ENGINEERING MATHEMATICS - I

Partial Differentiation

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ENGINEERING MATHEMATICS - I

UNIT 2 : Partial Differentiation

Session : 2

Sub Topic : Higher Order Partial Derivatives, Geometrical Interpretation

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Higher Order Partial Derivatives

- The partial derivative $\frac{\partial f}{\partial x}$ obtained by differentiating once is known as first order partial derivatives.
- $\frac{\partial^2 f}{\partial x^2}$, $\frac{\partial^2 f}{\partial y^2}$, $\frac{\partial^2 f}{\partial x \partial y}$, $\frac{\partial^2 f}{\partial y \partial x}$ which are obtained by differentiating twice are known as second-order partial derivatives.
- Third, fourth and nth order derivatives involve 3, 4 or n times differentiation respectively.

Note :

A function of 2 variables has two first order derivatives, four second order derivatives and 2^n of nth order derivatives.

A function of m independent variables will have m^n derivatives of order n.

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Geometrical Interpretation of Partial differentiation

We know that the derivative of a single valued function gives the slope of the tangent line to the curve at the given point.

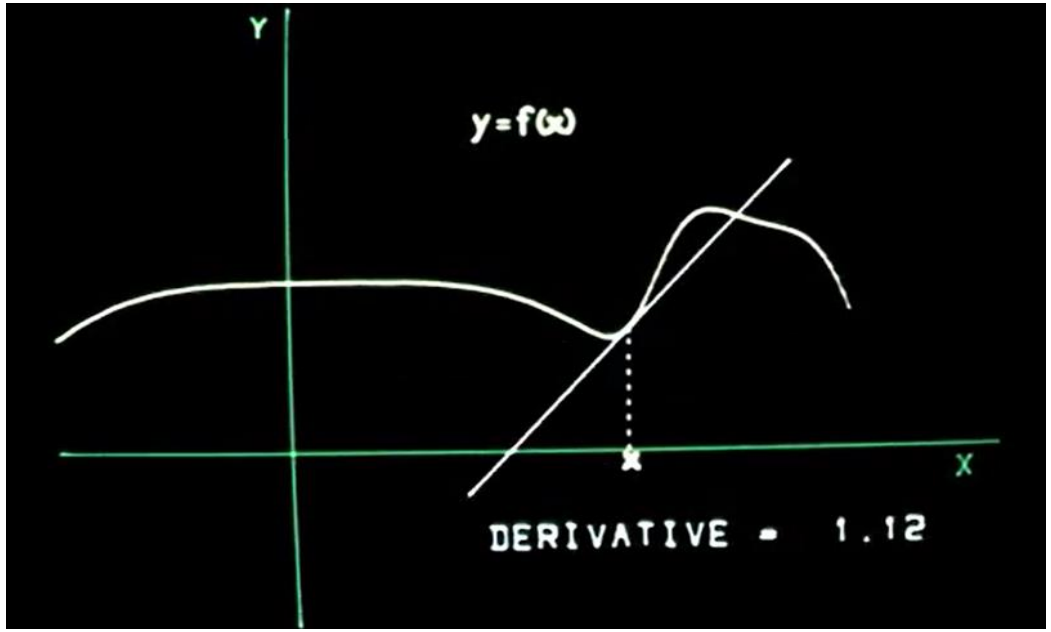

IMAGE SOURCE: https://www.youtube.com/watch?v=Q8mbXy0oJj8

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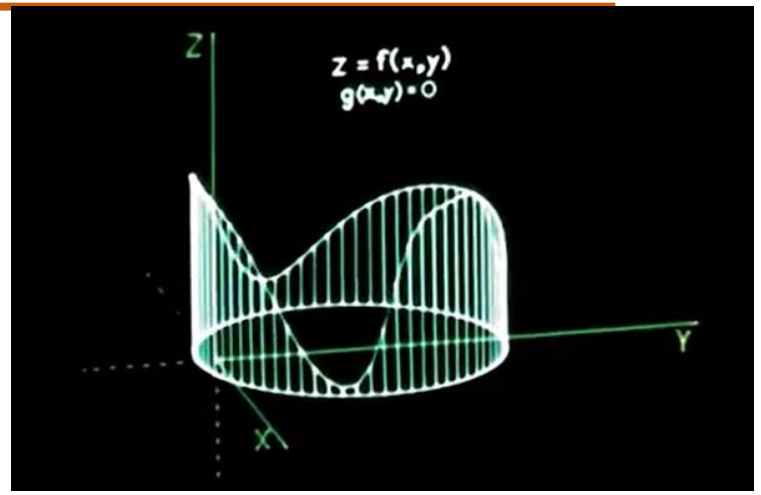
Geometrical Interpretation of Partial differentiation

If the points (x,y) lie on a circle in the xy plane, then z =f(x,y) is a curve which looks like the graph shown.



If the points (x,y) lie on a parabola in the xy plane, then z =f(x,y) is a curve which looks like the graph shown.

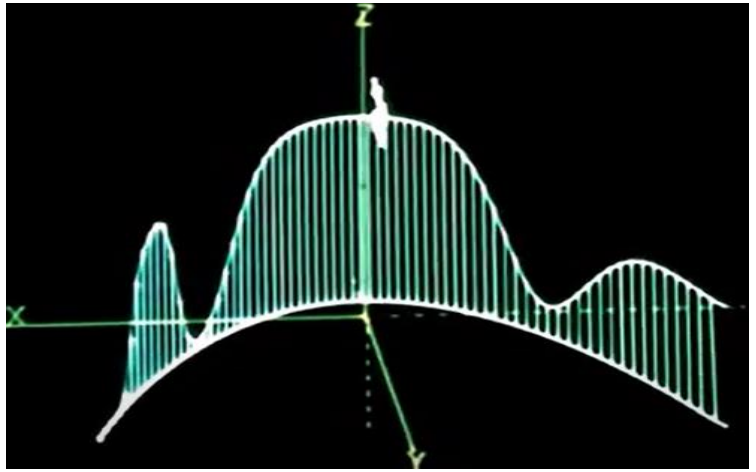


IMAGE SOURCE:
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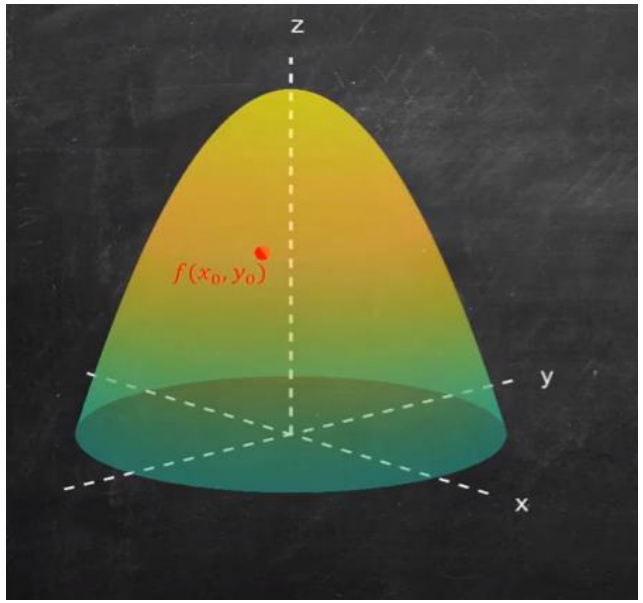
Geometrical Interpretation of Partial differentiation

Partial derivative of the function f(x,y) at the point (x_0, y_0) can be visualized as the slope of the tangent line along the direction of the independent variable with respect to which we would differentiate the function.



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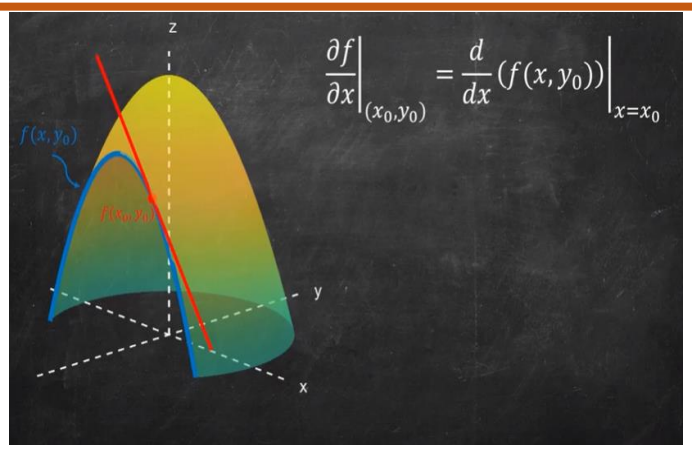
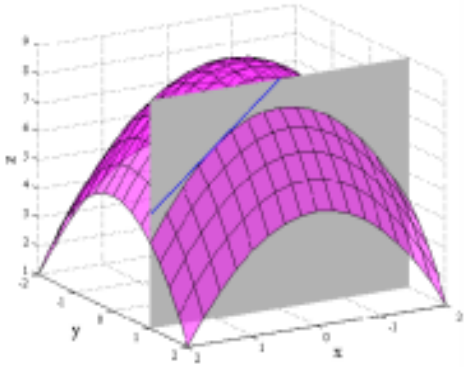
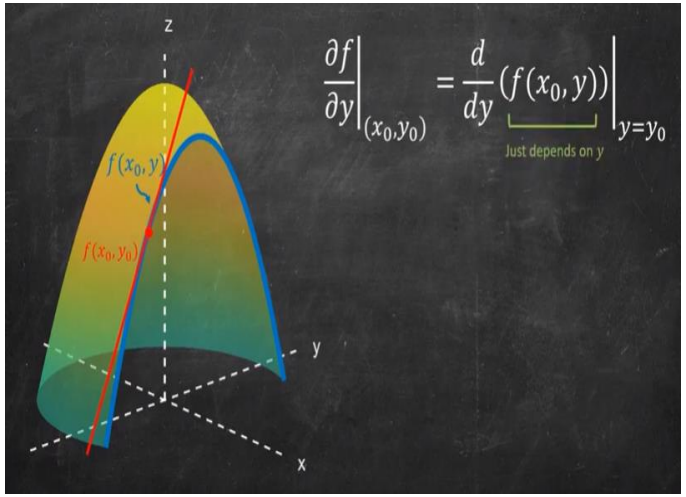
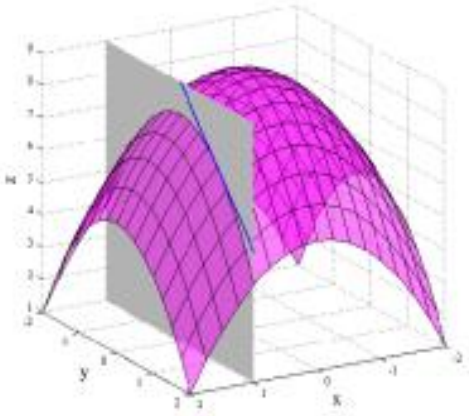
Geometrical Interpretation of Partial differentiation









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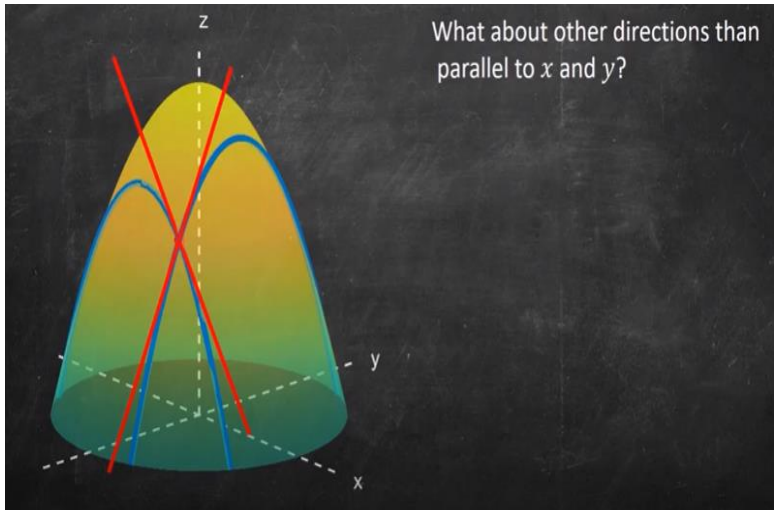
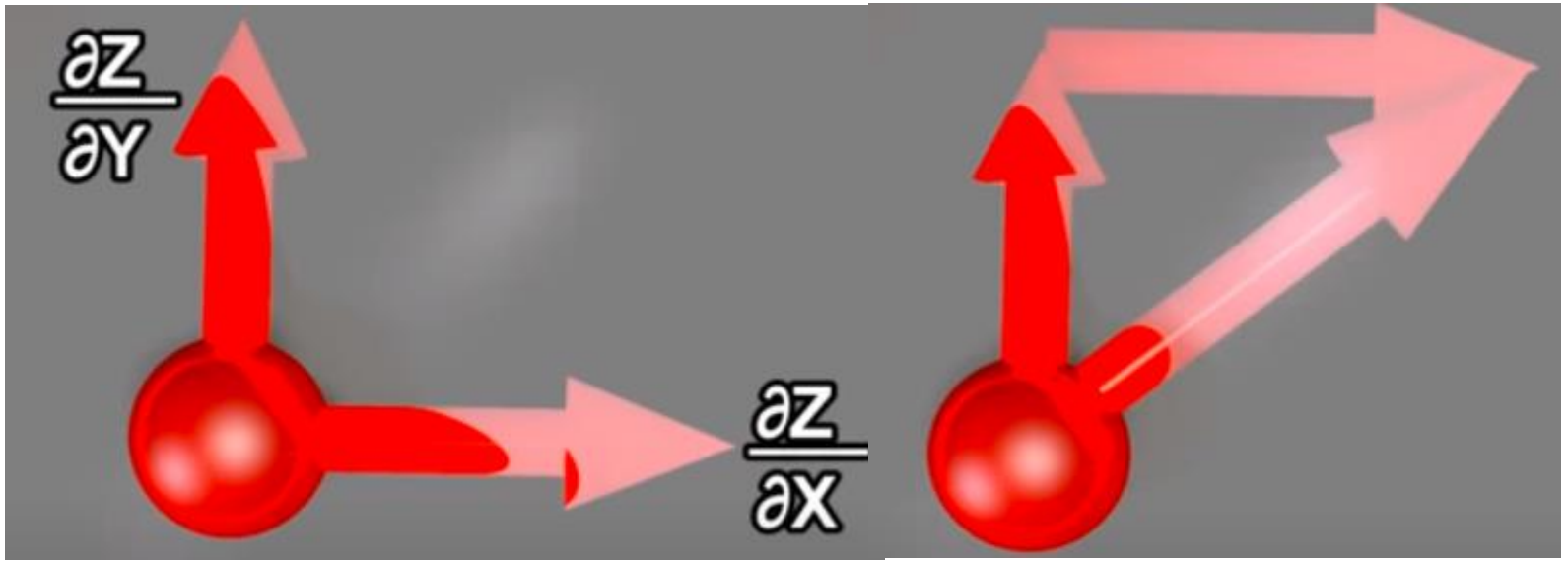
Slope of tangent along any arbitrary direction (Gradient of a function)





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Geometrical Interpretation of Partial differentiation

- If $f_{xx} > 0$ then f(x,y) is concave up in the x direction
- If $f_{yy} > 0$ then f(x,y) is concave up in the y direction.
- Mixed partials tell us how a partial in one variable is changing in the direction of the other.
- f_{xy} tells us how the rate of change of f(x,y) in the x direction is changing as we move in the y direction.

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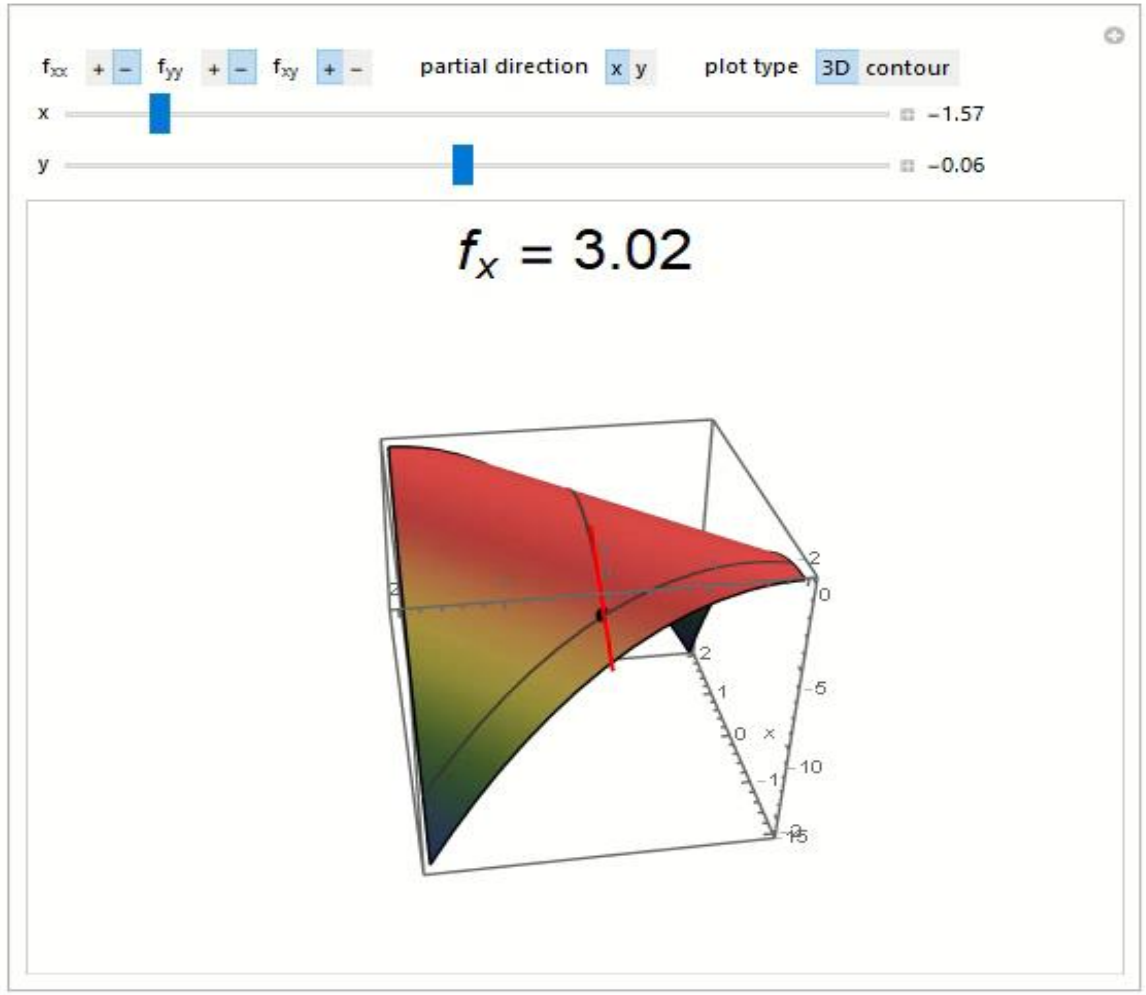
Geometrical Interpretation of Partial differentiation



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