In [1]:

```
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
import seaborn as sns
import warnings
warnings.filterwarnings('ignore')
```

In [2]:

```
from sklearn.datasets import load_iris
```

In [3]:

```
iris=load_iris()
```

In [6]:

```
iris.data
```

Out[6]:

```
array([[5.1, 3.5, 1.4, 0.2],
       [4.9, 3. , 1.4, 0.2],
       [4.7, 3.2, 1.3, 0.2],
       [4.6, 3.1, 1.5, 0.2],
       [5. , 3.6, 1.4, 0.2],
       [5.4, 3.9, 1.7, 0.4],
       [4.6, 3.4, 1.4, 0.3],
       [5. , 3.4, 1.5, 0.2],
       [4.4, 2.9, 1.4, 0.2],
       [4.9, 3.1, 1.5, 0.1],
       [5.4, 3.7, 1.5, 0.2],
       [4.8, 3.4, 1.6, 0.2],
       [4.8, 3. , 1.4, 0.1],
       [4.3, 3. , 1.1, 0.1],
       [5.8, 4. , 1.2, 0.2],
       [5.7, 4.4, 1.5, 0.4],
       [5.4, 3.9, 1.3, 0.4],
       [5.1, 3.5, 1.4, 0.3],
       [5.7, 3.8, 1.7, 0.3],
       [5.1, 3.8, 1.5, 0.3],
       [5.4, 3.4, 1.7, 0.2],
       [5.1, 3.7, 1.5, 0.4],
       [4.6, 3.6, 1. , 0.2],
       [5.1, 3.3, 1.7, 0.5],
       [4.8, 3.4, 1.9, 0.2],
       [5. , 3. , 1.6, 0.2],
       [5. , 3.4, 1.6, 0.4],
       [5.2, 3.5, 1.5, 0.2],
       [5.2, 3.4, 1.4, 0.2],
       [4.7, 3.2, 1.6, 0.2],
       [4.8, 3.1, 1.6, 0.2],
       [5.4, 3.4, 1.5, 0.4],
       [5.2, 4.1, 1.5, 0.1],
       [5.5, 4.2, 1.4, 0.2],
       [4.9, 3.1, 1.5, 0.2],
       [5. , 3.2, 1.2, 0.2],
       [5.5, 3.5, 1.3, 0.2],
       [4.9, 3.6, 1.4, 0.1],
       [4.4, 3. , 1.3, 0.2],
       [5.1, 3.4, 1.5, 0.2],
       [5. , 3.5, 1.3, 0.3],
       [4.5, 2.3, 1.3, 0.3],
       [4.4, 3.2, 1.3, 0.2],
       [5. , 3.5, 1.6, 0.6],
       [5.1, 3.8, 1.9, 0.4],
       [4.8, 3. , 1.4, 0.3],
```

```
[5.1, 3.8, 1.6, 0.2],
[4.6, 3.2, 1.4, 0.2],
[5.3, 3.7, 1.5, 0.2],
[5. , 3.3, 1.4, 0.2],
[7. , 3.2, 4.7, 1.4],
[6.4, 3.2, 4.5, 1.5],
[6.9, 3.1, 4.9, 1.5],
[5.5, 2.3, 4. , 1.3],
[6.5, 2.8, 4.6, 1.5],
[5.7, 2.8, 4.5, 1.3],
[6.3, 3.3, 4.7, 1.6],
[4.9, 2.4, 3.3, 1. ],
[6.6, 2.9, 4.6, 1.3],
[5.2, 2.7, 3.9, 1.4],
[5. , 2. , 3.5, 1. ],
[5.9, 3. , 4.2, 1.5],
[6. , 2.2, 4. , 1. ],
[6.1, 2.9, 4.7, 1.4],
[5.6, 2.9, 3.6, 1.3],
[6.7, 3.1, 4.4, 1.4],
[5.6, 3. , 4.5, 1.5],
[5.8, 2.7, 4.1, 1. ],
[6.2, 2.2, 4.5, 1.5],
[5.6, 2.5, 3.9, 1.1],
[5.9, 3.2, 4.8, 1.8],
[6.1, 2.8, 4. , 1.3],
[6.3, 2.5, 4.9, 1.5],
[6.1, 2.8, 4.7, 1.2],
[6.4, 2.9, 4.3, 1.3],
[6.6, 3. , 4.4, 1.4],
[6.8, 2.8, 4.8, 1.4],
[6.7, 3. , 5. , 1.7],
[6. , 2.9, 4.5, 1.5],
[5.7, 2.6, 3.5, 1. ],
[5.5, 2.4, 3.8, 1.1],
[5.5, 2.4, 3.7, 1. ],
[5.8, 2.7, 3.9, 1.2],
[6. , 2.7, 5.1, 1.6],
[5.4, 3. , 4.5, 1.5],
[6. , 3.4, 4.5, 1.6],
[6.7, 3.1, 4.7, 1.5],
[6.3, 2.3, 4.4, 1.3],
[5.6, 3. , 4.1, 1.3],
[5.5, 2.5, 4. , 1.3],
[5.5, 2.6, 4.4, 1.2],
[6.1, 3. , 4.6, 1.4],
[5.8, 2.6, 4. , 1.2],
[5. , 2.3, 3.3, 1. ],
[5.6, 2.7, 4.2, 1.3],
[5.7, 3. , 4.2, 1.2],
[5.7, 2.9, 4.2, 1.3],
[6.2, 2.9, 4.3, 1.3],
[5.1, 2.5, 3. , 1.1],
[5.7, 2.8, 4.1, 1.3],
[6.3, 3.3, 6. , 2.5],
[5.8, 2.7, 5.1, 1.9],
[7.1, 3. , 5.9, 2.1],
[6.3, 2.9, 5.6, 1.8],
[6.5, 3. , 5.8, 2.2],
[7.6, 3. , 6.6, 2.1],
[4.9, 2.5, 4.5, 1.7],
[7.3, 2.9, 6.3, 1.8],
[6.7, 2.5, 5.8, 1.8],
[7.2, 3.6, 6.1, 2.5],
[6.5, 3.2, 5.1, 2. ],
[6.4, 2.7, 5.3, 1.9],
```

```
       [6.8, 3. , 5.5, 2.1],
       [5.7, 2.5, 5. , 2. ],
       [5.8, 2.8, 5.1, 2.4],
       [6.4, 3.2, 5.3, 2.3],
       [6.5, 3. , 5.5, 1.8],
       [7.7, 3.8, 6.7, 2.2],
       [7.7, 2.6, 6.9, 2.3],
       [6. , 2.2, 5. , 1.5],
       [6.9, 3.2, 5.7, 2.3],
       [5.6, 2.8, 4.9, 2. ],
       [7.7, 2.8, 6.7, 2. ],
       [6.3, 2.7, 4.9, 1.8],
       [6.7, 3.3, 5.7, 2.1],
       [7.2, 3.2, 6. , 1.8],
       [6.2, 2.8, 4.8, 1.8],
       [6.1, 3. , 4.9, 1.8],
       [6.4, 2.8, 5.6, 2.1],
       [7.2, 3. , 5.8, 1.6],
       [7.4, 2.8, 6.1, 1.9],
       [7.9, 3.8, 6.4, 2. ],
       [6.4, 2.8, 5.6, 2.2],
       [6.3, 2.8, 5.1, 1.5],
       [6.1, 2.6, 5.6, 1.4],
       [7.7, 3. , 6.1, 2.3],
       [6.3, 3.4, 5.6, 2.4],
       [6.4, 3.1, 5.5, 1.8],
       [6. , 3. , 4.8, 1.8],
       [6.9, 3.1, 5.4, 2.1],
       [6.7, 3.1, 5.6, 2.4],
       [6.9, 3.1, 5.1, 2.3],
       [5.8, 2.7, 5.1, 1.9],
       [6.8, 3.2, 5.9, 2.3],
       [6.7, 3.3, 5.7, 2.5],
       [6.7, 3. , 5.2, 2.3],
       [6.3, 2.5, 5. , 1.9],
       [6.5, 3. , 5.2, 2. ],
       [6.2, 3.4, 5.4, 2.3],
       [5.9, 3. , 5.1, 1.8]])
```

In [8]:

```
iris.feature_names
```

Out[8]:

```
['sepal length (cm)',
 'sepal width (cm)',
 'petal length (cm)',
 'petal width (cm)']
```

In [9]:

```
iris.target
```

Out[9]:

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

In [10]:

```
df=pd.DataFrame(iris.data,columns=iris.feature_names)
```

In [11]:

```
df.head()
```

Out[11]:

sepal length (cm)	sepal width (cm)	petal length (cm)	petal width (cm)

	sepal length (cm)	sepal width (cm)	petal length (cm)	petal width (cm)
0	5.1	3.5	1.4	0.2
1	4.9	3.0	1.4	0.2
2	4.7	3.2	1.3	0.2
3	4.6	3.1	1.5	0.2
4	5.0	3.6	1.4	0.2

In [12]:

```
df['class']=iris.target
```

In [13]:

```
df.head()
```

Out[13]:

	sepal length (cm)	sepal width (cm)	petal length (cm)	petal width (cm)	class
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 [14]:

```
df.isna().sum()
```

Out[14]:

```
sepal length (cm)    0
sepal width (cm)     0
petal length (cm)    0
petal width (cm)     0
class                0
dtype: int64
```

In [15]:

```
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 150 entries, 0 to 149
Data columns (total 5 columns):
 #   Column             Non-Null Count  Dtype  
---  ------             --------------  -----  
 0   sepal length (cm)  150 non-null    float64
 1   sepal width (cm)   150 non-null    float64
 2   petal length (cm)  150 non-null    float64
 3   petal width (cm)   150 non-null    float64
 4   class              150 non-null    int32  
dtypes: float64(4), int32(1)
memory usage: 5.4 KB
```

In [16]:

```
df.describe()
```

Out[16]:

	sepal length (cm)	sepal width (cm)	petal length (cm)	petal width (cm)	class
count	150.000000	150.000000	150.000000	150.000000	150.000000
mean	5.843333	3.057333	3.758000	1.199333	1.000000
std	0.828066	0.435866	1.765298	0.762238	0.819232

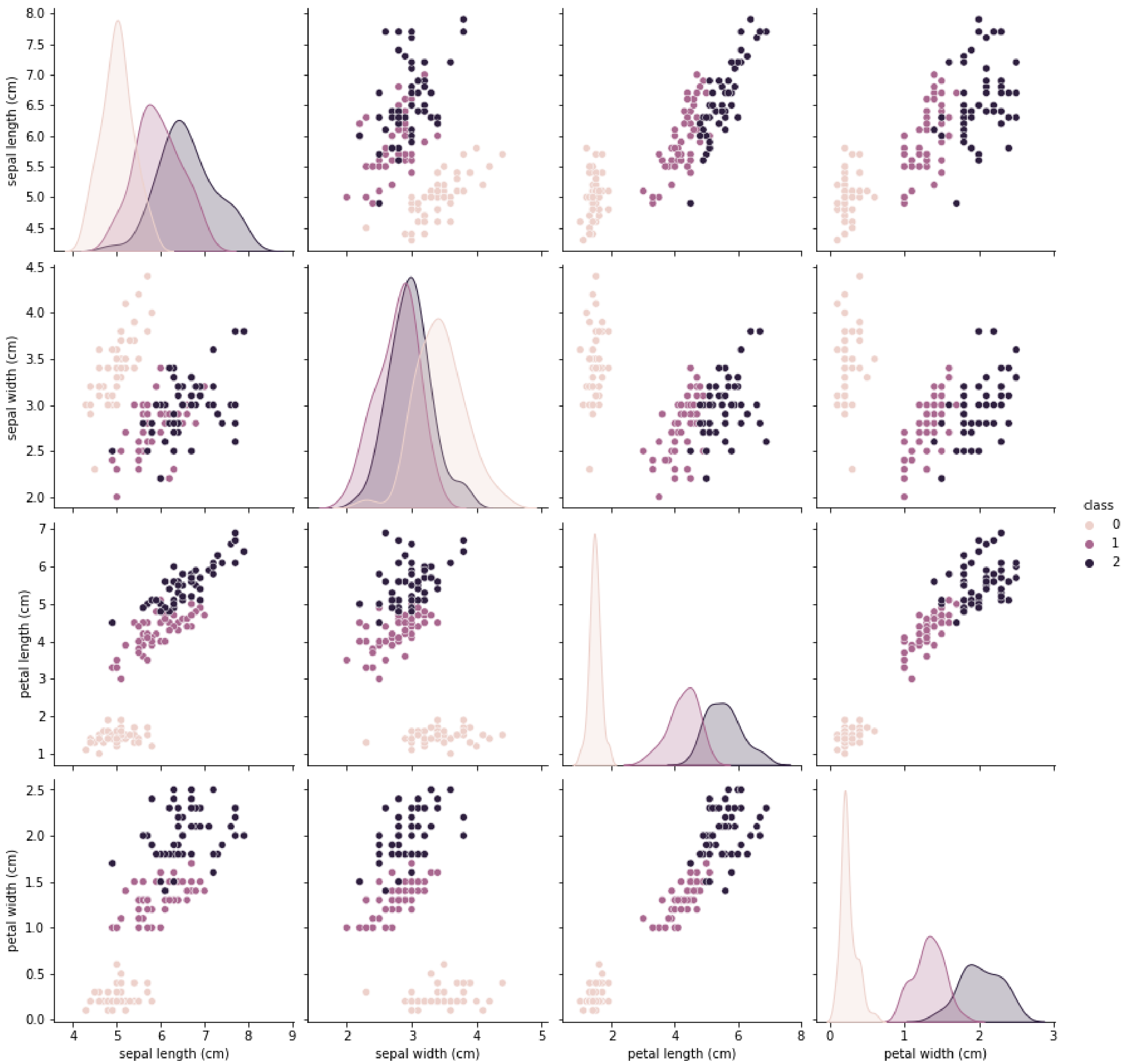
	sepal length (cm)	sepal width (cm)	petal length (cm)	petal width (cm)	class
min	4.300000	2.000000	1.000000	0.100000	0.000000
25%	5.100000	2.800000	1.600000	0.300000	0.000000
50%	5.800000	3.000000	4.350000	1.300000	1.000000
75%	6.400000	3.300000	5.100000	1.800000	2.000000
max	7.900000	4.400000	6.900000	2.500000	2.000000

In [48]:

```
sns.pairplot(data=df,hue='class',size=3,diag_kind='kde')
```

Out[48]:

```
<seaborn.axisgrid.PairGrid at 0x1dca435c310>
```



In [17]:

```
colname=df.select_dtypes('float64').columns
```

In [18]:

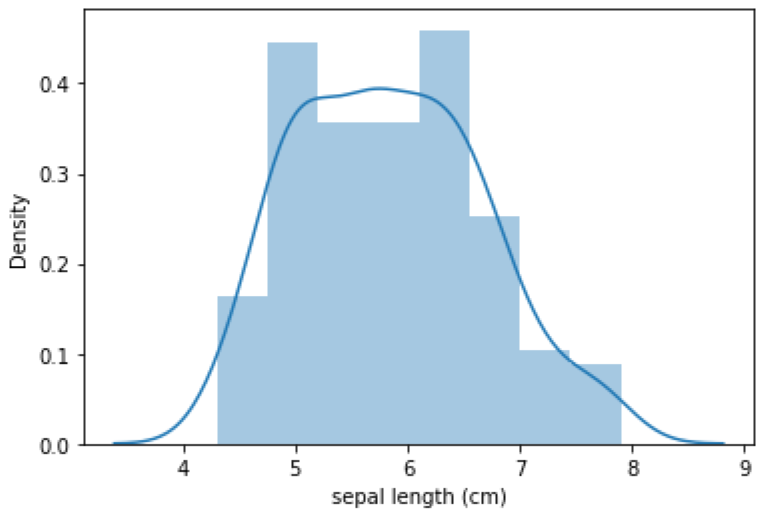
```
colname
```

```
Out[18]: Index(['sepal length (cm)', 'sepal width (cm)', 'petal length (cm)',
               'petal width (cm)'],
              dtype='object')
```

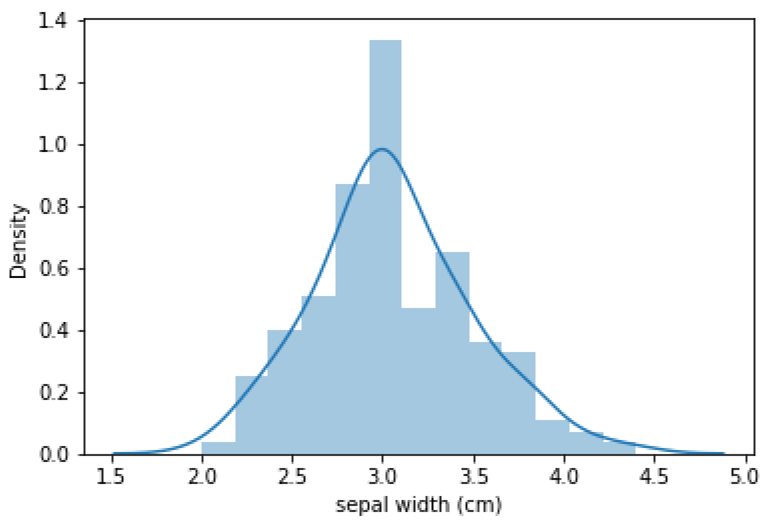
```
In [20]: from scipy.stats import skew
```

```
In [21]: for i in df[colname]:
             print(i)
             print(skew(df[i]))
             sns.distplot(df[i])
             plt.show()
```

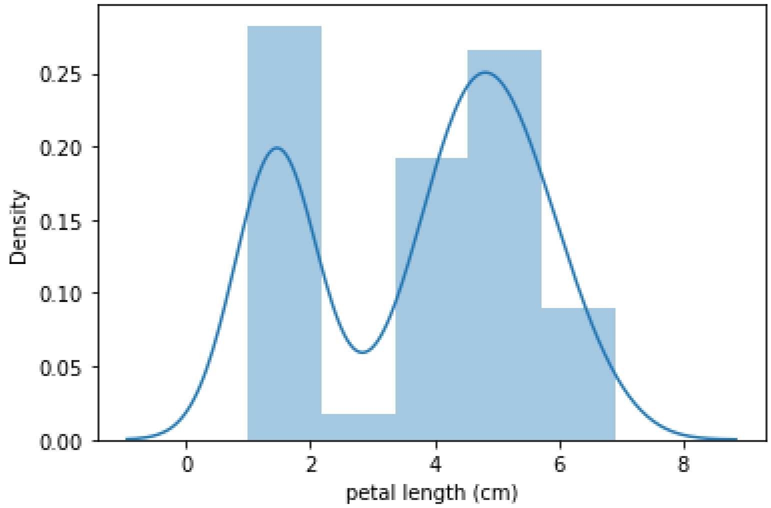
```
sepal length (cm)
0.3117530585022963
```



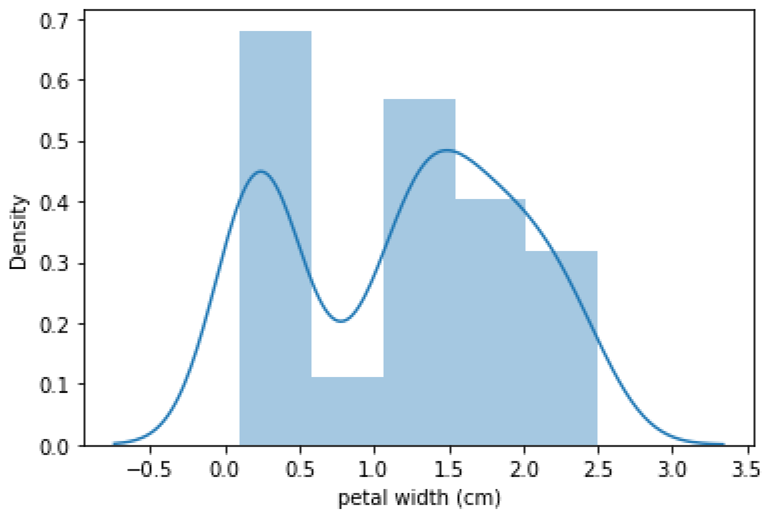

```
sepal width (cm)
0.31576710633893473
```




```
petal length (cm)
-0.2721276664567214
```

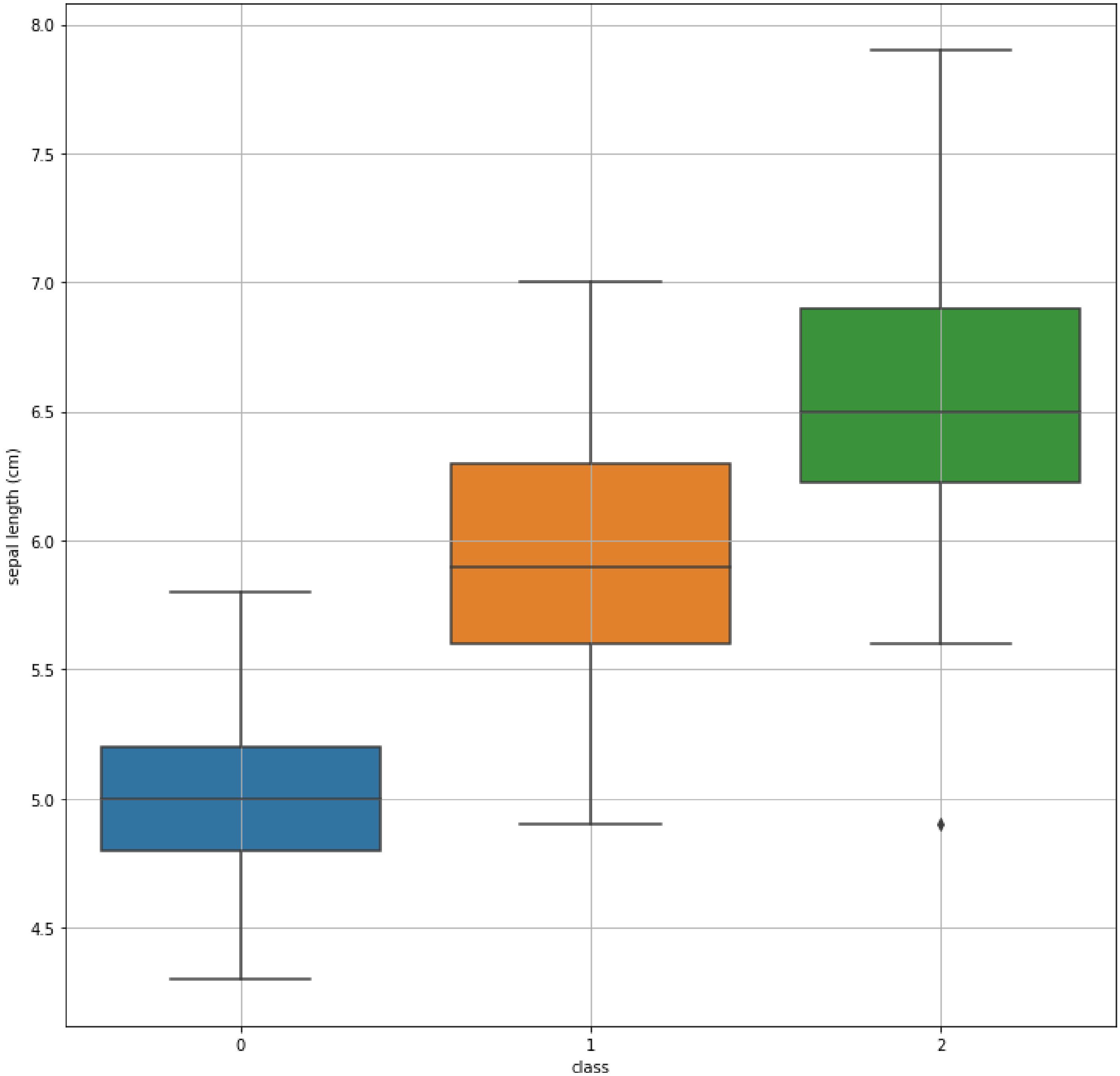



```
petal width (cm)
-0.10193420656560036
```

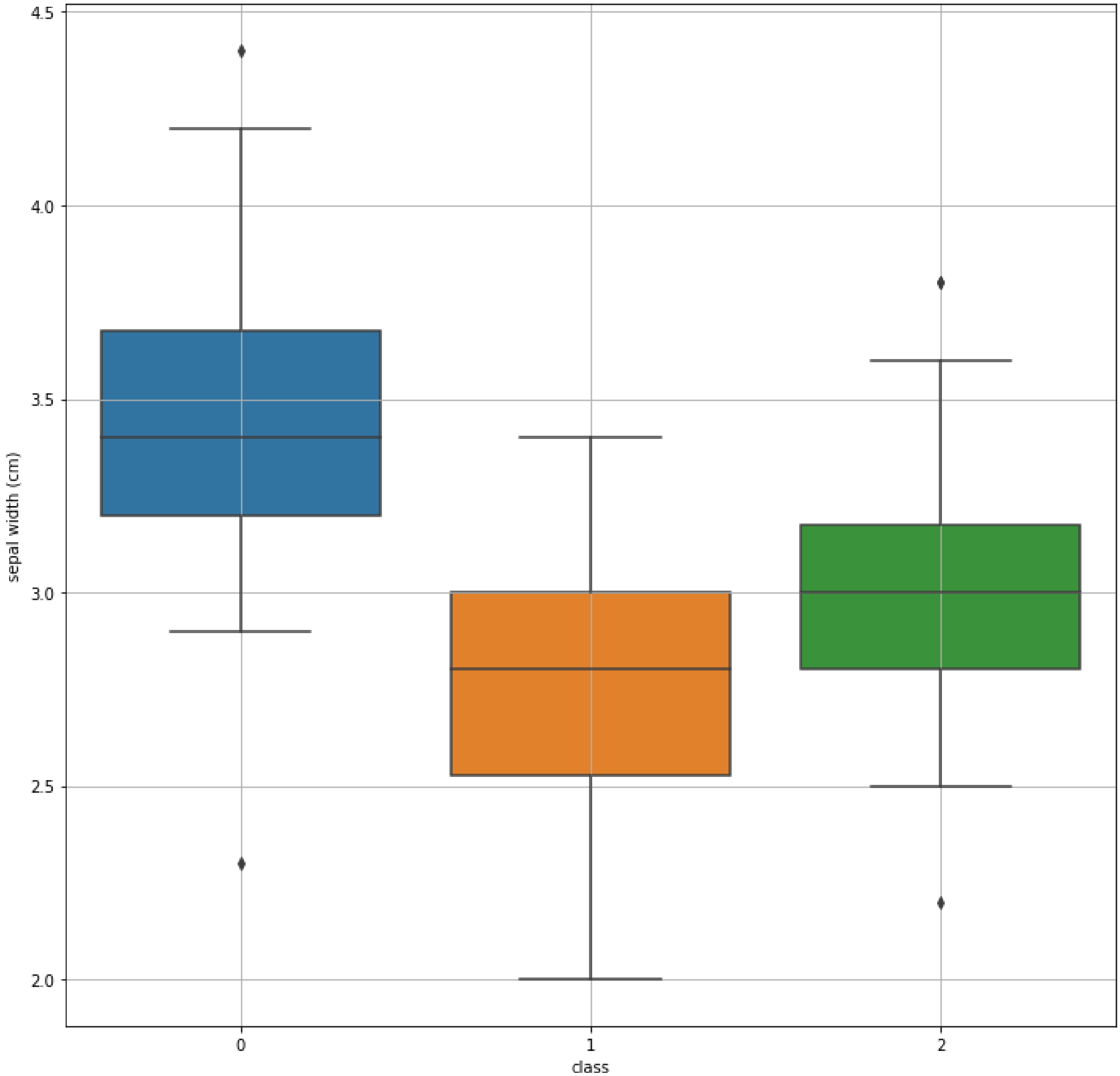


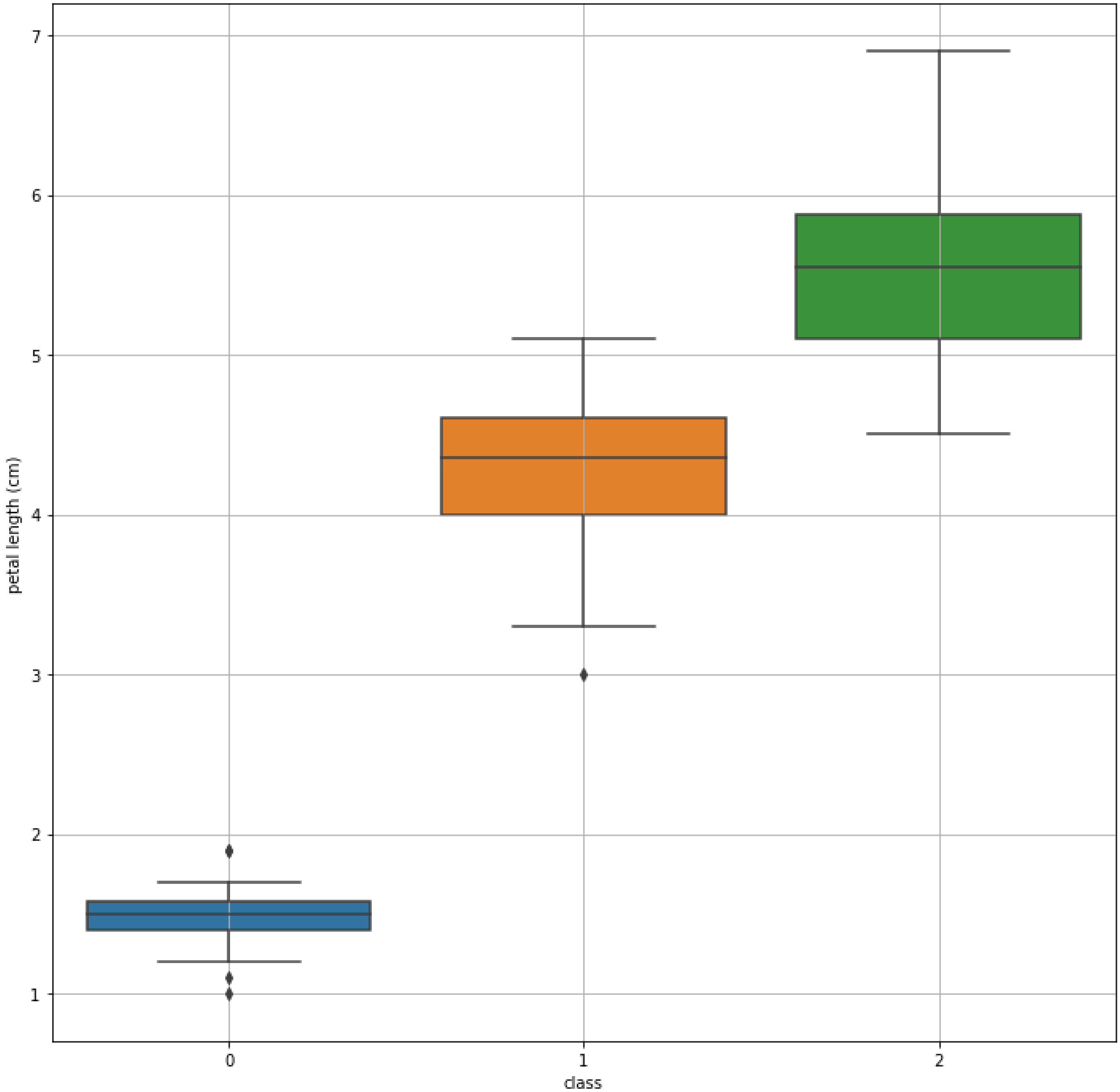
In [24]:

```
for i in df[colname]:
    plt.figure(figsize=(12,12))
    sns.boxplot(x='class',y=df[i],data=df)
    plt.grid()
    plt.show()
```

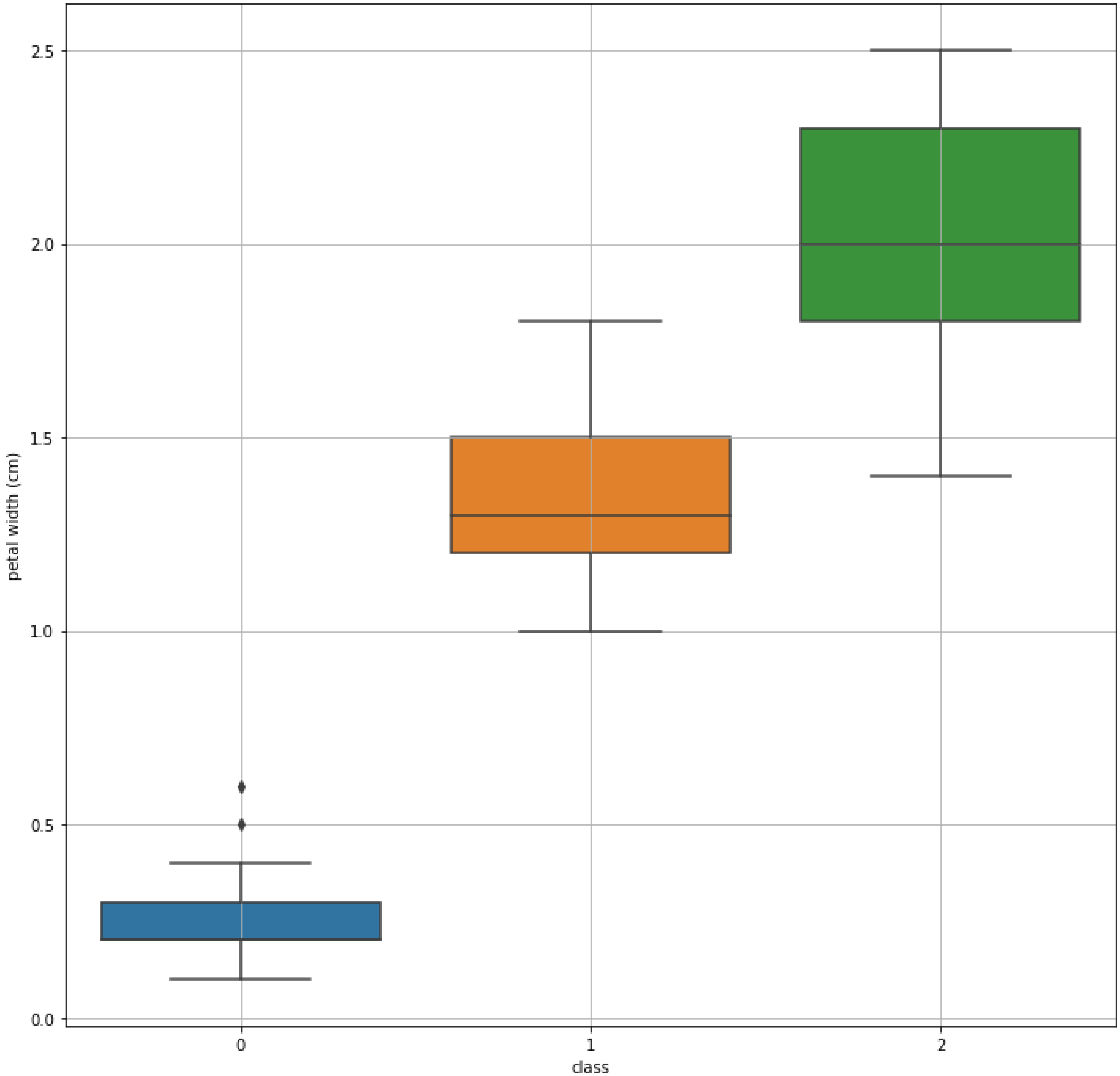


8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
sepal length (cm)
0
1
2
class


4.5
4.0
3.5
3.0
2.5
2.0
sepal width (cm)
0
1
2
class



7
6
5
4
3
2
1
petal length (cm)
0
1
2
class



In [25]:
```
x=df.iloc[:,:-1]
y=df.iloc[:,-1]
```

In [26]:
```
from sklearn.model_selection import train_test_split
```

In [27]:
```
xtrain,xtest,ytrain,ytest=train_test_split(x,y,test_size=0.3,random_state=1)
```

In [28]:
```
def mymodel(model):
    #model creation
    model.fit(xtrain,ytrain)
    ypred=model.predict(xtest)
    #checking bias and variance
    train=model.score(xtrain,ytrain)
    test=model.score(xtest,ytest)
    print(f'training acc :{train}\ntesting acc :{test}')
    #checking accuracy
```

```python
    print(classification_report(ytest,ypred))
    return model
```

In [38]:

```python
from sklearn.neighbors import KNeighborsClassifier
from sklearn.linear_model import LogisticRegression
from sklearn.svm import SVC
from sklearn.tree import DecisionTreeClassifier
from sklearn.metrics import classification_report
```

In [41]:

```python
knn=mymodel(KNeighborsClassifier())
```

```
training acc :0.9523809523809523
testing acc :0.9777777777777777
              precision    recall  f1-score   support

           0       1.00      1.00      1.00        14
           1       0.95      1.00      0.97        18
           2       1.00      0.92      0.96        13

    accuracy                           0.98        45
   macro avg       0.98      0.97      0.98        45
weighted avg       0.98      0.98      0.98        45
```

In [42]:

```python
logreg=mymodel(LogisticRegression())
```

```
training acc :0.9809523809523809
testing acc :0.9777777777777777
              precision    recall  f1-score   support

           0       1.00      1.00      1.00        14
           1       1.00      0.94      0.97        18
           2       0.93      1.00      0.96        13

    accuracy                           0.98        45
   macro avg       0.98      0.98      0.98        45
weighted avg       0.98      0.98      0.98        45
```

In [43]:

```python
svm=mymodel(SVC())
```

```
training acc :0.9619047619047619
testing acc :0.9777777777777777
              precision    recall  f1-score   support

           0       1.00      1.00      1.00        14
           1       1.00      0.94      0.97        18
           2       0.93      1.00      0.96        13

    accuracy                           0.98        45
   macro avg       0.98      0.98      0.98        45
weighted avg       0.98      0.98      0.98        45
```

In [44]:

```python
dt=mymodel(DecisionTreeClassifier())
```

```
training acc :1.0
testing acc :0.9555555555555556
              precision    recall  f1-score   support

           0       1.00      1.00      1.00        14
```

```
           1       0.94      0.94      0.94        18
           2       0.92      0.92      0.92        13

    accuracy                           0.96        45
   macro avg       0.96      0.96      0.96        45
weighted avg       0.96      0.96      0.96        45
```

In [53]:

```python
parameters={
    'criterion': ['gini','entropy'],
    'max_depth': list(range(1,20)),
    'min_samples_leaf': list(range(1,20))
}
```

In [54]:

```python
from sklearn.model_selection import GridSearchCV
grid=GridSearchCV(DecisionTreeClassifier(),parameters,verbose=3)
grid.fit(xtrain,ytrain)
```

```
Fitting 5 folds for each of 722 candidates, totalling 3610 fits
[CV 1/5] END criterion=gini, max_depth=1, min_samples_leaf=1;, score=0.714 total time=
0.0s
[CV 2/5] END criterion=gini, max_depth=1, min_samples_leaf=1;, score=0.714 total time=
0.0s
[CV 3/5] END criterion=gini, max_depth=1, min_samples_leaf=1;, score=0.714 total time=
0.0s
[CV 4/5] END criterion=gini, max_depth=1, min_samples_leaf=1;, score=0.667 total time=
0.0s
[CV 5/5] END criterion=gini, max_depth=1, min_samples_leaf=1;, score=0.667 total time=
0.0s
[CV 1/5] END criterion=gini, max_depth=1, min_samples_leaf=2;, score=0.714 total time=
0.0s
[CV 2/5] END criterion=gini, max_depth=1, min_samples_leaf=2;, score=0.714 total time=
0.0s
[CV 3/5] END criterion=gini, max_depth=1, min_samples_leaf=2;, score=0.714 total time=
0.0s
[CV 4/5] END criterion=gini, max_depth=1, min_samples_leaf=2;, score=0.667 total time=
0.0s
[CV 5/5] END criterion=gini, max_depth=1, min_samples_leaf=2;, score=0.667 total time=
0.0s
[CV 1/5] END criterion=gini, max_depth=1, min_samples_leaf=3;, score=0.714 total time=
0.0s
[CV 2/5] END criterion=gini, max_depth=1, min_samples_leaf=3;, score=0.714 total time=
0.0s
[CV 3/5] END criterion=gini, max_depth=1, min_samples_leaf=3;, score=0.714 total time=
0.0s
[CV 4/5] END criterion=gini, max_depth=1, min_samples_leaf=3;, score=0.667 total time=
0.0s
[CV 5/5] END criterion=gini, max_depth=1, min_samples_leaf=3;, score=0.667 total time=
0.0s
[CV 1/5] END criterion=gini, max_depth=1, min_samples_leaf=4;, score=0.714 total time=
0.0s
[CV 2/5] END criterion=gini, max_depth=1, min_samples_leaf=4;, score=0.714 total time=
0.0s
[CV 3/5] END criterion=gini, max_depth=1, min_samples_leaf=4;, score=0.714 total time=
0.0s
[CV 4/5] END criterion=gini, max_depth=1, min_samples_leaf=4;, score=0.667 total time=
0.0s
[CV 5/5] END criterion=gini, max_depth=1, min_samples_leaf=4;, score=0.667 total time=
0.0s
[CV 1/5] END criterion=gini, max_depth=1, min_samples_leaf=5;, score=0.714 total time=
0.0s
[CV 2/5] END criterion=gini, max_depth=1, min_samples_leaf=5;, score=0.714 total time=
0.0s
```

```
[CV 3/5] END criterion=gini, max_depth=1, min_samples_leaf=5;, score=0.714 total time=
0.0s
[CV 4/5] END criterion=gini, max_depth=1, min_samples_leaf=5;, score=0.667 total time=
0.0s
[CV 5/5] END criterion=gini, max_depth=1, min_samples_leaf=5;, score=0.667 total time=
0.0s
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   0.0s
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   0.0s
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[CV 2/5] END criterion=entropy, max_depth=18, min_samples_leaf=10;, score=0.810 total time
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[CV 4/5] END criterion=entropy, max_depth=18, min_samples_leaf=11;, score=0.952 total time
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[CV 2/5] END criterion=entropy, max_depth=18, min_samples_leaf=14;, score=0.810 total time
=   0.0s
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[CV 3/5] END criterion=entropy, max_depth=18, min_samples_leaf=14;, score=1.000 total time
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```

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```

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[CV 2/5] END criterion=entropy, max_depth=19, min_samples_leaf=10;, score=0.810 total time
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[CV 2/5] END criterion=entropy, max_depth=19, min_samples_leaf=11;, score=0.810 total time
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[CV 3/5] END criterion=entropy, max_depth=19, min_samples_leaf=11;, score=1.000 total time
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[CV 3/5] END criterion=entropy, max_depth=19, min_samples_leaf=12;, score=1.000 total time
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[CV 5/5] END criterion=entropy, max_depth=19, min_samples_leaf=12;, score=0.857 total time
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[CV 4/5] END criterion=entropy, max_depth=19, min_samples_leaf=13;, score=0.952 total time
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[CV 5/5] END criterion=entropy, max_depth=19, min_samples_leaf=13;, score=0.857 total time
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[CV 1/5] END criterion=entropy, max_depth=19, min_samples_leaf=14;, score=1.000 total time
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[CV 3/5] END criterion=entropy, max_depth=19, min_samples_leaf=14;, score=1.000 total time
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[CV 5/5] END criterion=entropy, max_depth=19, min_samples_leaf=14;, score=0.857 total time
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[CV 5/5] END criterion=entropy, max_depth=19, min_samples_leaf=18;, score=0.857 total time
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=   0.0s
[CV 5/5] END criterion=entropy, max_depth=19, min_samples_leaf=19;, score=0.857 total time
=   0.0s
```

Out[54]:

```
GridSearchCV(estimator=DecisionTreeClassifier(),
             param_grid={'criterion': ['gini', 'entropy'],
                         'max_depth': [1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12,
                                       13, 14, 15, 16, 17, 18, 19],
                         'min_samples_leaf': [1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11,
                                              12, 13, 14, 15, 16, 17, 18, 19]},
             verbose=3)
```

In [55]:

```
grid.best_score_
```

Out[55]:

```
0.9523809523809523
```

In [56]:

```
grid.best_estimator_
```

Out[56]:

```
DecisionTreeClassifier(max_depth=3)
```

In [57]:

```
dt=mymodel(grid.best_estimator_)
```

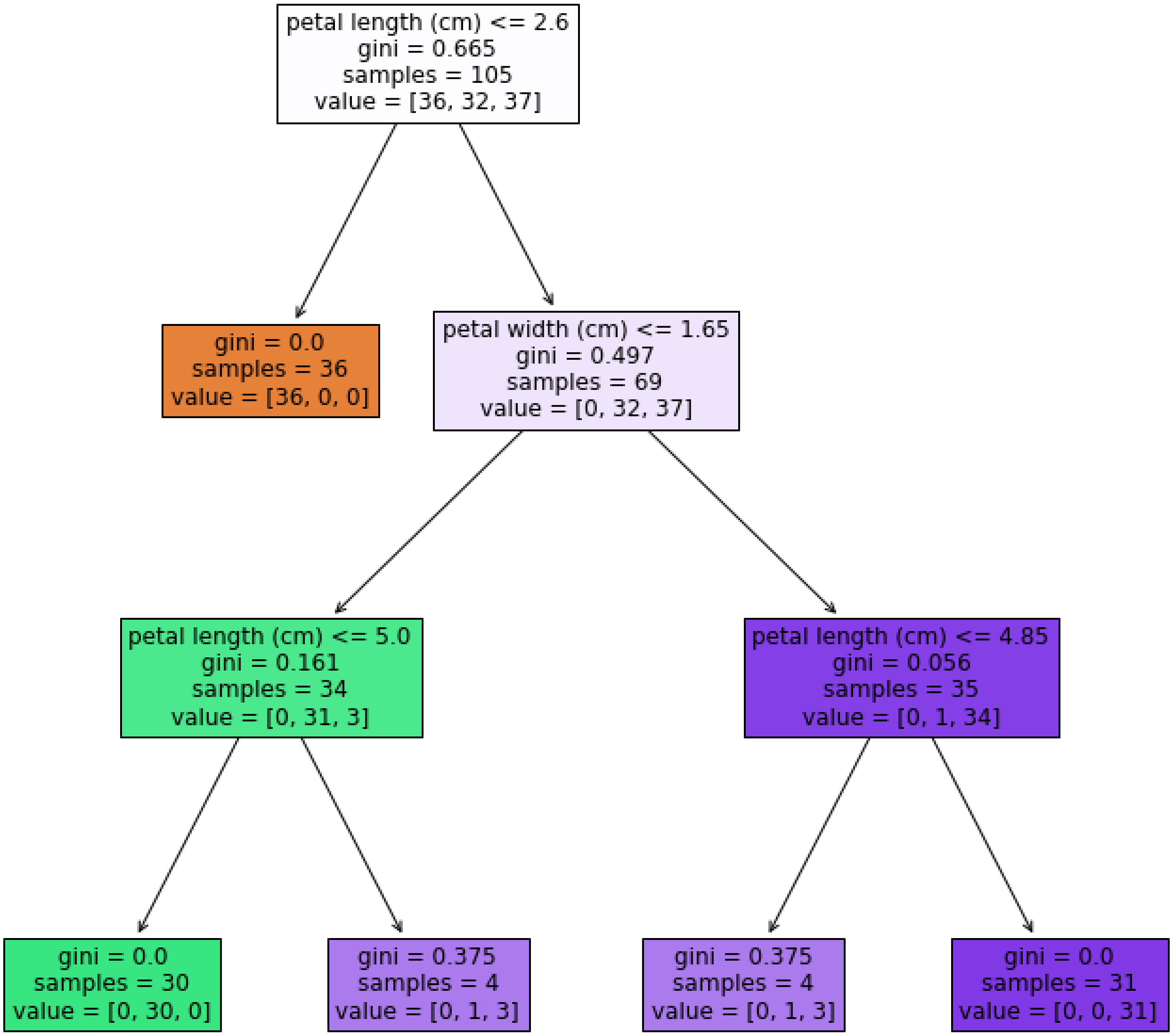
```
training acc :0.9809523809523809
testing acc :0.9555555555555556
              precision    recall  f1-score   support

           0       1.00      1.00      1.00        14
           1       0.94      0.94      0.94        18
           2       0.92      0.92      0.92        13

    accuracy                           0.96        45
   macro avg       0.96      0.96      0.96        45
weighted avg       0.96      0.96      0.96        45
```

In [58]:

```
from sklearn import tree
```

In [59]:

```
plt.figure(figsize=(12,12))
tree.plot_tree(dt,feature_names=iris.feature_names,filled=True)
plt.show()
```


petal length (cm) <= 2.6
gini = 0.665
samples = 105
value = [36, 32, 37]
gini = 0.0
samples = 36
value = [36, 0, 0]
petal width (cm) <= 1.65
gini = 0.497
samples = 69
value = [0, 32, 37]
petal length (cm) <= 5.0
gini = 0.161
samples = 34
value = [0, 31, 3]
petal length (cm) <= 4.85
gini = 0.056
samples = 35
value = [0, 1, 34]
gini = 0.0
samples = 30
value = [0, 30, 0]
gini = 0.375
samples = 4
value = [0, 1, 3]
gini = 0.375
samples = 4
value = [0, 1, 3]
gini = 0.0
samples = 31
value = [0, 0, 31]

In [ ]: