

16.1 Multi-Variable Calc Notes

Vector Fields

If F is a vector field, then $F(x, y) = P(x, y)\mathbf{i} + Q(x, y)\mathbf{j} = \langle P(x, y), Q(x, y) \rangle \rightarrow F = P\mathbf{i} + Q\mathbf{j}$

Gradient Vector Fields

If f is a scalar function of two variables, then ∇f is a gradient vector field

Conservative Vector Fields

If a vector field is conservative, then the law of conservation of energy applies

There are 2 ways to check if a vector field is conservative.

- If the potential function exists, then the vector field is conservative. The potential function is the sum of each component integrated with respect to its corresponding variable, ignoring repeated terms

$$F(x, y) = \langle 2x^4 - 2y - y^2, z - 2x - 3xy^2, 6 + y + 8xz^2 \rangle$$

$$\int 2x^4 - 2y - y^2 \, dx \rightarrow 2xz^4 - 2xy - xy^2 + C$$

$$\int z - 2x - 3xy^2 \, dy \rightarrow yz - 2xy - xy^2 + C$$

$$\int 6 + y + 8xz^2 \, dz \rightarrow 6z + yz + 2xz^2 + C$$

$$\text{Potential function} = 2xz^4 - 2xy - xy^2 + yz + 6z + K$$

- If the mixed partials of the components equal each other, then the vector field is conservative. This only really works for 2-dimensional vector fields

$$F(x, y) = \langle 2xe^{xy} + x^2ye^{xy}, x^2e^{xy} + 2y \rangle$$

$$\frac{\partial}{\partial y} 2xe^{xy} + x^2ye^{xy} \rightarrow 2x^2e^{xy} + x^2ye^{xy} + x^2e^{xy} \rightarrow 3x^2e^{xy} + x^2ye^{xy}$$

$$\frac{\partial}{\partial x} x^2e^{xy} + 2y \rightarrow x^2ye^{xy} + 3x^2e^{xy}$$

The partials equal each other so the vector field is conservative

Multivariable Calculus Chapter 16

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