In [41]:

```
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
import seaborn as sns
from sklearn.decomposition import PCA
from sklearn.naive_bayes import MultinomialNB
from sklearn.tree import DecisionTreeClassifier
from sklearn.naive_bayes import GaussianNB
from sklearn.svm import SVC
from sklearn.ensemble import RandomForestClassifier
from sklearn.model_selection import train_test_split
from sklearn.metrics import accuracy_score,confusion_matrix,classification_report
import warnings
warnings.filterwarnings('ignore')
```

In [7]:

```
wine=pd.read_csv('winedataset.csv')
```

In [8]:

```
wine.head()
```

Out[8]:

	Class	Alcohol	Malic acid	Ash	Alcalinity of ash	Magnesium	Total phenols	Flavanoids	Nonflavanoid phenols	Proanthocyanins	Color intensity	Hue	diluted wines	Pr
0	1	14.23	1.71	2.43	15.6	127	2.80	3.06	0.28	2.29	5.64	1.04	3.92	
1	1	13.20	1.78	2.14	11.2	100	2.65	2.76	0.26	1.28	4.38	1.05	3.40	
2	1	13.16	2.36	2.67	18.6	101	2.80	3.24	0.30	2.81	5.68	1.03	3.17	
3	1	14.37	1.95	2.50	16.8	113	3.85	3.49	0.24	2.18	7.80	0.86	3.45	
4	1	13.24	2.59	2.87	21.0	118	2.80	2.69	0.39	1.82	4.32	1.04	2.93	

In [9]:

```
wine.shape
```

Out[9]:

```
(178, 14)
```

In [10]:

```
wine.dtypes
```

Out[10]:

```
Class                     int64
Alcohol                 float64
Malic acid              float64
Ash                     float64
Alcalinity of ash       float64
Magnesium                 int64
Total phenols           float64
Flavanoids              float64
Nonflavanoid phenols    float64
Proanthocyanins         float64
Color intensity         float64
Hue                     float64
diluted wines           float64
Proline                   int64
dtype: object
```

In [11]:

```
wine.columns
```

Out[11]:

```
Index(['Class', 'Alcohol', 'Malic acid', 'Ash', 'Alcalinity of ash',
       'Magnesium', 'Total phenols', 'Flavanoids', 'Nonflavanoid phenols',
       'Proanthocyanins', 'Color intensity', 'Hue', 'diluted wines',
       'Proline    '],
      dtype='object')
```

In [12]:

```
wine.describe()
```

Out[12]:

	Class	Alcohol	Malic acid	Ash	Alcalinity of ash	Magnesium	Total phenols	Flavanoids	Nonflavanoid phenols	Proanthocyanin
count	178.000000	178.000000	178.000000	178.000000	178.000000	178.000000	178.000000	178.000000	178.000000	178.00000
mean	1.938202	13.000618	2.336348	2.366517	19.494944	99.741573	2.295112	2.029270	0.361854	1.59089
std	0.775035	0.811827	1.117146	0.274344	3.339564	14.282484	0.625851	0.998859	0.124453	0.57235
min	1.000000	11.030000	0.740000	1.360000	10.600000	70.000000	0.980000	0.340000	0.130000	0.41000
25%	1.000000	12.362500	1.602500	2.210000	17.200000	88.000000	1.742500	1.205000	0.270000	1.25000
50%	2.000000	13.050000	1.865000	2.360000	19.500000	98.000000	2.355000	2.135000	0.340000	1.55500
75%	3.000000	13.677500	3.082500	2.557500	21.500000	107.000000	2.800000	2.875000	0.437500	1.95000
max	3.000000	14.830000	5.800000	3.230000	30.000000	162.000000	3.880000	5.080000	0.660000	3.58000

In [13]:

```
wine.Class.unique()
```

Out[13]:

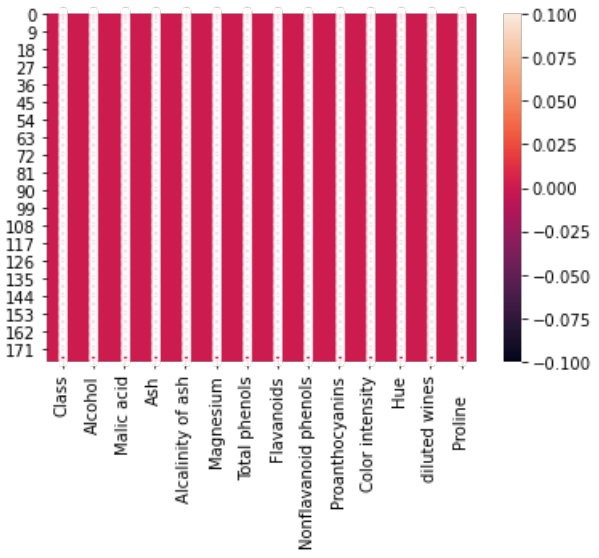
```
array([1, 2, 3], dtype=int64)
```

In [14]:

```
sns.heatmap(wine.isnull(),annot=True)
```

Out[14]:

```
<matplotlib.axes._subplots.AxesSubplot at 0x1f7b129bc70>
```



In [16]:

```
wine.corr()
```

Out[16]:

	Class	Alcohol	Malic acid	Ash	Alcalinity of ash	Magnesium	Total phenols	Flavanoids	Nonflavanoid phenols	Proanthocyanins
Class	1.000000	-0.328222	0.437776	-0.049643	0.517859	-0.209179	-0.719163	-0.847498	0.489109	-0.499130
Alcohol	-0.328222	1.000000	0.094397	0.211545	-0.310235	0.270798	0.289101	0.236815	-0.155929	0.136698
Malic acid	0.437776	0.094397	1.000000	0.164045	0.288500	-0.054575	-0.335167	-0.411007	0.292977	-0.220746
Ash	-0.049643	0.211545	0.164045	1.000000	0.443367	0.286587	0.128980	0.115077	0.186230	0.009652
Alcalinity of ash	0.517859	-0.310235	0.288500	0.443367	1.000000	-0.083333	-0.321113	-0.351370	0.361922	-0.197327
Magnesium	-0.209179	0.270798	-0.054575	0.286587	-0.083333	1.000000	0.214401	0.195784	-0.256294	0.236441
Total phenols	-0.719163	0.289101	-0.335167	0.128980	-0.321113	0.214401	1.000000	0.864564	-0.449935	0.612413
Flavanoids	-0.847498	0.236815	-0.411007	0.115077	-0.351370	0.195784	0.864564	1.000000	-0.537900	0.652692
Nonflavanoid phenols	0.489109	-0.155929	0.292977	0.186230	0.361922	-0.256294	-0.449935	-0.537900	1.000000	-0.365845
Proanthocyanins	-0.499130	0.136698	-0.220746	0.009652	-0.197327	0.236441	0.612413	0.652692	-0.365845	1.000000
Color intensity	0.265668	0.546364	0.248985	0.258887	0.018732	0.199950	-0.055136	-0.172379	0.139057	-0.025250
Hue	-0.617369	-0.071747	-0.561296	-0.074667	-0.273955	0.055398	0.433681	0.543479	-0.262640	0.295544
diluted wines	-0.788230	0.072343	-0.368710	0.003911	-0.276769	0.066004	0.699949	0.787194	-0.503270	0.519067
Proline	-0.633717	0.643720	-0.192011	0.223626	-0.440597	0.393351	0.498115	0.494193	-0.311385	0.330417

In [17]:

```
plt.figure(figsize=(9,5))
```

Out[17]:

```
<Figure size 648x360 with 0 Axes>
```


```
<Figure size 648x360 with 0 Axes>
```


In [18]:

```
wine.skew()
```

Out[18]:

```
Class                 0.107431
Alcohol              -0.051482
Malic acid            1.039651
Ash                  -0.176699
Alcalinity of ash     0.213047
Magnesium             1.098191
Total phenols         0.086639
Flavanoids            0.025344
Nonflavanoid phenols  0.450151
Proanthocyanins       0.517137
Color intensity       0.868585
Hue                   0.021091
diluted wines        -0.307285
Proline               0.767822
```

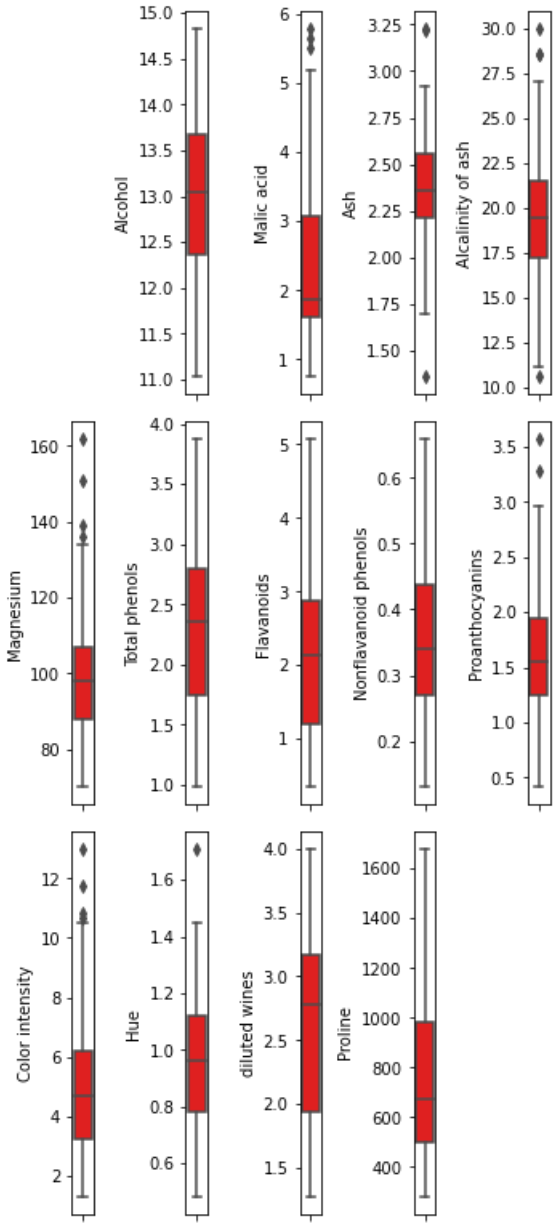
```
dtype: float64
```

In [17]:

```
col=wine.columns.values
ncol=5
nrow=7
```

In [18]:

```
plt.figure(figsize=(ncol,5*ncol))
for i in range(1,len(col)):
    plt.subplot(nrow,ncol,i+1)
    sns.boxplot(wine[col[i]],color='red',orient='v')
    plt.tight_layout()
```



In [19]:

```
from scipy.stats import zscore
z_score=abs(zscore(wine))
print(wine.shape)
wine_df=wine.loc[(z_score<3).all(axis=1)]
print(wine_df.shape)
```

```
(178, 14)
(168, 14)
```

In [20]:

```
wine_df
```

Out[20]:

	Class	Alcohol	Malic acid	Ash	Alcalinity of ash	Magnesium	Total phenols	Flavanoids	Nonflavanoid phenols	Proanthocyanins	Color intensity	Hue	diluted wines
0	1	14.23	1.71	2.43	15.6	127	2.80	3.06	0.28	2.29	5.64	1.04	3.92
1	1	13.20	1.78	2.14	11.2	100	2.65	2.76	0.26	1.28	4.38	1.05	3.40
2	1	13.16	2.36	2.67	18.6	101	2.80	3.24	0.30	2.81	5.68	1.03	3.17
3	1	14.37	1.95	2.50	16.8	113	3.85	3.49	0.24	2.18	7.80	0.86	3.45
4	1	13.24	2.59	2.87	21.0	118	2.80	2.69	0.39	1.82	4.32	1.04	2.93
...	...	...	...	...	...	...	...	...	...	...	...	...	...
173	3	13.71	5.65	2.45	20.5	95	1.68	0.61	0.52	1.06	7.70	0.64	1.74
174	3	13.40	3.91	2.48	23.0	102	1.80	0.75	0.43	1.41	7.30	0.70	1.56
175	3	13.27	4.28	2.26	20.0	120	1.59	0.69	0.43	1.35	10.20	0.59	1.56
176	3	13.17	2.59	2.37	20.0	120	1.65	0.68	0.53	1.46	9.30	0.60	1.62
177	3	14.13	4.10	2.74	24.5	96	2.05	0.76	0.56	1.35	9.20	0.61	1.60

168 rows × 14 columns

In [21]:

```
wine_df=pd.DataFrame(data=wine_df)
```

In [22]:

```
wine_df
```

Out[22]:

	Class	Alcohol	Malic acid	Ash	Alcalinity of ash	Magnesium	Total phenols	Flavanoids	Nonflavanoid phenols	Proanthocyanins	Color intensity	Hue	diluted wines
0	1	14.23	1.71	2.43	15.6	127	2.80	3.06	0.28	2.29	5.64	1.04	3.92
1	1	13.20	1.78	2.14	11.2	100	2.65	2.76	0.26	1.28	4.38	1.05	3.40
2	1	13.16	2.36	2.67	18.6	101	2.80	3.24	0.30	2.81	5.68	1.03	3.17
3	1	14.37	1.95	2.50	16.8	113	3.85	3.49	0.24	2.18	7.80	0.86	3.45
4	1	13.24	2.59	2.87	21.0	118	2.80	2.69	0.39	1.82	4.32	1.04	2.93
...	...	...	...	...	...	...	...	...	...	...	...	...	...
173	3	13.71	5.65	2.45	20.5	95	1.68	0.61	0.52	1.06	7.70	0.64	1.74
174	3	13.40	3.91	2.48	23.0	102	1.80	0.75	0.43	1.41	7.30	0.70	1.56
175	3	13.27	4.28	2.26	20.0	120	1.59	0.69	0.43	1.35	10.20	0.59	1.56
176	3	13.17	2.59	2.37	20.0	120	1.65	0.68	0.53	1.46	9.30	0.60	1.62
177	3	14.13	4.10	2.74	24.5	96	2.05	0.76	0.56	1.35	9.20	0.61	1.60

168 rows × 14 columns

In [23]:

```
print(wine.shape)
wine_df=wine.loc[(z_score<3).all(axis=1)]
print(wine_df.shape)
```

```
(178, 14)
(168, 14)
```

In [24]:

```
x=wine_df.iloc[:,1:-1]
```

In [25]:

```
x
```

Out[25]:

	Alcohol	Malic acid	Ash	Alcalinity of ash	Magnesium	Total phenols	Flavanoids	Nonflavanoid phenols	Proanthocyanins	Color intensity	Hue	diluted wines
0	14.23	1.71	2.43	15.6	127	2.80	3.06	0.28	2.29	5.64	1.04	3.92
1	13.20	1.78	2.14	11.2	100	2.65	2.76	0.26	1.28	4.38	1.05	3.40
2	13.16	2.36	2.67	18.6	101	2.80	3.24	0.30	2.81	5.68	1.03	3.17
3	14.37	1.95	2.50	16.8	113	3.85	3.49	0.24	2.18	7.80	0.86	3.45
4	13.24	2.59	2.87	21.0	118	2.80	2.69	0.39	1.82	4.32	1.04	2.93
...	...	...	...	...	...	...	...	...	...	...	...	...
173	13.71	5.65	2.45	20.5	95	1.68	0.61	0.52	1.06	7.70	0.64	1.74
174	13.40	3.91	2.48	23.0	102	1.80	0.75	0.43	1.41	7.30	0.70	1.56
175	13.27	4.28	2.26	20.0	120	1.59	0.69	0.43	1.35	10.20	0.59	1.56
176	13.17	2.59	2.37	20.0	120	1.65	0.68	0.53	1.46	9.30	0.60	1.62
177	14.13	4.10	2.74	24.5	96	2.05	0.76	0.56	1.35	9.20	0.61	1.60

168 rows × 12 columns

In [26]:

```
x.shape
```

Out[26]:

```
(168, 12)
```

In [27]:

```
y=wine_df.iloc[:,0]
```

In [28]:

```
y
```

Out[28]:

```
0       1
1       1
2       1
3       1
4       1
       ..
173     3
174     3
175     3
176     3
177     3
Name: Class, Length: 168, dtype: int64
```

In [29]:

```
y.shape
```

Out[29]:

```
(168,)
```

In [30]:

```
x_train,x_test,y_train,y_test=train_test_split(x,y,test_size=.22,random_state=50)
```

In [35]:

```
from sklearn.neighbors import KNeighborsClassifier
knn=KNeighborsClassifier()
knn.fit(x_train,y_train)
knn.score(x_train,y_train)
predknn=knn.predict(x_test)
print(accuracy_score(y_test,predknn))
print(confusion_matrix(y_test,predknn))
print(classification_report(y_test,predknn))
```

```
0.8648648648648649
[[10  1  1]
 [ 0 11  0]
 [ 2  1 11]]
              precision    recall  f1-score   support

           1       0.83      0.83      0.83        12
           2       0.85      1.00      0.92        11
           3       0.92      0.79      0.85        14

    accuracy                           0.86        37
   macro avg       0.87      0.87      0.87        37
weighted avg       0.87      0.86      0.86        37
```

In [36]:

```
rf=RandomForestClassifier(n_estimators=100,random_state=42)
rf.fit(x_train,y_train)
predrf=rf.predict(x_test)
print(accuracy_score(y_test,predrf))
print(confusion_matrix(y_test,predrf))
print(classification_report(y_test,predrf))
```

```
0.972972972972973
[[12  0  0]
 [ 1 10  0]
 [ 0  0 14]]
              precision    recall  f1-score   support

           1       0.92      1.00      0.96        12
           2       1.00      0.91      0.95        11
           3       1.00      1.00      1.00        14

    accuracy                           0.97        37
   macro avg       0.97      0.97      0.97        37
weighted avg       0.98      0.97      0.97        37
```

In [42]:

```
gnb=GaussianNB()
gnb.fit(x_train,y_train)
gnb.score(x_train,y_train)
predgnb=gnb.predict(x_test)
print(accuracy_score(y_test,predgnb))
print(confusion_matrix(y_test,predgnb))
print(classification_report(y_test,predgnb))
```

```
0.972972972972973
[[12  0  0]
 [ 1 10  0]
 [ 0  0 14]]
              precision    recall  f1-score   support
```

```
           1       0.92      1.00      0.96        12
           2       1.00      0.91      0.95        11
           3       1.00      1.00      1.00        14

    accuracy                           0.97        37
   macro avg       0.97      0.97      0.97        37
weighted avg       0.98      0.97      0.97        37
```

In [43]:

```
dtc=DecisionTreeClassifier()
dtc.fit(x_train,y_train)
dtc.score(x_train,y_train)
preddtc=dtc.predict(x_test)
print(accuracy_score(y_test,preddtc))
print(confusion_matrix(y_test,preddtc))
print(classification_report(y_test,preddtc))
```

```
0.972972972972973
[[11  1  0]
 [ 0 11  0]
 [ 0  0 14]]
              precision    recall  f1-score   support

           1       1.00      0.92      0.96        12
           2       0.92      1.00      0.96        11
           3       1.00      1.00      1.00        14

    accuracy                           0.97        37
   macro avg       0.97      0.97      0.97        37
weighted avg       0.98      0.97      0.97        37
```

In [44]:

```
#DecisionTreeClassifier
import joblib
joblib.dump(dtc,'wine.pkl')
```

Out[44]:

```
['wine.pkl']
```