***Derivatives***

|  |  |  |
| --- | --- | --- |
| ***Constant Rule*** | , c is a constant |  |
| ***Constant Multiple Rule*** | , *c* is a constant |  |
| ***Sum and Difference Rules*** |  |  |
| ***Product Rule*** |  |  |
| ***Quotient Rule*** |  |  |
| ***Power Rules*** |  |  |
| ***Chain Rule*** |  |

|  |  |  |
| --- | --- | --- |
|  |  |  |
|  |  |  |





|  |  |  |
| --- | --- | --- |
| ***Trigonometric*** | | |
|  |  |  |
|  |  |  |
| ***Inverse Trigonometric*** | | |
|  |  |  |
|  |  |  |
| ***Hyperbolic*** | | |
|  |  |  |
|  |  |  |
|  |  |  |
| ***Inverse Hyperbolic*** | | |
|  |  |  |
|  |  |  |
| ***Exponential Rule*** | | |
|  |  |  |
|  |  |  |
| ***Derivative of Natural Log* (*ln*)** | | |
|  |  |  |
|  |  |  |

***Increasing and Decreasing Functions***

Suppose that  is continuous on [*a, b*] and differentiable on (*a, b*).

* If for all *x* in (*a, b*), then *f* is increasing on (*a, b*)
* If for all *x* in (*a, b*), then *f* is decreasing on (*a, b*)
* If for all *x* in (*a, b*), then *f* is constant on (*a, b*)

***Local Extrema***

* If  changes from negative to positive at *c*, then  has a local minimum (***LMIN***).
* If  changes from positive to negative at *c*, then  has a local maximum (***LMAX***).
* If doesn’t change sign at *c*, then  has no local extremum at *c*.

***Concavity***

Let *f* be function whose second derivative exists on an open interval *I*.

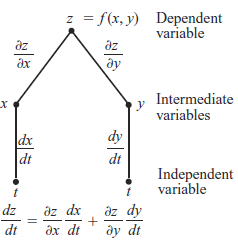
* If for all *x* in I, then *f* is ***concave up*** on I.
* If  for all *x* in I, then *f* is ***concave down*** on I.





***Partial Derivatives***

To compute  differentiate  treating *y* as a constant. 

***Chain Rule*** 

***Gradient Vector*** 

***Directional Derivative***: 

***Tangent Plane*** for  at :



***Tangent Plane to a Surface*** : 

***Second Derivative Test for Local Extrema***

* If  and  at (*a, b*), then *f* has a ***local maximum*** at (*a, b*).
* If  and  at (*a, b*), then *f* has a ***local minimum*** at (*a, b*).
* If  at (*a, b*), then *f* has a ***saddle point*** at (*a, b*).
* If  at (*a, b*), then ***the Test is inconclusive*** at (*a, b*).

***Lagrange Multipliers***

***One constraint***: Suppose that  and  are differentiable. To find the local maximum and minimum values of *f* subject to the constraint , find the values of *x*, *y*, *z*, and λ that simultaneously satisfy the equations



***Two constraints***: For constraints  and  *g* and *h* differentiable, find the values of *x*, *y*, *z*, and λ that simultaneously satisfy the equations

