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Physics Assignment

1) $\psi(x,y,z) = 2xz^2 - x^2y$

Find the value of $\vec{\nabla}\psi$ and $|\vec{\nabla}\psi|$ at the point $(2,-2,-1)$

→ we are to compute
i) the gradient vector $\nabla\psi$
ii) the magnitude $|\nabla\psi|$ at the point $(2,-2,-1)$

compute gradient $\nabla\psi$

$$\nabla\psi = \left(\frac{\partial\psi}{\partial x}, \frac{\partial\psi}{\partial y}, \frac{\partial\psi}{\partial z}\right)$$

$$\frac{\partial\psi}{\partial x} = 2z^4 - 2xy$$

$$\frac{\partial\psi}{\partial y} = -x^2$$

$$\frac{\partial\psi}{\partial z} = 8xz^2$$

step2 : Evalute at $(x,y,z) = (2,-2,-1)$

$$\frac{\partial\psi}{\partial x} = 2(-1)^2 - 2(2)(-2) = 2+8 = 10$$

$$\frac{\partial\psi}{\partial y} = -2^2 = -4$$

$$\frac{\partial\psi}{\partial z} = 8(2)(-1)^3 = 8(2)(-1) = -16$$

so, $\nabla\psi\ (2,-2,-1) = (10, -4, -16)$

step -3 magnitude of gradient

$$|\nabla\psi| = \sqrt{10^2 + (-4)^2 + (-16)^2} = \sqrt{100+16+256}$$

$$= \sqrt{372}$$

$$|\nabla\psi| = 2\sqrt{93}$$

2) what is Gauss's Divergence theorem?

→ Gauss divergence theorem is a fundamental result in vector calculus that relates the flux of a vector field through a ~~calculus that relates~~ close surface to the divergence of the field inside the volume bounded by the surface.

Let $\vec{F}$ be a continuously differentiable vector field on region V enclosed by a closed surface s, then:

$$\boxed{\iint_s \vec{F} \cdot \hat{x}\, ds = \iiint_V (\Delta \cdot \vec{F})\, dv}$$

3) Starting from the consideration that the rate of loss of energy is equal to power dissipated to the damping establish the constitutes equation of damping

→ Let ε be mechanical energy of the system.

Pd be the power dissipated due to damping

$$\frac{\delta \varepsilon}{\delta t} = -P_d$$ [this represents that energy is lost due to damping]

power dissipated by damping force.

$$Fd = -cx$$

then power dissipated:

$$Pd = Fd \cdot \dot{x} = (-c\dot{x}) \cdot \dot{x} = -c\dot{x}^2$$

Equality rate of energy loss & power dissipated

$$\frac{\partial \varepsilon}{\partial t} = -Pd = c\dot{x}^2$$

This show how energy is lost at rate proportional to the square velocity with proportional constant c

constitutive equ^n of damping

$$\boxed{Fd = -c\dot{x}}$$

It is derived by equating the rate of energy loss to the power dissipated due to the damping force which is proportional to the square velocity.