

NAME : *answers*

Find the point on the surface $x^2 + 3xy + 2y^2 + 7x$ that lies closest to the origin.

1. Give the Sage command(s) to define this problem as a polynomial system.

```
x,y,z = var('x,y,z')
f = x^2 + 3*x*y + 2*y^2 + 7*x
target = x^2 + y^2 + z^2
Lambda = var('Lambda')
e1 = diff(target,x) - diff(f,x)*Lambda
e2 = diff(target,y) - diff(f,y)*Lambda
e3 = diff(target,z) - diff(f,z)*Lambda
s = [e1 == 0, e2 == 0, e3 == 0, f == 0]
print s
```

this shows

```
[-(2*x + 3*y + 7)*Lambda + 2*x == 0, -(3*x + 4*y)*Lambda + 2*y == 0,
 2*z == 0, x^2 + 3*x*y + 2*y^2 + 7*x == 0]
```

2. Give the Sage command(s) to solve the polynomial system.

Also give all real solutions of this system.

```
sols = solve(s,x,y,z,Lambda); print sols;
```

We see two real solutions:

```
[
 [x == 0, y == 0, z == 0, Lambda == 0],
 [x == 56.1985752449, y == -41.3137829912, z == 0.0,
  Lambda == -24.7342747112]
]
```

Alternative: Bring to class on Monday the answers to assignments 2 and 6 of the fifth lecture on MATLAB; 1, 2, and 3 of the assignments in the first lecture on Sage.