2. Planes, normal vectors, and tangent planes

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Part A due Oct 5, 2021 20:30 IST

Practice

5A-2

1/1 point (graded)
Let P be the plane defined by $x+2y+3z=17$. Find a vector which is normal to this plane. (It doesn't have to be a unit vector.)

[1,2,3] **Answer:** [1,2,3]

? INPUT HELP

Solution:

A normal vector can be taken as

$$\vec{n}=\nabla\left(x+2y+3z\right)=\boxed{\langle 1,2,3\rangle.}$$

Submit You have used 1 of 3 attempts

Answers are displayed within the problem

5A-3

1/1 point (graded)
Find the equation of a plane which is perpendicular to the vector $\langle 3,2,1\rangle$ and passes through the point $(1,1,1)$.

(Express the plane in the format $0=ax+by+cz+d$. We provide the $0=$ for you, so you do not need to type that part.)

$0=$ 3*x+2*y+z-6 **Answer:** 3*x + 2*y + z -6

Solution:

To find the equation of the plane we can use the fact that for any other point in the plane (x,y,z) the vector from $(1,1,1)$ to (x,y,z), which is $\langle x-1,y-1,z-1\rangle$ is normal to the vector $\langle 3,2,1\rangle$. That is the dot product between these two vectors is zero.

Therefore equation of the plane is

$$\langle 3,2,1\rangle\cdot\langle x-1,y-1,z-1\rangle \;=\; 0 \qquad (6.261)$$
$$3\left(x-1\right)+2\left(y-1\right)+\left(z-1\right) \;=\; 0 \qquad (6.262)$$

, or equivalently, $\boxed{3x+2y+z-6=0.}$

Alternatively, we only need that a normal vector is $\langle 3,2,1\rangle$, so the plane takes the form $3x+2y+z+d=0$. We can plug in the point $(1,1,1)$ as it lies on the plane.

This gives

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$$3(1) + 2(1) + (1) + d = 0 \quad (6.263)$$
$$6 + d = 0 \quad (6.264)$$
$$d = -6 \quad (6.265)$$

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5A-4

2/2 points (graded)

Suppose that $f(x, y, z) = xz - yz^2 + xy$. Suppose that we start at the point $(2, 1, 1)$ and increase z slightly. Does f increase, decrease, or stay the same?

- ( ) f increases
- (•) f decreases
- ( ) f stays the same

✓

Is $f_z(2, 1, 1)$ positive, negative, or zero?

- ( ) positive
- ( ) negative
- (•) zero

✓

Solution:

A direct calculation yields

$$f(2, 1, 1 + t) - f(2, 1, 1) = -t^2 < 0.$$

Hence $\boxed{f \text{ decreases.}}$

Computing the partial derivative, you find that

$$f_z(x, y, z) = x - 2yz \quad (6.266)$$
$$f_z(2, 1, 1) = 2 - 2(1)(1) = 0 \quad (6.267)$$

Can you see why the function can both decrease as z increases, but have a zero partial derivative? (Hint, the function is not equal to its linear approximation.)

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5A-5

1/1 point (graded)
Let S be the surface defined by $x^2+4y^2+4z^2=3$. The point $(1,0.5,0.5)$ lies in S. Find a normal vector to the surface S at the point $(1,0.5,0.5)$. (It does not have to be a unit vector.)

[2,4,4]

✔ **Answer:** [2,4,4]

? INPUT HELP

Solution:

A normal vector is

$$\nabla\left(x^2+4y^2+4z^2\right)(1,0.5,0.5) = \langle 2x, 8y, 8z\rangle|_{(1,0.5,0.5)} \quad (6.268)$$

$$= \langle 2(1), 8(0.5), 8(0.5)\rangle \quad (6.269)$$

$$= \boxed{\langle 2,4,4\rangle.} \quad (6.270)$$

Note that any constant multiple is also correct.

Submit

You have used 1 of 3 attempts

Answers are displayed within the problem

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[STAFF] Which is the preferred answer?

discussion posted 2 days ago by **valleymd**

5A-4 has different answers depending upon whether the linear approximation approach is used with the gradient or if an actual calculation with a test value is used. Which is the desired approach?

This post is visible to everyone.

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1 response

yves-M (Community TA)
2 days ago

The first one is better. The second one has a flaw: think of $f(x)=x^3$ and what happens at $x=0$.

I used the first approach (the linear approximation with the gradient) as you suggested and was marked incorrect. My second approach (the direct calculation which was actually my first impulse) was the desired approach. Can this problem be reset so that I might get credit for realizing the difference in answers depending upon the approach used?

posted 2 days ago by **valleymd**

I have also used the method of linear approximation and the one based on the partial derivative. They both return the same answer .The direct calculation shows a different answer . It is problematic if one cannot have abs confidence in these tools even if the conditions to apply them are met. The origin of the error is not at all o

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to spot.

posted a day ago by **bdpedx**

I think the confusion arises from the fact that we often ask the opposite question: Is the sign of f_z positive, negative, or zero. But truly, despite the fact that the z direction is tangent to the level curve here, it is in fact increasing.

I guess this is a problem with how this question is posed! I will reword, reframe, and reset attempts.

posted a day ago by **jfrench** (Staff)

A variable change of 0.1% results in a total change of 0.0001%. As far as I'm concerned, for estimation purposes, that's staying the same.

posted about 7 hours ago by **mmark**

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