 **Calculus III – MTH 283 – Part 1**

**Cleveland State University | Math Learning Center**

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| **Dot Product** | **Calculus of Vector Functions** |
| **Cross Product**  is orthogonal to both and and the direction is defined by the right hand rule | **Gradient and Directional Derivative**  Given the function , the point , the vector **v** and unit vector **u** in the direction of **v**  has its maximum rate of increase at in the direction of the gradient . The rate of increase is  has its maximum rate of decrease at in the direction of the gradient . The rate of decrease is  The directional derivative in zero in any direction orthogonal to |
| **Parameterization**  Given points |
| **Plane Equations**  The plane passing through the point with normal vector  Two planes are parallel/orthogonal if their normal vectors are parallel/orthogonal | **Tangent Plane and Linear Approximation**  Given and , the tangent plane is  For linear approximation, use the gradient for a point near the point of interest, then plug in the point of interest. |
| **Critical Points and Second Derivative Test**  A critical point exists if either of the following is true:  or at  Let   * If and , then has a local max at * If and , then has a local min at * If , then has a saddle point at * If , then the test is inconclusive |
| **Partial Derivatives**  Take the derivative of the variable given (the subscript) and hold the other variable constant |
| **Chain Rule**  Given and | **Polar and Cylindrical Coordinates** |

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