WEEK2

```
%circle with centre (1, 3)
clc
clear all
t = linspace(0, 2*pi, 101);
x = 1 +2*cos(t);
y = 3 +2*sin(t);
plot(x,y,'r.')
axis equal
xlabel('x-axis')
ylabel('y-axis')
title('Circle')

% graph by using without hold on function
y = linspace(-10,10,1000)
plot(y,cos(y),'b.',y,cos(2*y),'g.')
xlabel('x axis')
ylabel('y axis')
legend('cos(x)','cos(2x)','location','northeast')

%Draw the surface by using plot3
t=linspace(0,2*pi,500);
x=cos(t);
y=sin(t);
z=sin(5*t);
comet3(x,y,z)
plot3(x,y,z,'g*','markersize',7)
xlabel('x-axis')
ylabel('y-axis')
zlabel('z-axis')
title('3D Curve')

%Draw the four curves sinx, cosx, e-x, sin3x in one window
x=0:.1:2*pi;
subplot(2,2,1);
plot(x,sin(x),'b*');
title('sin(x)')
subplot(2,2,2);
plot(x,cos(x),'r-o');
title('cos(x)')
subplot(2,2,3)
plot(x,exp(-x),'g.');
title('exp(-x)')
subplot(2,2,4);
plot(x,sin(3*x),'m-o');
title('sin(3x)')

%Draw the surface by using ezsurf and ezplot
syms x y
f = 2*(x^2+y^2)
ezsurf(f)
colormap cool

%Draw the ezplot for the function x^2+2*x-6
syms x
y = x^2+2*x-6
ezplot(y)
```

```
%
x=-1:.05:1;
y=-1:.05:1;
[x,y]=meshgrid(x,y);
z=x.*y.^2-x.^3
surf(x,y,z);
colormap spring
shading interp

%Find df/dx, if f(x) = x2 + cos(2x) + 4 sin(x) + e^x
syms x
f= x^2+cos(2*x)+4*sin(x)+exp(x)
diff(f,x) % differentiate f w.r.t x
diff(f,x,2)

%integrate
syms x
f= 3*x-x^2;
int(f,x,0,3)
```

WEEK3

```
% MATLAB code for visualizing local maxima and minima (using first and second derivative test)and visualizing concavity,this code willwork for polynomial of degree 2 or more.
clc
clear all
syms x real
f= input('Enter the function f(x):');
fx= diff(f,x);
c = solve(fx);
cmin = min(double(c));
cmax = max(double(c));
figure(1)
ezplot(f,[cmin-2,cmax+2])
hold on
fxx= diff(fx,x);
for i = 1:1:size(c)
    T1 = subs(fxx, x ,c(i) );
    T3= subs(f, x, c(i));
    if (double(T1)==0)
        sprintf('The point x is %d inflecionpoint',double (c(i)))
    else
        if (double(T1)<0)
            sprintf('The maximum point x is %d', double(c(i)))
            sprintf('The value of the function is %d', double (T3))
        else
            sprintf('The minimum point x is %d', double(c(i)))
            sprintf('The value of the function is %d', double (T3))
        end

    end
    plot(double(c(i)), double(T3), 'r*', 'markersize', 15);

end
% plotting inflection points for testing concavity
de=polynomialDegree(fxx);
if(de==0)
```

```
sprintf('the given polynomial is second degree or less')
else
d = solve(fxx); % finding inflection points
for i = 1:1:size(d)
T2 = subs(f, x ,d(i) );
plot(double(d(i)), double(T2), 'g*', 'markersize', 15);
end
end
% Identifying maxima and minima through first derivative test
figure(2)
ezplot(fx,[cmin-2,cmax+2])
title('Plotting first derivative of f and critical points')
hold on
for i = 1:1:size(c)
T4 = subs(fx, x ,c(i) );
plot(double(c(i)), double(T4), 'r*', 'markersize', 15);
end
figure(3)
ezplot(fxx,[cmin-2,cmax+2])
hold on
if(de==0)
sprintf('the given polynomial is second degree or less, second derivative plot is
not possible')
else
for i = 1:1:size(d)
T4 = subs(fxx, x ,d(i) );
plot(double(d(i)), double(T4), 'r*', 'markersize', 15);
end
title('Plotting second derivative of f and inflection points')
end
```

WEEK4

```
%To find the area of the regions enclosed by curves and visualize it
clc
clear all
syms x y real
y1=input('ENTER THE first(f) curve');
y2=input('ENTER THE second(g) curve');
fg=figure;
ax=axes;
t=solve(y1-y2);
k=double(t)
n=length(k)
m1=min(k)
m2=max(k)
ez1=ezplot(y1,[m1-1,m2+1]);
hold on
TA=0;
ez2=ezplot(y2,[m1-1,m2+1]);
if n>2
    for i=1:n-1
        A=int(y1-y2,t(i),t(i+1))
        TA= TA+abs(A)
        x1 = linspace(k(i),k(i+1));
        yy1 =subs(y1,x,x1);
        yy2 = subs(y2,x,x1);
        x1 = [x1,fliplr(x1)];
```

```
        yy = [yy1,fliplr(yy2)];
        fill(x1,yy,'g')
        grid on
    end
else
    A=int(y1-y2,t(1),t(2))
    TA=abs(A)
    x1 = linspace(k(1),k(2));
    yy1 =subs(y1,x,x1);
    yy2 = subs(y2,x,x1);
    x1 = [x1,fliplr(x1)];
    yy = [yy1,fliplr(yy2)];
    fill(x1,yy,'g')
end
```

WEEK6

```
% Partial Derivatives for functions two variables
clc
clear all
syms x y
z = input("Enter the two dimensional function f(x,y): ");
x1 = input("enter the x value at which the derivative has to be evaluated:");
y1 = input("enter the y value at which the derivative has to be evaluated: ");
z1 = subs(subs(z,x,x1),y,y1)
ezsurf(z,[x1-2 x1+2])
f1 = diff(z,x)
slopex = subs(subs(f1,x,x1),y,y1);
[x2,z2]=meshgrid(x1-2:.25:x1+2,0:0.5:10);
y2=y1*ones(size(x2));
hold on
h1=surf(x2,y2,z2);
set(h1,"FaceColor",[0.7,0.7,0.7],"EdgeColor","none")
t=linspace(-1,1);
x3=x1+t;
y3=y1*ones(size(t));
z3=z1+slopex*t;
line(x3,y3,z3,"color","blue","linewidth",2)

% Local maxima and minima for two variables
clc
clear all
syms x y k T3 real
f = input('Enter the function f(x,y): ');
fx = diff(f,x);
fy = diff(f,y);
[ax ay] = solve(fx,fy);
fxx = diff(fx,x);
D = fxx*diff(fy,y) - diff(fx,y)^2;
r=1;
for k=1:1:size(ax)
    if((imag(ax(k))==0)&&(imag(ay(k))==0))
        ptx(r)=ax(k);
        pty(r)=ay(k);
        r=r+1
    end
end
a1=max(double(ax))
```

```
a2=min(double(ax))
b1=max(double(ay))
b2=min(double(ay))
ezsurf(f,[a2-.5,a1+.5,b2-.5,b1+.5])
colormap('summer');
shading interp
hold on
for r1=1:1:(r-1)
    T1=subs(subs(D,x,ptx(r1)),y,pty(r1));
    T2=subs(subs(fxx,x,ptx(r1)),y,pty(r1));
    if(double(T1) == 0)
        sprintf('The point (x,y) is (%d,%d) and need further investigation',
double(ptx(r1)),double(pty(r1)))
    elseif(double(T1) < 0)
        T3=subs(subs(f,x,ptx(r1)),y,pty(r1))
        sprintf('The point (x,y) is (%d,%d) a saddle point',
double(ptx(r1)),double(pty(r1)))
        plot3(double(ptx(r1)),double(pty(r1)),double(T3),'b.','markersize',30);
    else
        if(double(T2) < 0)
            sprintf('The maximum point(x,y) is (%d, %d)',
double(ptx(r1)),double(pty(r1)))
            T3=subs(subs(f,x,ptx(r1)),y,pty(r1))
            sprintf('The value of the function is %d', double(T3))

plot3(double(ptx(r1)),double(pty(r1)),double(T3),'r+','markersize',30);
        else
            sprintf('The minimum point(x,y) is (%d, %d)',
double(ptx(r1)),double(pty(r1)))
            T3=subs(subs(f,x,ptx(r1)),y,pty(r1))
            sprintf('The value of the function is %d', double(T3))

plot3(double(ptx(r1)),double(pty(r1)),double(T3),'m*','markersize',30);
        end
    end
end
```

WEEK7

```
%Lagranage’s Multiplier Method for two variables
clc
clear all
syms x y lam real
f= input('Enter f(x,y) to be extremized : ');
g= input('Enter the constraint function g(x,y) : ');
F=f+lam*g;
Fd=jacobian(F,[x y lam]);
[ax,ay,alam]=solve(Fd,x,y,lam);
ax=double(ax); ay=double(ay);
T = subs(f,{x,y},{ax,ay}); T=double(T);
epxl=min(ax);
epxr=max(ax);
epyl=min(ay);
epyu=max(ay)
D=[epxl-0.5 epxr+0.5 epyl-0.5 epyu+0.5 ]
ezcontourf(f,D)
hold on
h = ezplot(g,D);
set(h,'Color',[1,0.7,0.9])
```

```
for i = 1:length(T)
    fprintf('The critical point (x,y) is (%1.3f,%1.3f).',ax(i),ay(i))
    fprintf('The value of the function is %1.3f\n',T(i))
    plot(ax(i),ay(i),'k.','markersize',15)
end
TT=sort(T);
f_min=TT(1)
f_max=TT(end)
```

WEEK9

```
%triple integral
syms x y z
sol = int(int(int(3*x*y,z,0,x+y),y,0,x),x,0,2)

%triple integral
syms x y z
sol = int(int(int(6*x*y,z,0,1+x+y),y,0,sqrt(x)),x,0,1)
viewsolid(z,0+0*x*y,1+x+y,y,0+0*x,sqrt(x),x,0,1);
axis equal; grid on;

%triple integral
syms x y z
sol = int(int(int(y,z,0,4-2*x-2*y),y,0,2-x),x,0,2)
viewSolid(z,0+0*x*y,4-2*x-2*y,y,0+0*x,2-x,x,0,2);
axis equal; grid on;
```

A solid E lies within the cylinder $\boldsymbol{x}\,\mathbf{2} + \boldsymbol{y}\,\mathbf{2} = \mathbf{1}$, below the plane z =4, and above the paraboloid $\boldsymbol{z} = \mathbf{1}$ − ($\boldsymbol{x}\,\mathbf{2} + \boldsymbol{y}\,\mathbf{2}$). The density at any point is proportional to its distance from the axis of the cylinder. Find the mass of E.

```
syms r z theta K
Ma= int(int(int((K*r)*r, z, 1-r^2,4), r ,0, 1),theta,0,2*pi) % integration
x = r*cos(theta), y = r*sin(theta), s = sym(4)
fsurf(x,y,1-r^2, [0 1 0 2*pi], 'g', 'EdgeColor', 'none'); % plotting paraboloid
hold on
fsurf(1*cos(theta), 1*sin(theta), r, 'y', [0 4 0 2*pi], 'EdgeColor', 'none') %
plotting
cylinder of radius 1 with height z = 4
fsurf(x,y,s, [0 1 0 2*pi], 'b', 'EdgeColor', 'none'); % plotting circular plane
z=4.
hold on
axis equal; xlabel('x'); ylabel('y'); zlabel('z');
alpha 0.5


%draw the solid enclosed by the paraboloids 𝒛 = 𝒙2 + 𝒚2 and z= 𝟓 − 𝒙2
%− 𝒚2
syms r z theta
x = r*cos(theta); y = r*sin(theta);
fsurf(x,y,5-r^2,[0 sqrt(5) 0 2*pi], 'g', 'EdgeColor', 'none');
hold on
fsurf(x,y,r^2, [0 sqrt(5) 0 2*pi], 'y', 'EdgeColor', 'none');
axis equal; xlabel('x'); ylabel('y'); zlabel('z');
alpha 0.5
```

Evaluate $\iiint_E e^z\, dV$, where E is enclosed by the paraboloid $z = 1 + x^2 + y^2$, the cylinder $x^2 + y^2 = 5$, and the xy-plane.

Sol

By Converting Cartesian to Cylindrical coordinates we get

$$\iiint_E e^z\, dV = \int_0^{2\pi} \int_0^{\sqrt{5}} \int_0^{1+r^2} e^z\, r dz dr d\theta$$

```
syms x y r z theta
Sol= int(int(int(exp(z)*r,z,0,1+r^2),r,0,sqrt(5)),theta,0,2*pi) % integration
f=1+(x^2+y^2);
fsurf(f,[-sqrt(5) sqrt(5) -sqrt(5) sqrt(5)])
hold on
fsurf(sqrt(5)*cos(theta), sqrt(5)*sin(theta), r, 'y', [0 8 0 2*pi], 'EdgeColor',
'none')
alpha 0.5


%Draw a sphere of radius 5 with centre at (0,0,0)
syms r z phi rho theta
rho=5
x= rho*sin(phi)*cos(theta), y = rho*sin(phi)*sin(theta), z= rho*cos(phi) ;
fsurf(x,y,z, [0 pi 0 2*pi], 'g', 'MeshDensity', 20);


%Draw a hemisphere of radius 3 with centre at (0,0,0)
syms r z phi rho theta
rho=3
x= rho*sin(phi)*cos(theta), y = rho*sin(phi)*sin(theta), z= rho*cos(phi) ;
fsurf(x,y,z, [0 pi/2 0 2*pi], 'g', 'MeshDensity', 20);
```

Example 9

Evaluate $\iiint_E e^{\sqrt{x^2+y^2+z^2}}\, dV$, where E is enclosed by the sphere $x^2 + y^2 + z^2 = 9$ in the first octant.

Sol: By Changing Cartesian to Spherical coordinates we can get

$$\iiint_E e^{\sqrt{x^2+y^2+z^2}}\, dV = \int_0^{\pi/2} \int_0^{\pi/2} \int_0^{3} \rho^2 e^{\rho} \sin\phi \, d\rho\, d\phi\, d\theta$$

```
syms r phi rho theta
Sol=int(int(int((exp(rho))*(rho)^2*sin(phi), rho,0,3), phi ,0,pi/2),theta,0,pi/2)
rho=3
x = rho*sin(phi)*cos(theta), y = rho*sin(phi)*sin(theta), z =
rho*cos(phi) ;
fsurf(x,y,z, [0 pi/2 0 pi/2], 'g', 'MeshDensity', 20);
```

Example 10

Evaluate $\iiint_E z\,dV$, where E is enclosed by the spheres $x^2+y^2+z^2=1$ and $x^2+y^2+z^2=4$ in the first octant.

Sol: By Changing Cartesian to Spherical coordinates we can get

$$\iiint_E z\,dV = \int_0^{\pi/2}\int_0^{\pi/2}\int_1^{2}(\rho\cos\phi)\rho^2\sin\phi\,d\rho\,d\theta\,d\phi$$

```
clc
clear all
syms r phi rho theta
Sol=int(int(int((rho*cos(phi))*(rho)^2*sin(phi), rho,1,2), phi ,0,
pi/2),theta,0,pi/2)
rho=1;
x = rho*sin(phi)*cos(theta), y = rho*sin(phi)*sin(theta), z = rho*cos(phi) ;
fsurf(x,y,z, [0 pi/2 0 pi/2], 'g', 'MeshDensity', 20);
hold on
rho=2;
x = rho*sin(phi)*cos(theta), y = rho*sin(phi)*sin(theta), z = rho*cos(phi) ;
fsurf(x,y,z, [0 pi/2 0 pi/2], 'b', 'MeshDensity', 20);
```

WEEK10

```
%Draw the two dimensional vector field for the vector xi +yj
clc
clear all
syms x y
F=input('enter the vector as i, and j order in vector form:');
P = inline(vectorize(F(1)), 'x', 'y');
Q = inline(vectorize(F(2)), 'x', 'y');
x = linspace(-1, 1, 10);
y = x;
[X,Y] = meshgrid(x,y);
U = P(X,Y);
V = Q(X,Y);
quiver(X,Y,U,V,1)
axis on
xlabel('x')
ylabel('y')
```

```
%Draw the three dimensional vector field for the vector xi -yj +zk
syms x y z
F=input('enter the vector as i,j and k order in vector form:')
P = inline(vectorize(F(1)), 'x', 'y','z');
Q = inline(vectorize(F(2)), 'x', 'y','z');
R = inline(vectorize(F(3)), 'x', 'y','z');
x = linspace(-1, 1, 5);
y = x;
z=x;
[X,Y,Z] = meshgrid(x,y,z);
U = P(X,Y,Z);
V = Q(X,Y,Z);
```

```
W = R(X,Y,Z);
quiver3(X,Y,Z,U,V,W,2)
axis on
xlabel('x')
ylabel('y')
zlabel('z')
```

% Find the gradient vector field of$(x, y) = x\ 2y - y\ 3$. Plot the gradient vector field together with a contour map of f. How are they related?

```
clc
clear all
syms x y
f=input('enter the function f(x,y):');
F=gradient(f)
P = inline(vectorize(F(1)), 'x', 'y');
Q = inline(vectorize(F(2)), 'x','y');
x = linspace(-2, 2, 10);
y = x;
[X,Y] = meshgrid(x,y);
U = P(X,Y);
V = Q(X,Y);
quiver(X,Y,U,V,1)
axis on
xlabel('x')
ylabel('y')
hold on
ezcontour(f,[-2 2])
```

Example 4

Find (a) the curl and (b) the divergence of the vector field.

$$\mathbf{F}(x, y, z) = x^2yz\,\mathbf{i} + xy^2z\,\mathbf{j} + xyz^2\,\mathbf{k}$$

```
clc
clear all
syms x y z real
F=input('enter the vector as i, j and k order in vector form:')
curl_F = curl(F, [x y z])
div_F = divergence(F, [x y z])
```

Example 5

Determine whether or not the vector field $\mathbf{F}(x, y, z) = y^2z^3\,\mathbf{i} + 2xyz^3\,\mathbf{j} + 3xy^2z^2\,\mathbf{k}$ is conservative. If it is conservative, find a function f such that $\mathbf{F} = \nabla f$..

```
clc
clear all
syms x y z real
F=input('enter the vector as i,j and k order in vector form:')
curl_F = curl(F, [x y z])
if(curl_F ==[0 0 0])
f = potential(F, [x y z])
```

```
else
sprintf('curl_F is not equal to zero')
end
```

WEEK11

```
%line integral
clc
clear all
syms t x y
f=input('enter the f vector as i and j order in vector form:');
rbar = input('enter the r vector as i and j order in vector form:');
lim=input('enter the limit of integration:');
vecfi=input('enter the vector field range'); % knowledge of the
curve is essential
drbar=diff(rbar,t);
sub = subs(f,[x,y],rbar);
f1=dot(sub,drbar)
int(f1,t,lim(1),lim(2))
P = inline(vectorize(f(1)), 'x', 'y');
Q = inline(vectorize(f(2)), 'x', 'y')
x = linspace(vecfi(1),vecfi(2), 10);
y = x;
[X,Y] = meshgrid(x,y);
U = P(X,Y);
V = Q(X,Y);
quiver(X,Y,U,V)
hold on
fplot(rbar(1),rbar(2),[lim(1),lim(2)])
axis on
xlabel('x')
ylabel('y')
```

Example 1

Evaluate $\oint_C \left(3y - e^{\sin(x)}\right)dx + \left(7x + \sqrt{y^4 + 1}\right)dy$, where C is the circle $x^2 + y^2 = 9$.

```
%green's theorem
clc
clear all
syms x y r t
F=input('enter the F vector as i and j order in vector form:');
integrand=diff(F(2),x)-diff(F(1),y);
polarint=r*subs(integrand,[x,y],[r*cos(t), r*sin(t)]);
sol=int(int(polarint,r,0,3),t,0,2*pi)
P = inline(vectorize(F(1)), 'x', 'y');
Q = inline(vectorize(F(2)), 'x', 'y')
x = linspace(-3.2,3.2, 10);
y = x;
[X,Y] = meshgrid(x,y);
U = P(X,Y);
V = Q(X,Y);
quiver(X,Y,U,V)
```

```
hold on
fplot(3*cos(t),3*sin(t),[0,2*pi])
axis equal
```

Evaluate $\oint_C (y^2)dx + (3xy)dy$, where C is the boundary of the semiannular region D in the upper –plane between the circles $x^2 + y^2 = 1$ and $x^2 + y^2 = 4$.

```
%green's theorem 2
clc
clear all
syms x y r t
F=input('enter the F vector as i and j order in vector form:');
integrand=diff(F(2),x)-diff(F(1),y);
polarint=r*subs(integrand,[x,y],[r*cos(t),r*sin(t)]);
sol=int(int(polarint,r,1,2),t,0,pi);
P = inline(vectorize(F(1)), 'x', 'y');
Q = inline(vectorize(F(2)), 'x', 'y')
x = linspace(-3.2,3.2,10); y = x;
[X,Y] = meshgrid(x,y);
U = P(X,Y);
V = Q(X,Y);
quiver(X,Y,U,V)
hold on
fplot(1*cos(t),1*sin(t),[0,pi])
fplot(2*cos(t),2*sin(t),[0,pi])
axis equal
```