ENGINEERING MATHEMATICS-I
MATLAB

Department of Science and Humanities

Finding partial derivative of a function:

Find the partial derivative of the following functions:

a) If $\mathrm{f} = \sin(x) + y^3 + x^{10} - y^2 + \log(x)$, then find f_x & f_y.

b) If $\mathrm{f} = x^2 + 2 * y^2 - 22$, then find $f_x{}^2$ & $f_y{}^2$.

c) If $\mathrm{f} = xy^3 + tanx + cos\sqrt{logx}$, then find f_x.

d) If $\mathrm{f} = {}^{\mathrm{xy}^3}/_{\mathrm{x+y}}$, then find $\mathrm{f_x}$; $\mathrm{f_y}$, $\mathrm{f_{xx}}$; f_{xy}; $\mathrm{f_{yx}}$.

Finding partial derivative of a function, Continued…

If $f = \sin(x) + y^3 + x^{10} - y^2 + \log(x)$, then find f_x & f_y.

```
syms x y

f=sin(x)+y^3+x^10-y^2+log(x);

diff(f,x)

diff(f,y)
```

Output:

$$f = \log(x) + \sin(x) + x^{10} - y^2 + y^3$$

$$ans = \cos(x) + \frac{1}{x} + 10x^9$$

$$ans = 3y^2 - 2y$$

Finding partial derivative of a function, Continued…

If f $= x^2 + 2 * y^2 - 22$, then find f_{xx} & f_{yy}.

```
syms x y
f=x^2+2*y^2-22
diff(f,x,2)
diff(f,y,2)
```

Output:

$$f = x^2 + 2y^2 - 22$$

$$ans = 2$$

$$ans = 4$$

Finding partial derivative of a function, Continued…

If f $= xy^3 + tanx + cos\sqrt{logx}$, then find f_x.

```
syms x y;
f=x*y^3+tan(x)+cos(sqrt(log(x)))
diff(f,x)
```

Output:

$$f = \cos\left(\sqrt{\log x}\right) + \tan(x) + xy^3$$

$$ans = \tan(x)^2 + y^3 - \frac{\sin\sqrt{\log(x)}}{2x\sqrt{\log(x)}} + 1$$

Finding partial derivative of a function, Continued…

If $f = {xy^3}/_{x+y}$, then find f_x; f_y,f_{xx}; f_{xy}; f_{yx}.

```
syms x y
f=(x*y^3)/(x+y)
diff(f,x)
diff(f,y)
diff(f,x,2)
diff(f, x, y)
diff(f, y, x)
```

Output: $f = \frac{xy^3}{x+y}$

Finding partial derivative of a function, Continued…

$$ans = \frac{y^3}{x+y} - \frac{xy^3}{(x+y)^2}$$

$$ans = \frac{3xy^2}{x+y} - \frac{xy^3}{(x+y)^2}$$

$$ans = \frac{2xy^3}{(x+y)^3} - \frac{2y^3}{(x+y)^2}$$

$$ans = \frac{3y^2}{x+y} - \frac{y^3}{(x+y)^2} - \frac{3xy^2}{(x+y)^2} + \frac{2xy^3}{(x+y)^3}$$

$$ans = \frac{3y^2}{x+y} - \frac{y^3}{(x+y)^2} - \frac{3xy^2}{(x+y)^2} + \frac{2xy^3}{(x+y)^3}$$

Note that $f_{xy} = f_{yx}$.

Finding partial derivative of a function, Continued…

If u $= x^2y + y^2z + z^2x$, find the first order partial derivative of u.

```
syms x y z
u=x^2*y+y^2*z+z^2*x
diff(u,x,1)
diff(u,y,1)
diff(u,z,1)
```

Output:

$$u = x^2y + xz^2 + y^2z$$

$$ans = z^2 + 2xy$$

$$ans = x^2 + 2yz$$

$$ans = y^2 + 2xz$$

Finding partial derivative of a function, Continued…

If $z = \sin 2x + 3y$, find the first order partial derivative of z.

```
syms x y

z=sin(2*x)+3*y;

diff(z,x,1)

diff(z,y,1)
```

Output:

$$ans = 2\cos(2x)$$

$$ans = 3$$

Finding partial derivative of a function, Continued…

If $u = \sqrt{x^2 + y^2 + z^2} + tan^{-1}(xy)$, find the first order partial derivative of u.

```
syms x y z
u=sqrt(x^2+y^2+z^2)+atan(x*y);
 diff(u,x,1)
diff(u,y,1)
 diff(u,z,1)
```

Finding partial derivative of a function, Continued…

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Output: Ans: $\frac{x}{\sqrt{x^2+y^2+z^2}} + \frac{y}{x^2y^2+1}$

Ans: $\frac{y}{\sqrt{x^2+y^2+z^2}} + \frac{x}{x^2y^2+1}$

Ans: $\frac{z}{\sqrt{x^2+y^2+z^2}}$

Finding partial derivative of a function, Continued...

Find all the second partial derivatives of f$(x, y) = log\left(\frac{1}{x} - \frac{1}{y}\right)$ at 1,2.

```
syms x y

f=log(1/(x)-1/(y))

a(x,y)=diff(f,x,2)

b(x,y)=diff(f,y,2)

c(x,y)=diff(f,x,y)

d(x,y)=diff(f,y,x)
```

Finding partial derivative of a function, Continued…

Cont...

a(1,2)

b(1,2)

c(1,2)

d(1,2)

Finding partial derivative of a function, Continued...

Output: $f = \log(\frac{1}{x} - \frac{1}{y})$

$$a(x, y) = \frac{2}{x^3\left(\frac{1}{x} - \frac{1}{y}\right)} - \frac{1}{x^4\left(\frac{1}{x} - \frac{1}{y}\right)^2}$$

$$b(x, y) = -\frac{2}{y^3\left(\frac{1}{x} - \frac{1}{y}\right)} - \frac{1}{y^4\left(\frac{1}{x} - \frac{1}{y}\right)^2}$$

$$c(x, y) = \frac{1}{x^2y^2\left(\frac{1}{x} - \frac{1}{y}\right)^2}$$

$$d(x, y) = \frac{1}{x^2y^2\left(\frac{1}{x} - \frac{1}{y}\right)^2}$$

Finding partial derivative of a function, Continued…

OUTPUT

a(1,2)=0

b(1,2)=-3/4

c(1,2)=1

d(1,2)=1

Finding partial derivative of a function, Continued…

If u $= e^{xy+yz+zx}$, then find $u_{xy}; u_{yz}; u_{zx}$.

```
syms x y z

u=exp(x*y+y*z+z*x);

diff(u,x,y)

diff(u,y,z)

diff(u,z,x)
```

Finding partial derivative of a function, Continued…

Output: $u = e^{xy+xz+yz}$

Ans: $e^{xy+xz+yz} + e^{xy+xz+yz}(x+z)(y+z)$

Ans: $e^{xy+xz+yz} + e^{xy+xz+yz}(x+y)(x+z)$

Ans: $e^{xy+xz+yz} + e^{xy+xz+yz}(x+y)(y+z)$

Finding partial derivative of a function, Continued…

If $f = e^{xyz}$, then find f_{xyz}; f_{xxz}; f_{yyz}

```
syms x y z

 f=exp(x*y*z);

 diff(f,x,y,z)

 diff(f,x,x,z)

 diff(f,y,y,z)
```

Finding partial derivative of a function, Continued…

Output:

$$f = e^{xyz}$$

Ans:$e^{xyz} + 3e^{xyz}xyz + e^{xyz}x^2y^2z^2$

Ans: $2e^{xyz}y^2z + e^{xyz}xy^3z^2$

Ans: $2e^{xyz}x^2\ z + e^{xyz}x^3yz^2$

Taylor's and Macluarin's series expansion of a function of single variable:

Expand f(x)=e^{xsinx} about the point $\mathrm{x} = 2$ up to two degree terms.

```
syms x

f = exp(x*sin(x));

t= taylor(f, 'ExpansionPoint', 2, 'Order', 3)
```

Output: $$t = e^{2\sin(2)} + e^{2\sin(2)}(2\cos(2) + \sin(2))(x-2) + e^{2\sin(2)}(x-2)^2\left(\cos(2) - \sin(2) + (2\cos(2) + \sin(2))\left(\cos(2) + \frac{\sin(2)}{2}\right)\right)$$

Taylor’s and Macluarin’s series expansion of a function of single variable:

Expand f(x)=log(cosx) about the point $x = \frac{\pi}{3}$ up to fifth degree terms.

```
syms x

f = log(cos(x));

t= taylor(f, 'ExpansionPoint', pi/3, 'Order', 6)
```

Output:

$$-\log 2-\sqrt{3}\left(x-\frac{\pi}{3}\right)-\frac{4\sqrt{3}\left(x-\frac{\pi}{3}\right)^{3}}{3}-\frac{44\sqrt{3}\left(x-\frac{\pi}{3}\right)^{5}}{15}-2\left(x-\frac{\pi}{3}\right)^{2}-\frac{10(x-\frac{\pi}{3})^{4}}{3}$$

Taylor’s and Macluarin’s series expansion of a function of single variable:

Expand f(x)=log(secx) about the origin up to six degree terms.

```
syms x

f = log(sec(x));

T= taylor(f, 'Order', 7)
```

Output:

$$T = \frac{x^6}{45} + \frac{x^4}{12} + \frac{x^2}{2}$$

Taylor’s and Macluarin’s series expansion of a function of single variable:

Expand f(x)=sin(log(x^2+2x+1)) about the origin up to six degree terms.

```
syms x

f = sin(log(x^2+2*x+1));

T= taylor(f, 'Order', 7)
```

Output:

$$T = \frac{3x^6}{2} - \frac{5x^5}{3} + \frac{3x^4}{2} - \frac{2x^3}{3} - x^2 + 2x$$

Taylor’s and Macluarin’s series expansion of a function of two variables:

Expand $\mathrm{f(x,y)} = \mathrm{e^x} cosy$ about the point $x = 1, y = \frac{\pi}{4}$ up to three degree terms.

```
syms x y
f=exp(x)*cos(y);
t = taylor(f, [x, y], [1, pi/4], 'Order', 4)
```

Output:

$$t = \frac{\sqrt{2}e}{2} - \frac{\sqrt{2}e\sigma_1}{4} + \frac{\sqrt{2}e\left(y-\frac{\pi}{4}\right)^3}{12} + \frac{\sqrt{2}e(x-1)^2}{4} + \frac{\sqrt{2}e(x-1)^3}{12} - \frac{\sqrt{2}e(y-\frac{y}{4})}{2} + \frac{\sqrt{2}e(x-1)}{2} - \frac{\sqrt{2}e\left(y-\frac{\pi}{4}\right)(x-1)}{2} - \frac{\sqrt{2}e\left(y-\frac{\pi}{2}\right)(x-1)^2}{4} - \frac{\sqrt{2}e\sigma_1(x-1)}{4}$$

Where

$$\sigma_1 = (y - \frac{\pi}{4})^2$$

Taylor's and Macluarin's series expansion of a function of two variables:

Expand $\mathrm{f}(\mathrm{x},\mathrm{y}) = x^3 + y^3 + xy^2$ about $x = 1, y = 2$ up to fourth degree terms.

```
syms x y

f=x^3+y^3+x*y^2;

t = taylor(f, [x, y], [1, 2], 'Order', 5)
```

Output:

$$t = 7x + 16y + 4(x-1)(y-2) + 3(x-1)^2 + (x-1)^3 + 7(y-2)^2 + (y-2)^3 + (x-1)(y-2)^2 - 26$$

Taylor’s and Macluarin’s series expansion of a function of two variables:

Expand $f(x, y) = e^{y} \log(1 + x)$ about the origin up to fourth degree

terms.

```
syms x y

f=exp(y)*log(1+x);

T= taylor(f, [x, y], 'Order', 5)
```

Output:

$$T = -\frac{x^4}{4} + \frac{x^3 y}{3} + \frac{x^3}{3} - \frac{x^2 y^2}{4} - \frac{x^2 y}{2} - \frac{x^2}{2} + \frac{x y^3}{6} + \frac{x y^2}{2} + xy + x$$

Taylor's and Macluarin's series expansion of a function of two variables:

Expand $f(x,y) = e^{x}\tan y$ about the origin up to fifth degree

terms.

```
syms x y

f=exp(x)*tan(y);

T= taylor(f, [x, y], 'Order', 6)
```

Output:

$$T = \frac{x^4 y}{24} + \frac{x^3 y}{6} + \frac{x^2 y^3}{6} + \frac{x^2 y}{2} + \frac{x y^3}{3} + xy + \frac{2y^5}{15} + \frac{y^3}{3} + y$$

THANK YOU