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※ **Your answer must be provided with descriptions how to get the answer.**

1.(5 points) Find the slope of the tangent line to the curve of the intersection of the plane $\sqrt{3}y - x = 0$ and the paraboloid $z + x^2 + y^2 = 5$ at the point $(\sqrt{3}, 1, 1)$.

2.(5 points) Find **all** saddle points of the function $f(x,y) = x\sin y + yx^2 - x^2$ that lie on the $y-axis$.

3.(6 points) Suppose $y = f(x)$ is a positive increasing differentiable function and $\frac{d}{dx}f(x)$ is continuous.

Derive a formula for the area of the surface of revolution S obtained by rotating the curve $y = f(x)$ about the $y-axis$ for $c_1 \leqq x \leqq c_2$ with $c_1 \geqq 0$.

4.(6 points) Evaluate the double integral $\iint_D \{1 + \sin(x^2) + \cos(y^2)\} dA$, where D is bounded by $x = 1,\ y = 1,\ x + y = 1$.

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5.(6 points) Evaluate the improper integral $I = \int_0^\infty e^{-x^2} dx$ by using double integral in polar coordinates.

6.(6 points) Let F be a vector field in R^3 defined by $F(x, y, z) = < y + y^2 z, x - z + 2xyz, -y + xy^2 >$.

(1) (2 points) Find a function f such that $\nabla f = F$.

(2) (4 points) Find $\int_C F \cdot dr$, where C is the line segment from the point (2,2,1) to (1,-1,2).

7.(6 points) Let F be a vector field in R^2 defined by $F(x,y) = < x^2 + y + 3x^2y, x^3 + \sin(y^2) >$.

Find $\int_C F \cdot dr$, where C is the positively oriented boundary of the region bounded by the line $y = 0$ and the parabola $y = x^2 - 1$.