MAC 2313 (Multivariable Calculus) — Answers
QUIZ 7, Friday October 14, 2016

Name: PID:

Remember that no documents or calculators, or any other electronic devices are allowed during the quiz. Also remember that you won't get any credit(s) if you do not show the steps to your answers.

1. [5] Find an equation for the tangent plane and parametric equations for the normal line to the surface $2x^2 + 4y^2 - 9z^2 = 3$ at the point $A(2, -1, 1)$.

Set $F(x,y,z) = 2x^2 + 4y^2 - 9z^2 + 3$; equation of surface is then $F(x,y,z) = 0$

$\nabla F(x,y,z) = \langle 4x, 8y, -18z \rangle$

$\nabla F(A) = \langle 8, -8, -18 \rangle$ = a normal to the tangent plane at A
= a parallel vector to normal line at A

Equation of tangent plane:

$$4(x-2) - 4(y+1) - 9(z-1) = 0$$

Parametric equations of normal line:

$$x = 2 + 4t, \quad y = -1 - 4t, \quad z = 1 - 9t$$

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2. [5] Let $g(x, y, z) = xy - 2yz + 3zx$. a) Find the gradient of g at the point $P(1, 2, -1)$. b) Find the directional derivative of g at P in the direction of the vector $\vec{a} = 2\vec{i} - 3\vec{j} + 4\vec{k}$. Is g increasing or decreasing at P in the direction of the vector $\vec{a}$?

a) $\nabla g(x,y,z) = \langle y + 3z, x - 2z, -2y + 3x \rangle$

$\nabla g(P) = \langle 2 - 3, 1 - 2(-1), -2(2) + 3 \rangle = \langle -1, 3, -1 \rangle$

$$D_{\vec{a}} g(P) = \nabla g(P) \cdot \frac{\vec{a}}{\|\vec{a}\|} = \frac{\langle -1, 3, -1 \rangle \cdot \langle 2, -3, 4 \rangle}{\sqrt{4 + 9 + 16}}$$

$$= \frac{-2 - 9 - 4}{\sqrt{29}}$$

$$= -\frac{15}{\sqrt{29}}$$

Since $D_{\vec{a}} g(P) < 0$, g is decreasing at P in the direction of $\vec{a}$.