

```
In [1]: using Plots
using LaTeXStrings
```

問 2 (1)

```
In [2]: using NLSolve

function nls(func, params...; ini = [0.0])
    if typeof(ini) <: Number
        r = nlsolve((vout,vin)->vout[1]=func(vin[1],params...), [ini])
        v = r.zero[1]
    else
        r = nlsolve((vout,vin)->vout . = func(vin,params...), ini)
        v = r.zero
    end
    return v, r.f_converged
end
```

Out[2]: nls (generic function with 1 method)

```
In [3]: f(y,x) = y^5 + 3*x*y + x^3 -x + 1
```

Out[3]: f (generic function with 1 method)

```
In [4]: sq_x = 0.0:0.02:4.0
sq_y = Float64[]

for x in sq_x
    y = nls(f, x, ini = -1.0)[1]
    # println(y)
    push!( sq_y, y )
end
```

```
In [5]: sq_x
```

Out[5]: 0.0:0.02:4.0

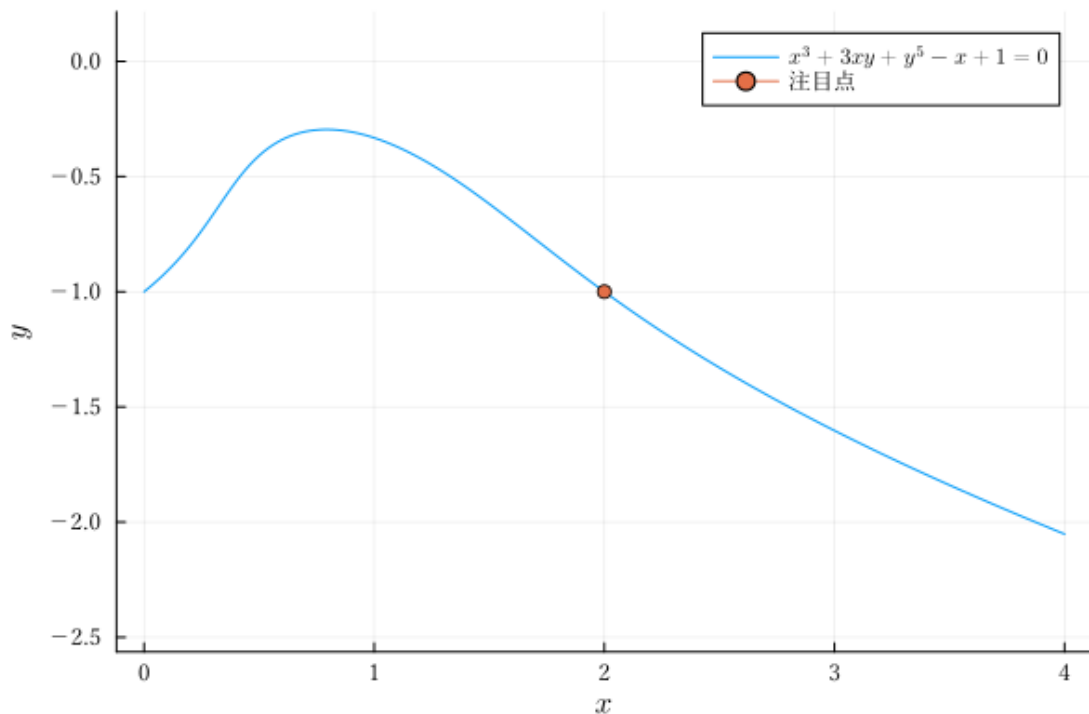
```
In [6]: sq_y
```

Out[6]: 201-element Vector{Float64}:

```
-1.0  
-0.9836730167901317  
-0.9666630542237852  
-0.9489242056817033  
-0.9304075848945111  
-0.9110618439005079  
-0.8908341583433755  
-0.8696719034560711  
-0.8475253288313529  
-0.8243516239064166  
-0.8001208176935451  
-0.7748239689103263  
-0.7484837884425254  
⋮  
-1.9609188699875009  
-1.9693430621576125  
-1.9777361997639662  
-1.986098681713236  
-1.994430898758432  
-2.002733233749206  
-2.011006061653138  
-2.019249750129103  
-2.0274646593505965  
-2.0356511423817167  
-2.0438095453252236  
-2.0519402075041717
```

```
In [7]: plot( sq_x, sq_y, aspect_ratio = 1.0, label = L"x^3 + 3xy + y^5 - x + 1 = 0", x1  
plot!((2,-1), marker = :circle, label = "注目点", fontfamily = "yumin" )
```

Out[7]:



```
In [8]: using SymPy
```

```
In [9]: let  
@syms x y  
  
f = x^3 + 3*x*y + y^5 - x + 1
```

```

fx = diff(f, x)
fy = diff(f, y)

yx = - fx/fy
display(yx)

f_yx = lambdify(yx, (x, y))
display(f_yx(2, -1))
end

```

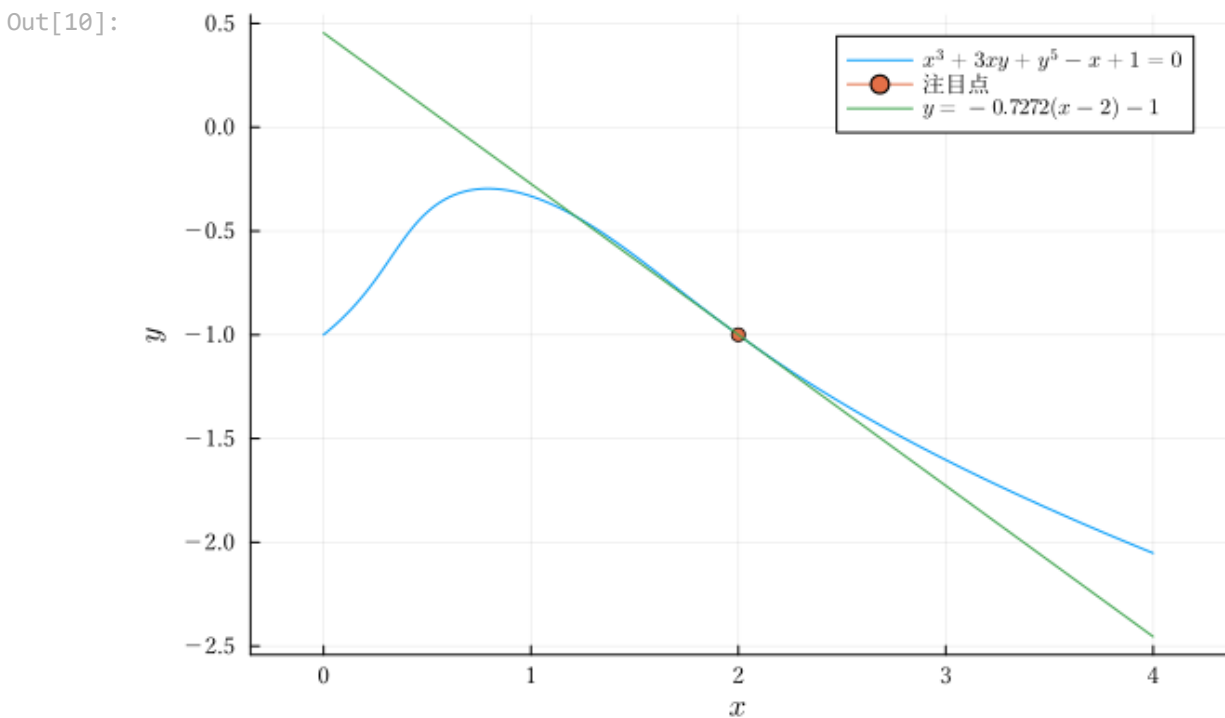
$$\frac{-3x^2-3y+1}{3x+5y^4}$$

-0.7272727272727273

```

In [10]: plot( sq_x, sq_y, aspect_ratio = 1.0, label = L"x^3 + 3xy + y^5 - x + 1 = 0", x1
plot!((2,-1), marker = :circle, label = "注目点", fontfamily = "yumin" )
plot!( x -> -0.7272 * (x-2) -1, label = L"y = - 0.7272(x-2) - 1" )

```



問 6 (1)

```

In [11]: f(x,y) = y - x

sq_theta = 0.0:0.01:2π
r = sqrt(2)

sq_vx = Vector{Float64}[]

for theta in sq_theta
    x, y = r * cos(theta), r * sin(theta)
    push!( sq_vx, [x,y, f(x,y)] )
end

```

```

In [12]: sq_vx

```

```

Out[12]: 629-element Vector{Vector{Float64}}:
 [1.4142135623730951, 0.0, -1.4142135623730951]
 [1.41414285228423, 0.014141899922649064, -1.400000952361581]
 [1.4139307290885852, 0.028282385667090744, -1.3856483434214943]
 [1.4135772139983032, 0.042420043196534286, -1.371157170801769]
 [1.4130823423645982, 0.056553458757008096, -1.3565288836075902]
 [1.4124461636742216, 0.07068121901873393, -1.3417649446554876]
 [1.4116687415445122, 0.0848019112174587, -1.3268668303270534]
 [1.4107501537170348, 0.09891412329572977, -1.311836030421305]
 [1.4096904920498072, 0.11301644404409943, -1.2966740480057077]
 [1.4084898625081126, 0.1271074632422447, -1.281382399265868]
 [1.4071483851539048, 0.1411857717999883, -1.2659626133539166]
 [1.4056661941338013, 0.15524996189820633, -1.250416232235595]
 [1.4040434376656692, 0.16929862712960905, -1.2347448105360601]
 ⋮
 [1.405164545085414, -0.15972664535042944, -1.5648911904358433]
 [1.4066915272761729, -0.14566724782678048, -1.5523587751029533]
 [1.4080778414864432, -0.13159328369973658, -1.5396711251861799]
 [1.4093233490859591, -0.11750616035398467, -1.5268295094399438]
 [1.4104279255249985, -0.10340728649011882, -1.5138352120151173]
 [1.4113914603468383, -0.08929807198377644, -1.5006895323306146]
 [1.412213857198799, -0.07517992774464922, -1.4873937849434482]
 [1.4128950338418806, -0.061054265575398524, -1.4739492994172791]
 [1.4134349221589868, -0.046922498030468676, -1.4603574201894556]
 [1.4138334681617355, -0.032786038274837725, -1.4466195064365732]
 [1.4140906319958586, -0.018646299942699646, -1.4327369319385583]
 [1.4142063879451874, -0.004504696996107086, -1.4187110849412945]

```

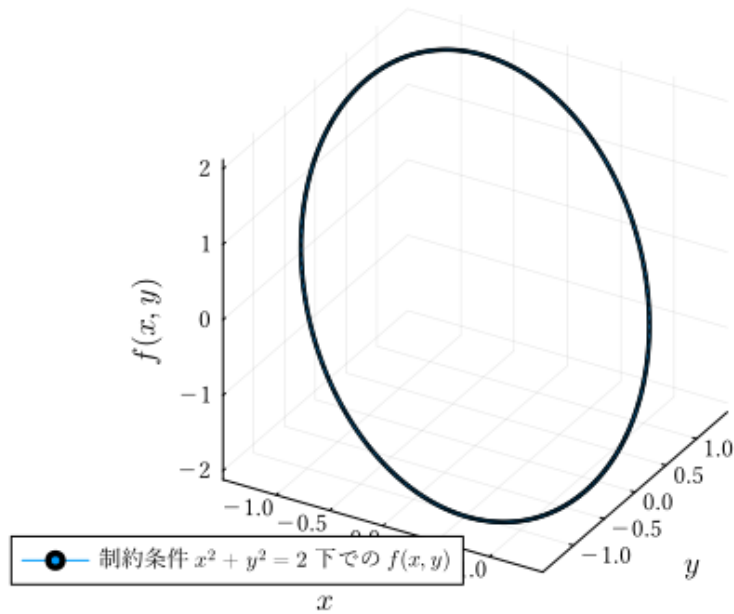
```

In [13]: xs = [v[1] for v in sq_vx]
          ys = [v[2] for v in sq_vx]
          zs = [v[3] for v in sq_vx]

          plot3d(
              xs, ys, zs;
              marker = :circle,
              markersize = 1,
              lw = 1,
              label = "制約条件  $x^2 + y^2 = 2$  下での  $f(x,y)$ ",
              xlabel = L"x",
              ylabel = L"y",
              zlabel = L"f(x,y)",
              fontfamily = "yumin"
          )

```

Out[13]:



問 6 (2)

In [14]: `f(x,y) = x*y`

```
sq_theta = 0.0;0.01:2π
cy = sqrt(2)

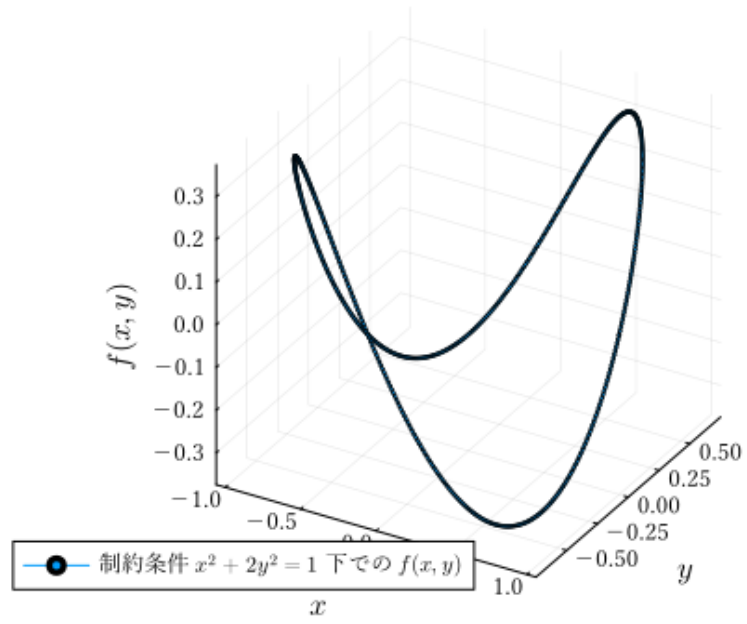
sq_vx = Vector{Float64}[]

for theta in sq_theta
    x, y = cos(theta), sin(theta)/cy
    push!( sq_vx, [x,y, f(x,y)] )
end
```

In [15]: `xs = [v[1] for v in sq_vx]`
`ys = [v[2] for v in sq_vx]`
`zs = [v[3] for v in sq_vx]`

```
plot3d(
    xs, ys, zs;
    marker = :circle,
    markersize = 1,
    lw = 1,
    label = "制約条件  $x^2 + 2y^2 = 1$  下での  $f(x,y)$ ",
    xlabel = L"x",
    ylabel = L"y",
    zlabel = L"f(x,y)",
    fontfamily = "yumin"
)
```

Out[15]:



In []: