In [7]:

```
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
import seaborn as sns
from sklearn.cluster import KMeans
```

In [8]:

```
IRIS = pd.read_csv("E:/Data Sets/IRIS.csv")
print(IRIS)
```

```
     sepal_length  sepal_width  petal_length  petal_width         species
0             5.1          3.5           1.4          0.2     Iris-setosa
1             4.9          3.0           1.4          0.2     Iris-setosa
2             4.7          3.2           1.3          0.2     Iris-setosa
3             4.6          3.1           1.5          0.2     Iris-setosa
4             5.0          3.6           1.4          0.2     Iris-setosa
..            ...          ...           ...          ...             ...
145           6.7          3.0           5.2          2.3  Iris-virginica
146           6.3          2.5           5.0          1.9  Iris-virginica
147           6.5          3.0           5.2          2.0  Iris-virginica
148           6.2          3.4           5.4          2.3  Iris-virginica
149           5.9          3.0           5.1          1.8  Iris-virginica

[150 rows x 5 columns]
```

In [9]:

```
IRIS.head(20)
```

Out[9]:

	sepal_length	sepal_width	petal_length	petal_width	species
0	5.1	3.5	1.4	0.2	Iris-setosa
1	4.9	3.0	1.4	0.2	Iris-setosa
2	4.7	3.2	1.3	0.2	Iris-setosa
3	4.6	3.1	1.5	0.2	Iris-setosa
4	5.0	3.6	1.4	0.2	Iris-setosa
5	5.4	3.9	1.7	0.4	Iris-setosa
6	4.6	3.4	1.4	0.3	Iris-setosa
7	5.0	3.4	1.5	0.2	Iris-setosa
8	4.4	2.9	1.4	0.2	Iris-setosa
9	4.9	3.1	1.5	0.1	Iris-setosa
10	5.4	3.7	1.5	0.2	Iris-setosa
11	4.8	3.4	1.6	0.2	Iris-setosa
12	4.8	3.0	1.4	0.1	Iris-setosa
13	4.3	3.0	1.1	0.1	Iris-setosa
14	5.8	4.0	1.2	0.2	Iris-setosa
15	5.7	4.4	1.5	0.4	Iris-setosa
16	5.4	3.9	1.3	0.4	Iris-setosa
17	5.1	3.5	1.4	0.3	Iris-setosa
18	5.7	3.8	1.7	0.3	Iris-setosa
19	5.1	3.8	1.5	0.3	Iris-setosa

In [10]:

```
IRIS = sns.load_dataset('iris')
IRIS.head()
```

Out[10]:

	sepal_length	sepal_width	petal_length	petal_width	species
0	5.1	3.5	1.4	0.2	setosa
1	4.9	3.0	1.4	0.2	setosa
2	4.7	3.2	1.3	0.2	setosa
3	4.6	3.1	1.5	0.2	setosa
4	5.0	3.6	1.4	0.2	setosa

In [12]:

```
IRIS['species'], categories = pd.factorize(IRIS['species'])
IRIS.head()
```

Out[12]:

	sepal_length	sepal_width	petal_length	petal_width	species
0	5.1	3.5	1.4	0.2	0
1	4.9	3.0	1.4	0.2	0
2	4.7	3.2	1.3	0.2	0
3	4.6	3.1	1.5	0.2	0
4	5.0	3.6	1.4	0.2	0

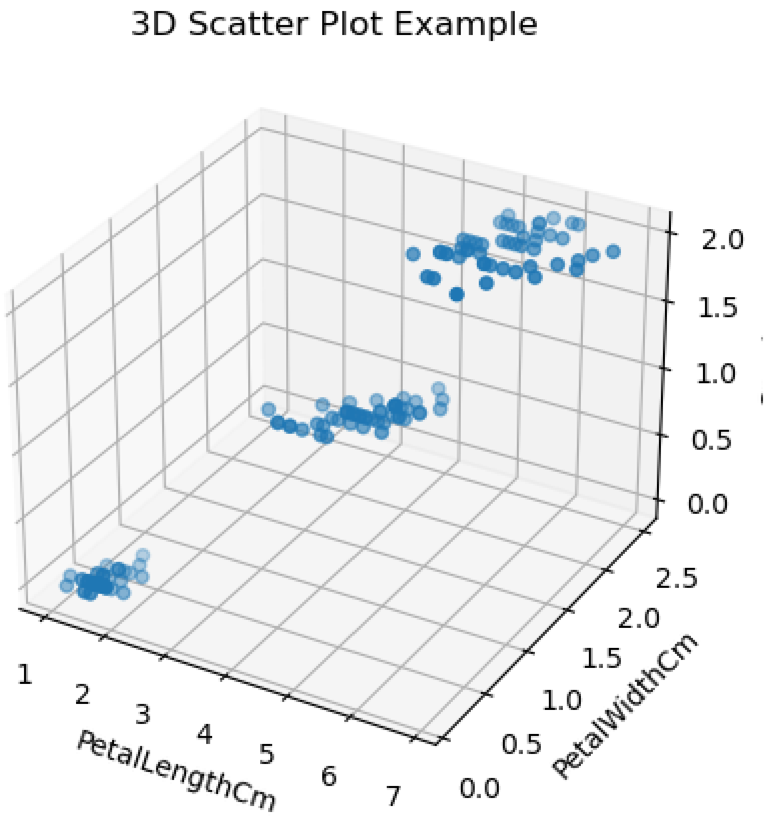
In [13]:
```
IRIS.describe
```

Out[13]:
```
<bound method NDFrame.describe of      sepal_length  sepal_width  petal_length  petal_width  species
0             5.1          3.5           1.4          0.2        0
1             4.9          3.0           1.4          0.2        0
2             4.7          3.2           1.3          0.2        0
3             4.6          3.1           1.5          0.2        0
4             5.0          3.6           1.4          0.2        0
..            ...          ...           ...          ...      ...
145           6.7          3.0           5.2          2.3        2
146           6.3          2.5           5.0          1.9        2
147           6.5          3.0           5.2          2.0        2
148           6.2          3.4           5.4          2.3        2
149           5.9          3.0           5.1          1.8        2

[150 rows x 5 columns]>
```

In [14]:
```
IRIS.isna().sum()
```

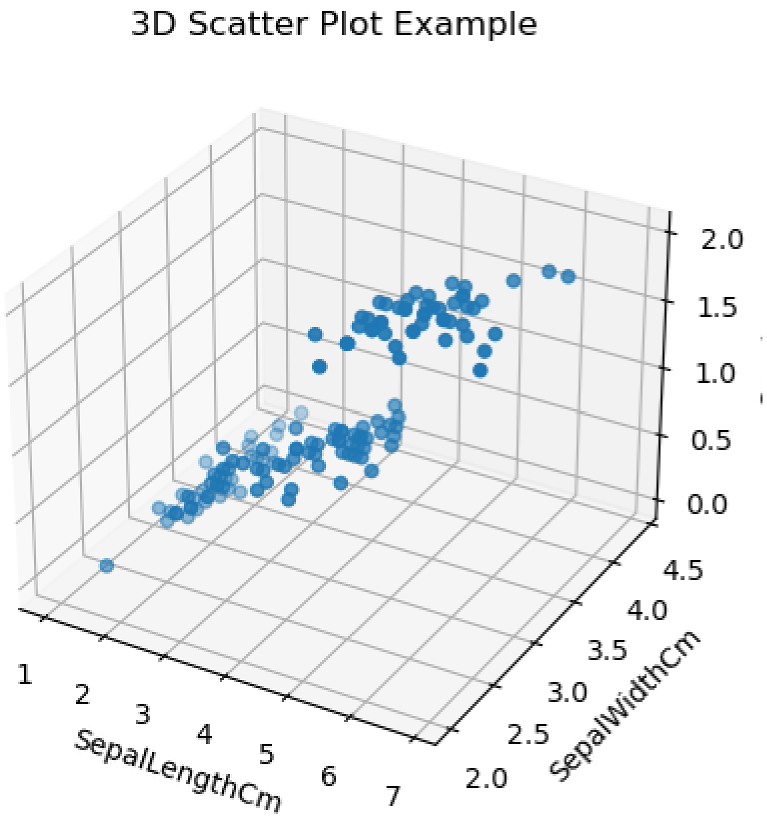
Out[14]:
```
sepal_length    0
sepal_width     0
petal_length    0
petal_width     0
species         0
dtype: int64
```

In [16]:
```
from mpl_toolkits.mplot3d import Axes3D
fig = plt.figure()
ax = fig.add_subplot(111, projection = '3d')
ax.scatter(IRIS.petal_length, IRIS.petal_width, IRIS.species)
ax.set_xlabel('PetalLengthCm')
ax.set_ylabel('PetalWidthCm')
ax.set_zlabel('Species')
plt.title('3D Scatter Plot Example')
plt.show()
```



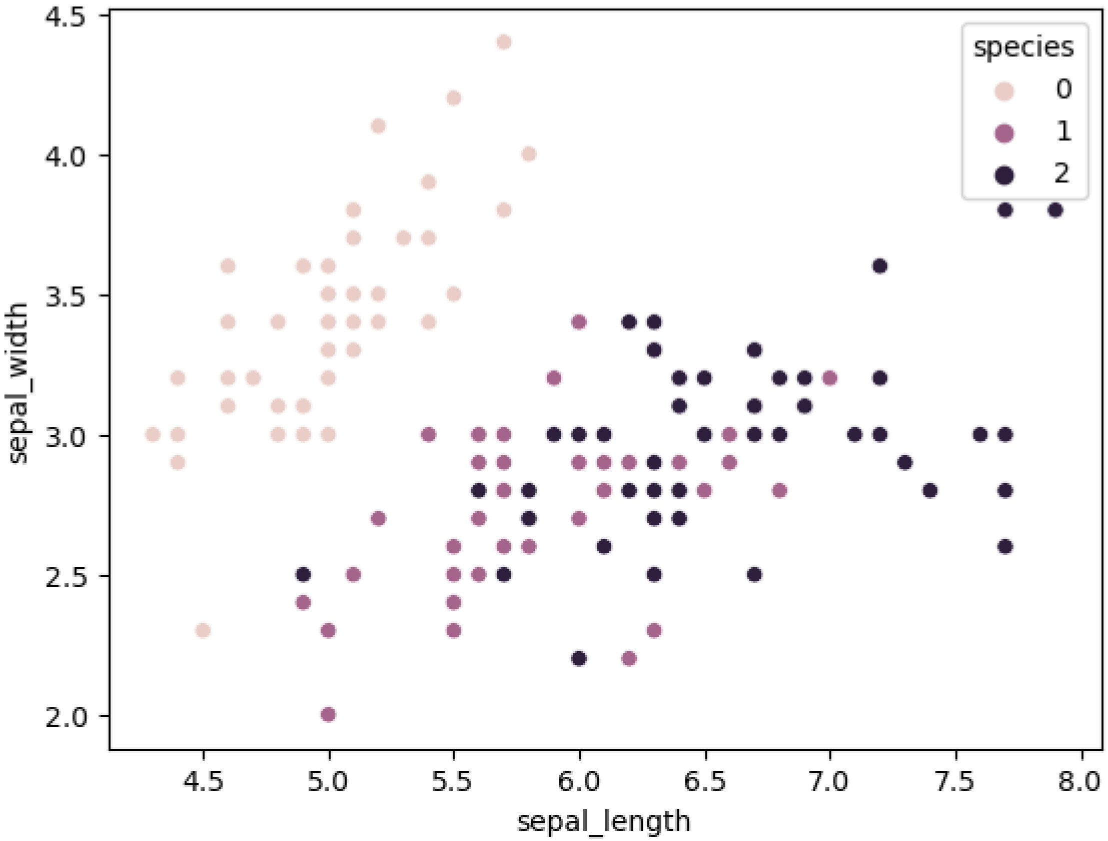
In [17]:

```
from mpl_toolkits.mplot3d import Axes3D
fig = plt.figure()
ax = fig.add_subplot(111, projection = '3d')
ax.scatter(IRIS.petal_length, IRIS.sepal_width, IRIS.species)
ax.set_xlabel('SepalLengthCm')
ax.set_ylabel('SepalWidthCm')
ax.set_zlabel('Species')
plt.title('3D Scatter Plot Example')
plt.show()
```



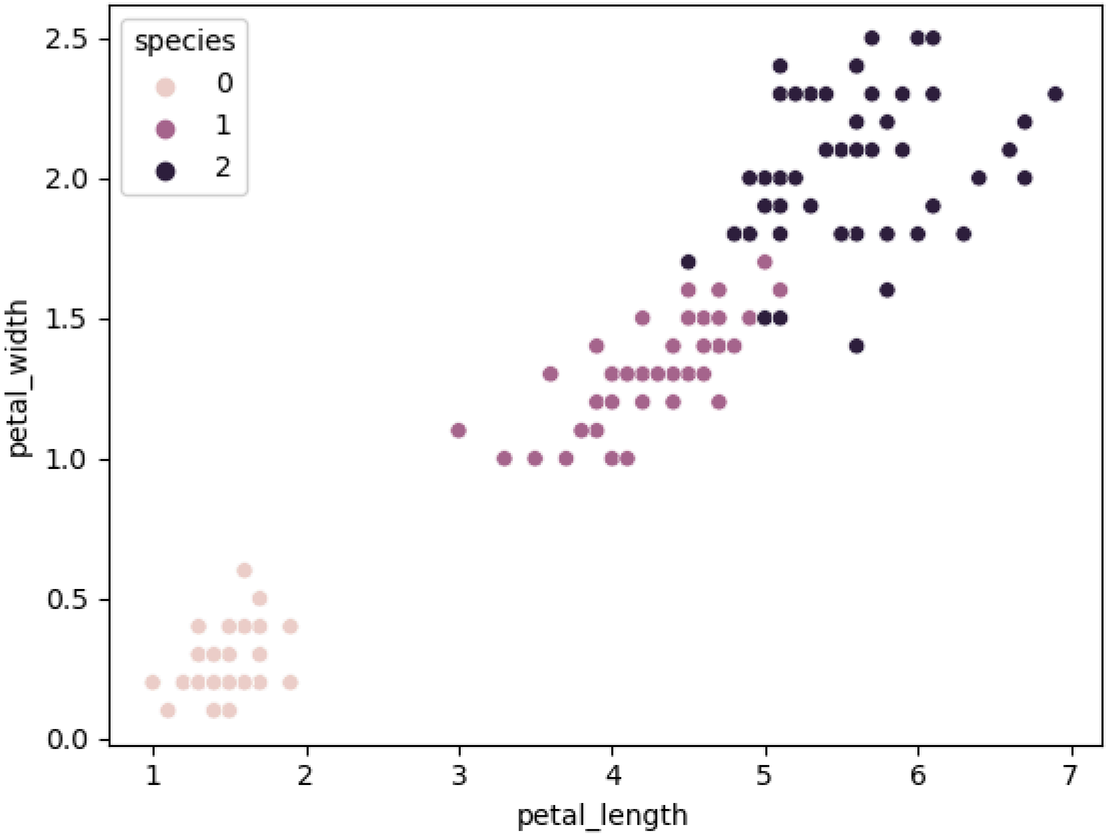
In [18]:
```
sns.scatterplot(data = IRIS, x = "sepal_length", y = "sepal_width", hue = "species")
```

Out[18]:
```
<Axes: xlabel='sepal_length', ylabel='sepal_width'>
```



In [19]:
```
sns.scatterplot(data = IRIS, x = "petal_length", y = "petal_width", hue = "species")
```

Out[19]:
```
<Axes: xlabel='petal_length', ylabel='petal_width'>
```

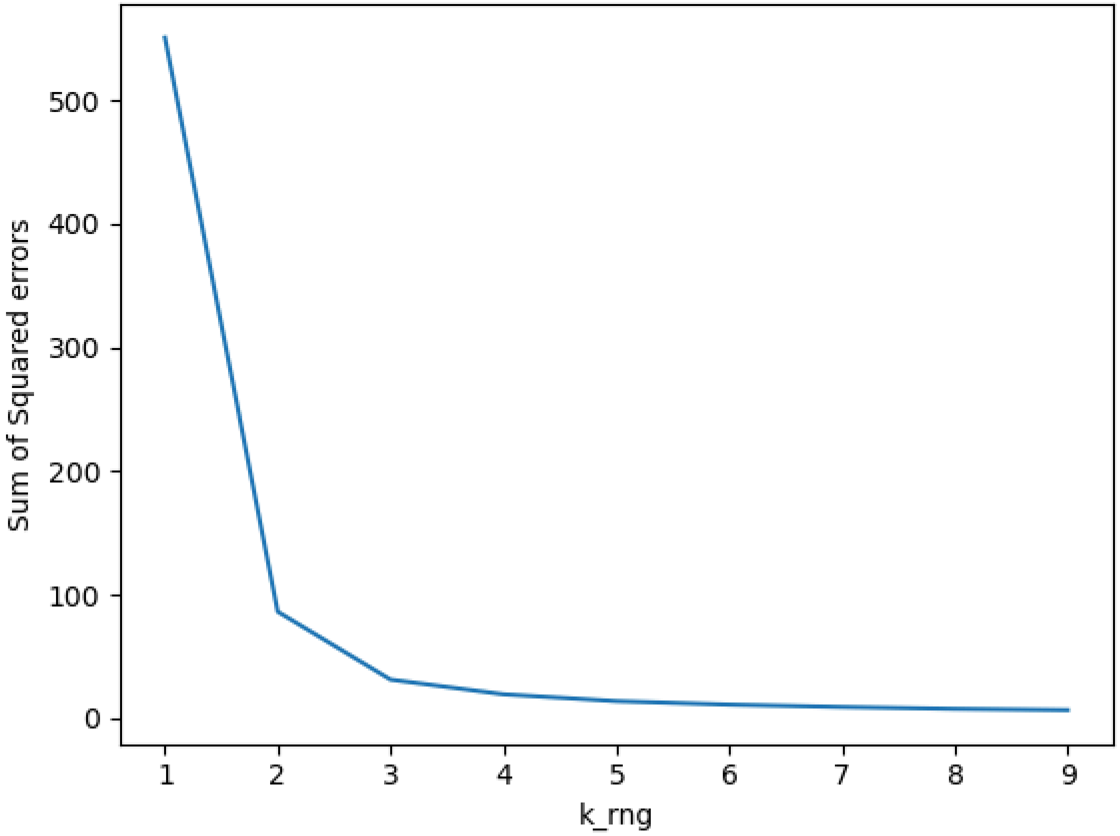


In [21]:

```
k_rng = range(1,10)
sse=[]

for k in k_rng:
    km = KMeans(n_clusters = k)
    km.fit(IRIS[['petal_length', 'petal_width']])
    sse.append(km.inertia_)
```

```
C:\Users\USER\anaconda3\Lib\site-packages\sklearn\cluster\_kmeans.py:1412: FutureWarning: The default value of `n_in
it` will change from 10 to 'auto' in 1.4. Set the value of `n_init` explicitly to suppress the warning
  super()._check_params_vs_input(X, default_n_init=10)
C:\Users\USER\anaconda3\Lib\site-packages\sklearn\cluster\_kmeans.py:1436: UserWarning: KMeans is known to have a me
mory leak on Windows with MKL, when there are less chunks than available threads. You can avoid it by setting the en
vironment variable OMP_NUM_THREADS=1.
  warnings.warn(
C:\Users\USER\anaconda3\Lib\site-packages\sklearn\cluster\_kmeans.py:1412: FutureWarning: The default value of `n_in
it` will change from 10 to 'auto' in 1.4. Set the value of `n_init` explicitly to suppress the warning
  super()._check_params_vs_input(X, default_n_init=10)
C:\Users\USER\anaconda3\Lib\site-packages\sklearn\cluster\_kmeans.py:1436: UserWarning: KMeans is known to have a me
mory leak on Windows with MKL, when there are less chunks than available threads. You can avoid it by setting the en
vironment variable OMP_NUM_THREADS=1.
  warnings.warn(
C:\Users\USER\anaconda3\Lib\site-packages\sklearn\cluster\_kmeans.py:1412: FutureWarning: The default value of `n_in
it` will change from 10 to 'auto' in 1.4. Set the value of `n_init` explicitly to suppress the warning
  super()._check_params_vs_input(X, default_n_init=10)
C:\Users\USER\anaconda3\Lib\site-packages\sklearn\cluster\_kmeans.py:1436: UserWarning: KMeans is known to have a me
mory leak on Windows with MKL, when there are less chunks than available threads. You can avoid it by setting the en
vironment variable OMP_NUM_THREADS=1.
  warnings.warn(
C:\Users\USER\anaconda3\Lib\site-packages\sklearn\cluster\_kmeans.py:1412: FutureWarning: The default value of `n_in
it` will change from 10 to 'auto' in 1.4. Set the value of `n_init` explicitly to suppress the warning
  super()._check_params_vs_input(X, default_n_init=10)
C:\Users\USER\anaconda3\Lib\site-packages\sklearn\cluster\_kmeans.py:1436: UserWarning: KMeans is known to have a me
mory leak on Windows with MKL, when there are less chunks than available threads. You can avoid it by setting the en
vironment variable OMP_NUM_THREADS=1.
  warnings.warn(
C:\Users\USER\anaconda3\Lib\site-packages\sklearn\cluster\_kmeans.py:1412: FutureWarning: The default value of `n_in
it` will change from 10 to 'auto' in 1.4. Set the value of `n_init` explicitly to suppress the warning
  super()._check_params_vs_input(X, default_n_init=10)
C:\Users\USER\anaconda3\Lib\site-packages\sklearn\cluster\_kmeans.py:1436: UserWarning: KMeans is known to have a me
mory leak on Windows with MKL, when there are less chunks than available threads. You can avoid it by setting the en
vironment variable OMP_NUM_THREADS=1.
  warnings.warn(
C:\Users\USER\anaconda3\Lib\site-packages\sklearn\cluster\_kmeans.py:1412: FutureWarning: The default value of `n_in
it` will change from 10 to 'auto' in 1.4. Set the value of `n_init` explicitly to suppress the warning
  super()._check_params_vs_input(X, default_n_init=10)
C:\Users\USER\anaconda3\Lib\site-packages\sklearn\cluster\_kmeans.py:1436: UserWarning: KMeans is known to have a me
mory leak on Windows with MKL, when there are less chunks than available threads. You can avoid it by setting the en
vironment variable OMP_NUM_THREADS=1.
```

```
  warnings.warn(
C:\Users\USER\anaconda3\Lib\site-packages\sklearn\cluster\_kmeans.py:1412: FutureWarning: The default value of `n_in
it` will change from 10 to 'auto' in 1.4. Set the value of `n_init` explicitly to suppress the warning
  super()._check_params_vs_input(X, default_n_init=10)
C:\Users\USER\anaconda3\Lib\site-packages\sklearn\cluster\_kmeans.py:1436: UserWarning: KMeans is known to have a me
mory leak on Windows with MKL, when there are less chunks than available threads. You can avoid it by setting the en
vironment variable OMP_NUM_THREADS=1.
  warnings.warn(
C:\Users\USER\anaconda3\Lib\site-packages\sklearn\cluster\_kmeans.py:1412: FutureWarning: The default value of `n_in
it` will change from 10 to 'auto' in 1.4. Set the value of `n_init` explicitly to suppress the warning
  super()._check_params_vs_input(X, default_n_init=10)
C:\Users\USER\anaconda3\Lib\site-packages\sklearn\cluster\_kmeans.py:1436: UserWarning: KMeans is known to have a me
mory leak on Windows with MKL, when there are less chunks than available threads. You can avoid it by setting the en
vironment variable OMP_NUM_THREADS=1.
  warnings.warn(
C:\Users\USER\anaconda3\Lib\site-packages\sklearn\cluster\_kmeans.py:1412: FutureWarning: The default value of `n_in
it` will change from 10 to 'auto' in 1.4. Set the value of `n_init` explicitly to suppress the warning
  super()._check_params_vs_input(X, default_n_init=10)
C:\Users\USER\anaconda3\Lib\site-packages\sklearn\cluster\_kmeans.py:1436: UserWarning: KMeans is known to have a me
mory leak on Windows with MKL, when there are less chunks than available threads. You can avoid it by setting the en
vironment variable OMP_NUM_THREADS=1.
  warnings.warn(
In [22]: plt.xlabel('k_rng')
plt.ylabel("Sum of Squared errors")
plt.plot(k_rng, sse)

Out[22]: [<matplotlib.lines.Line2D at 0x26dd2d4bdd0>]
```



In [23]:
```
sse
```

Out[23]:
```
[550.8953333333334,
 86.39021984551397,
 31.37135897435897,
 19.48300089968511,
 13.916908757908757,
 11.088890437134374,
 9.185075914423741,
 7.667019523446295,
 6.709427885981594]
```

In [29]:
```
km = KMeans(n_clusters=3,random_state=1)
y_predicted = km.fit_predict(IRIS[['petal_length','petal_width']])
y_predicted
```

```
C:\Users\USER\anaconda3\Lib\site-packages\sklearn\cluster\_kmeans.py:1412: FutureWarning: The default value of `n_in
it` will change from 10 to 'auto' in 1.4. Set the value of `n_init` explicitly to suppress the warning
  super()._check_params_vs_input(X, default_n_init=10)
C:\Users\USER\anaconda3\Lib\site-packages\sklearn\cluster\_kmeans.py:1436: UserWarning: KMeans is known to have a me
mory leak on Windows with MKL, when there are less chunks than available threads. You can avoid it by setting the en
vironment variable OMP_NUM_THREADS=1.
  warnings.warn(
```

Out[29]:
```
array([1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1,
       1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1,
       1, 1, 1, 1, 1, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
       0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 2, 0, 0, 0, 0, 0, 2, 0, 0, 0, 0,
       0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 2, 2, 2, 2, 2, 2, 0, 2, 2, 2,
       2, 2, 2, 2, 2, 2, 2, 2, 2, 0, 2, 2, 2, 2, 2, 2, 0, 2, 2, 2, 2, 2,
       2, 2, 2, 2, 2, 2, 0, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2])
```

In [28]:

```
IRIS['cluster'] = y_predicted
IRIS.head(160)
```

Out[28]:

	sepal_length	sepal_width	petal_length	petal_width	species	cluster
0	5.1	3.5	1.4	0.2	0	1
1	4.9	3.0	1.4	0.2	0	1
2	4.7	3.2	1.3	0.2	0	1
3	4.6	3.1	1.5	0.2	0	1
4	5.0	3.6	1.4	0.2	0	1
...	...	...	...	...	...	...
145	6.7	3.0	5.2	2.3	2	2
146	6.3	2.5	5.0	1.9	2	2
147	6.5	3.0	5.2	2.0	2	2
148	6.2	3.4	5.4	2.3	2	2
149	5.9	3.0	5.1	1.8	2	2

150 rows × 6 columns

In [30]:

```
km = KMeans(n_clusters = 3,random_state = 0)
y_predicted = km.fit_predict(IRIS[['petal_length','petal_width']])
y_predicted
```

```
C:\Users\USER\anaconda3\Lib\site-packages\sklearn\cluster\_kmeans.py:1412: FutureWarning: The default value of `n_in
it` will change from 10 to 'auto' in 1.4. Set the value of `n_init` explicitly to suppress the warning
  super()._check_params_vs_input(X, default_n_init=10)
C:\Users\USER\anaconda3\Lib\site-packages\sklearn\cluster\_kmeans.py:1436: UserWarning: KMeans is known to have a me
mory leak on Windows with MKL, when there are less chunks than available threads. You can avoid it by setting the en
vironment variable OMP_NUM_THREADS=1.
  warnings.warn(
```

Out[30]:

```
array([1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1,
       1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1,
       1, 1, 1, 1, 1, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
       0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 2, 0, 0, 0, 0, 0, 2, 0, 0, 0, 0,
       0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 2, 2, 2, 2, 2, 2, 0, 2, 2, 2,
       2, 2, 2, 2, 2, 2, 2, 2, 2, 0, 2, 2, 2, 2, 2, 2, 0, 2, 2, 2, 2, 2,
       2, 2, 2, 2, 2, 2, 0, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2])
```

In [31]:

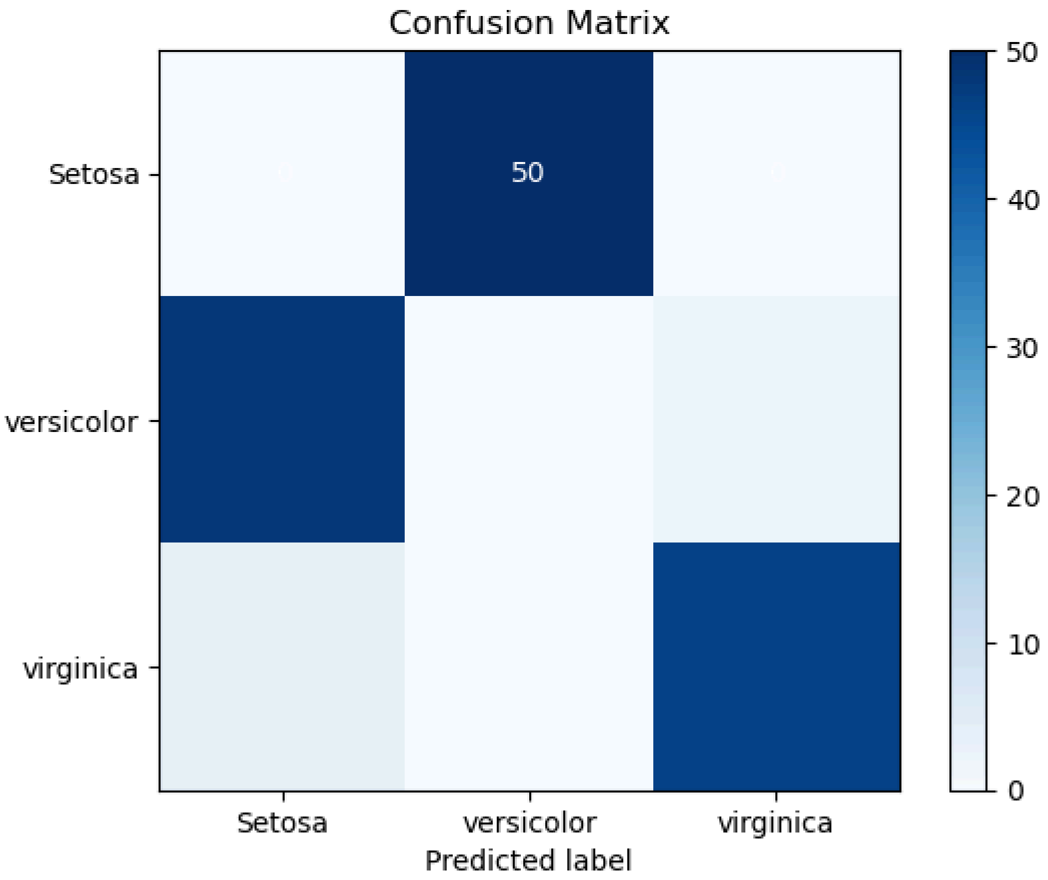
```
from sklearn.metrics import confusion_matrix
cm = confusion_matrix(IRIS.species, IRIS.cluster)
cm
```

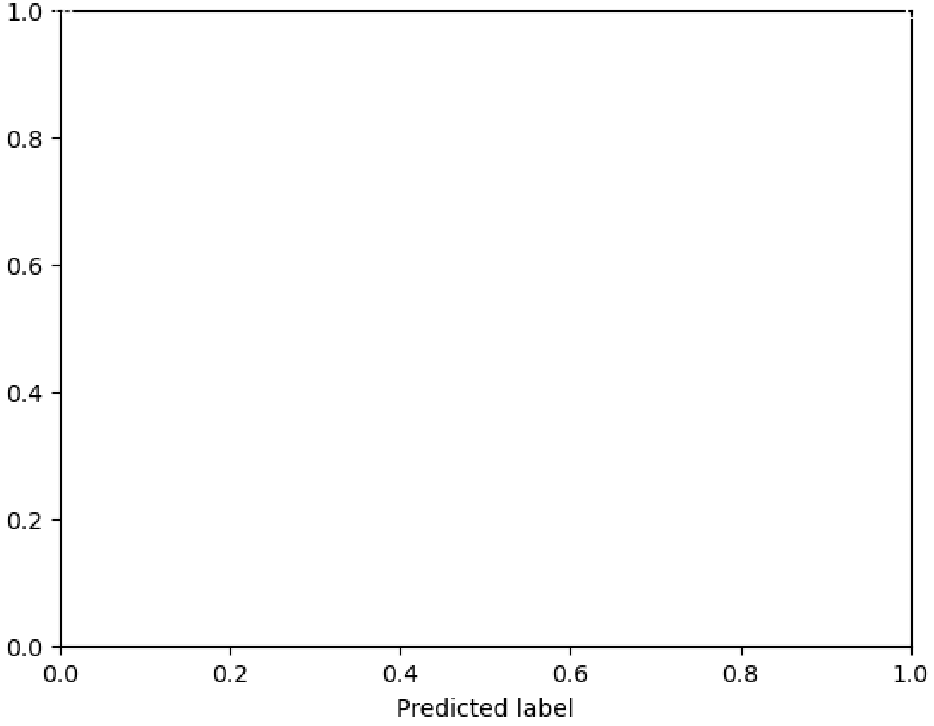
Out[31]:

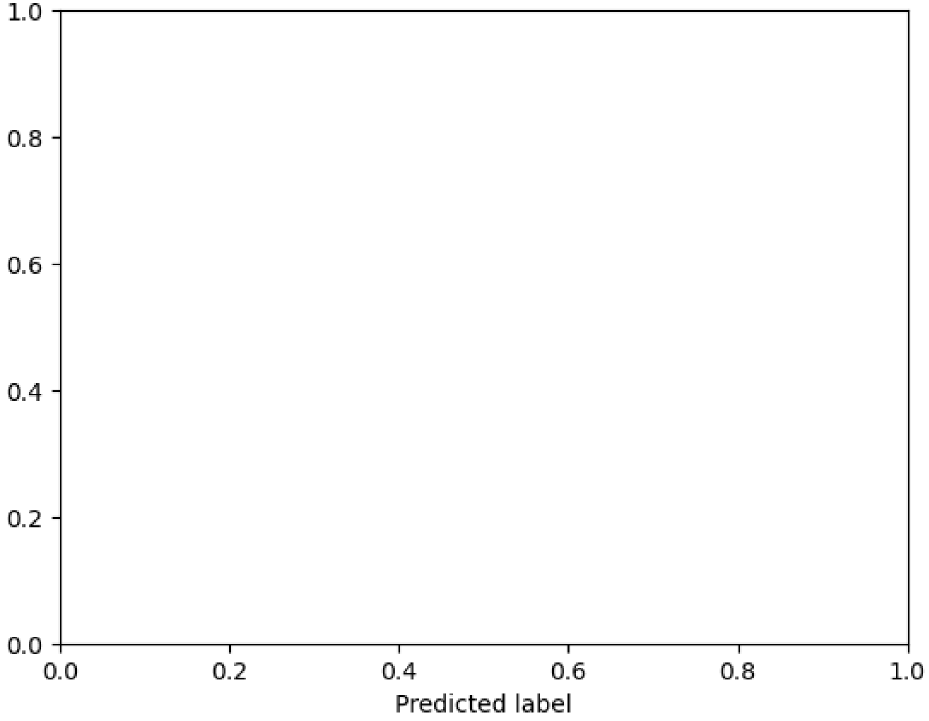
```
array([[ 0, 50,  0],
       [48,  0,  2],
       [ 4,  0, 46]], dtype=int64)
```

In [33]:

```
true_labels = IRIS.species
predicted_labels = IRIS.cluster

cm = confusion_matrix(true_labels, predicted_labels)
class_labels = ['Setosa', 'versicolor', 'virginica']

#Plot confusion matrix
plt.imshow(cm, interpolation = 'nearest', cmap = plt.cm.Blues)
plt.title('Confusion Matrix')
plt.colorbar()
tick_marks = np.arange(len(class_labels))
plt.xticks(tick_marks, class_labels)
plt.yticks(tick_marks, class_labels)

#Fill matrix with values
for i in range(len(class_labels)):
    for j in range(len(class_labels)):
        plt.text(j, i, str(cm[i][j]), ha ='center', va ='center', color = 'white')

    plt.xlabel('Predicted label')
    plt.show()
```


Confusion Matrix
Setosa
versicolor
virginica
0
50
0
Setosa
versicolor
virginica
Predicted label
50
40
30
20
10
0


1.0
0.8
0.6
0.4
0.2
0.0
0.0
0.2
0.4
0.6
0.8
1.0
Predicted label


1.0
0.8
0.6
0.4
0.2
0.0
0.0
0.2
0.4
0.6
0.8
1.0
Predicted label

In [ ]: