y_tochnoe for p=0; f=0 u't-u'xx=0;
0.000000 0.000133 0.000267 0.000400 0.000533 0.000666 0.000800 0.000933 0.001066 0.001199 0.001333 ...
err=2.585766e-05
Test4: Yavn method for Notstationar with func(x)=0; p(x)=0; u't-u'xx=0;
Not true that tau<=10h^2; Yavn doesn't work;
Goodbuy!
[tokaeva_a@de5aa051aa23 task4_progonka]$
```

Увидим, что у него $\text{err}=2.585766\text{e-}05$

То есть прямо в 100 раз точность увеличилась при уменьшении h в 10 раз, а τ в 100 раз.

Это и доказывает нужное $O(\tau+h^2)$;

4) Построим поверхность, как $u(x,t)$ эволюционировало при t от 0 до 1.

Для этого все y_{next} из неявного метода сложим в файл "file_for_surface.txt";

Потом пишем в командной строке `gnuplot`, потом в гнуплоте:

```
gnuplot> set pm3d
```

```
gnuplot> splot "file_for_surface.txt" matrix with lines
```

qt.qpa.fonts: Populating font family aliases took 433 ms. Replace uses of missing font family "Sans" with one that exists to avoid this cost.

```
gnuplot>
```

И рисуется поверхность, которую можно поворачивать.

