Lab Worksheet (Week-6)

Calculus and 3D Plots

1. Write a Python program to plot the $3D$ vectors $[1,1,1]$, $[2,1,5]$, and $[4,1,2]$.

Solution:

```
import matplotlib
import matplotlib.pyplot as plt
import numpy as np
%matplotlib qt
u=np.array([1,1,1])
v=np.array([2,1,5])
h=np.array([4,1,2])
fig = plt.figure()
ax =fig.add_subplot(projection='3d')
ax.set_xlim(-5,5)
ax.set_ylim(-5,5)
ax.set_zlim(-5,5)
sp= [0,0,0]
ax.quiver(sp[0],sp[1],sp[2],u[0],u[1],u[2])
ax.quiver(sp[0],sp[1],sp[2],v[0],v[1],v[2])
ax.quiver(sp[0],sp[1],sp[2],h[0],h[1],h[2])
plt.show()
```

2. Write a Python program to plot the 3D surface, $z = sin(\sqrt{x^2 + y^2})$.

Solution:

```
import matplotlib
import matplotlib.pyplot as plt
import numpy as np
%matplotlib qt
x = np.linspace(-5, 5, 200)
y = np.linspace(-5, 5, 200)
X, Y = np.meshgrid(x, y)
Z = np.sin(np.sqrt(X**2 + Y**2))
fig = plt.figure()
ax =fig.add_subplot(projection='3d')
ax.plot_surface(X, Y, Z)
```

```
ax.set_xlabel('X')
ax.set_ylabel('Y')
ax.set_zlabel('Z')
ax.set_title('3D Surface Plot')
ax.view_init(elev=20, azim=30)
plt.show()
```

3. For the expression $f(x) = \sin(x) + \cos(x)$

   (i) Print the derivative of the given expression with respect to x.

   (ii) Find the values of derivative over the interval $[-2\pi, 2\pi]$ with 100 points in between and store them in array.

   (iii) Plot the given function and its derivative in one plot with different line colors

   (iv) In the plot fill the area between the function and its derivative.

Solution:

```
import matplotlib as mpl
import matplotlib.pyplot as plt
import sympy as sp
import numpy as np
sp.init_printing()
import matplotlib
x,y=sp.symbols("x,y")
expr=sp.sin(x)+sp.cos(x)
der_1=expr.diff(x)
print(der_1)
a=np.linspace(-2*np.pi,2*np.pi,100)
expr=sp.lambdify(x,expr)
a1=expr(a)
der_1=sp.lambdify(x,der_1)
a2=der_1(a)
print(a2)
fig,ax=plt.subplots()
ax.plot(a,a1,color="r",lw="1",label="f(x)")
ax.plot(a,a2,color="blue",lw="1",label="f'(x)")
ax.fill_between(a,a1,a2,color="orange")
ax.legend()
```

4. Using Sympy do the following tasks

   (i) Import the matrices

$$A = \begin{bmatrix} 7 & 2a+3b \\ 1 & 8 \end{bmatrix} \text{ and } B = \begin{bmatrix} 7 & 5 \\ a+b & 8 \end{bmatrix}$$

   (ii) Find the values of constants a and b by equating above two matrices.

Solution:

```
a,b=sp.symbols("a,b")
A=sp.Matrix([[7,2*a+3*b],[1,8]])
B=sp.Matrix([[7,5],[a+b,8]])
sp.solve(A-B,(a,b))
```