

In [1]:

```
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
import seaborn as sns
from IPython import get_ipython
import warnings
warnings.filterwarnings("ignore")
```

In [2]:

```
data = pd.read_csv("creditcard.csv")
```

In [3]:

```
data.head()
```

Out[3]:

|   | Time | V1        | V2        | V3       | V4        | V5        | V6        | V7        | V8        |
|---|------|-----------|-----------|----------|-----------|-----------|-----------|-----------|-----------|
| 0 | 0.0  | -1.359807 | -0.072781 | 2.536347 | 1.378155  | -0.338321 | 0.462388  | 0.239599  | 0.098698  |
| 1 | 0.0  | 1.191857  | 0.266151  | 0.166480 | 0.448154  | 0.060018  | -0.082361 | -0.078803 | 0.085102  |
| 2 | 1.0  | -1.358354 | -1.340163 | 1.773209 | 0.379780  | -0.503198 | 1.800499  | 0.791461  | 0.247676  |
| 3 | 1.0  | -0.966272 | -0.185226 | 1.792993 | -0.863291 | -0.010309 | 1.247203  | 0.237609  | 0.377436  |
| 4 | 2.0  | -1.158233 | 0.877737  | 1.548718 | 0.403034  | -0.407193 | 0.095921  | 0.592941  | -0.270533 |

5 rows × 31 columns

In [4]:

```
data.tail()
```

Out[4]:

|        | Time     | V1         | V2        | V3        | V4        | V5        | V6        | V7        |
|--------|----------|------------|-----------|-----------|-----------|-----------|-----------|-----------|
| 284802 | 172786.0 | -11.881118 | 10.071785 | -9.834783 | -2.066656 | -5.364473 | -2.606837 | -4.918215 |
| 284803 | 172787.0 | -0.732789  | -0.055080 | 2.035030  | -0.738589 | 0.868229  | 1.058415  | 0.024330  |
| 284804 | 172788.0 | 1.919565   | -0.301254 | -3.249640 | -0.557828 | 2.630515  | 3.031260  | -0.296827 |
| 284805 | 172788.0 | -0.240440  | 0.530483  | 0.702510  | 0.689799  | -0.377961 | 0.623708  | -0.686180 |
| 284806 | 172792.0 | -0.533413  | -0.189733 | 0.703337  | -0.506271 | -0.012546 | -0.649617 | 1.577006  |

5 rows × 31 columns

In [5]:



```
data.shape
```

Out[5]:

```
(284807, 31)
```

In [6]:



```
data.columns
```

Out[6]:

```
Index(['Time', 'V1', 'V2', 'V3', 'V4', 'V5', 'V6', 'V7', 'V8', 'V9', 'V10',  
      'V11', 'V12', 'V13', 'V14', 'V15', 'V16', 'V17', 'V18', 'V19', 'V20',  
      'V21', 'V22', 'V23', 'V24', 'V25', 'V26', 'V27', 'V28', 'Amount',  
      'Class'],  
      dtype='object')
```

In [7]:



```
data.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 284807 entries, 0 to 284806
Data columns (total 31 columns):
 #   Column      Non-Null Count  Dtype
---  -
 0   Time        284807 non-null float64
 1   V1          284807 non-null float64
 2   V2          284807 non-null float64
 3   V3          284807 non-null float64
 4   V4          284807 non-null float64
 5   V5          284807 non-null float64
 6   V6          284807 non-null float64
 7   V7          284807 non-null float64
 8   V8          284807 non-null float64
 9   V9          284807 non-null float64
10  V10         284807 non-null float64
11  V11         284807 non-null float64
12  V12         284807 non-null float64
13  V13         284807 non-null float64
14  V14         284807 non-null float64
15  V15         284807 non-null float64
16  V16         284807 non-null float64
17  V17         284807 non-null float64
18  V18         284807 non-null float64
19  V19         284807 non-null float64
20  V20         284807 non-null float64
21  V21         284807 non-null float64
22  V22         284807 non-null float64
23  V23         284807 non-null float64
24  V24         284807 non-null float64
25  V25         284807 non-null float64
26  V26         284807 non-null float64
27  V27         284807 non-null float64
28  V28         284807 non-null float64
29  Amount      284807 non-null float64
30  Class       284807 non-null int64
dtypes: float64(30), int64(1)
memory usage: 67.4 MB
```

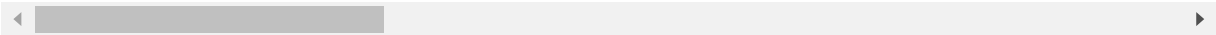
In [8]:

```
data.describe()
```

Out[8]:

|       | Time          | V1            | V2            | V3            | V4            |             |
|-------|---------------|---------------|---------------|---------------|---------------|-------------|
| count | 284807.000000 | 2.848070e+05  | 2.848070e+05  | 2.848070e+05  | 2.848070e+05  | 2.848070e+  |
| mean  | 94813.859575  | 1.759061e-12  | -8.251130e-13 | -9.654937e-13 | 8.321385e-13  | 1.649999e-  |
| std   | 47488.145955  | 1.958696e+00  | 1.651309e+00  | 1.516255e+00  | 1.415869e+00  | 1.380247e+  |
| min   | 0.000000      | -5.640751e+01 | -7.271573e+01 | -4.832559e+01 | -5.683171e+00 | -1.137433e+ |
| 25%   | 54201.500000  | -9.203734e-01 | -5.985499e-01 | -8.903648e-01 | -8.486401e-01 | -6.915971e- |
| 50%   | 84692.000000  | 1.810880e-02  | 6.548556e-02  | 1.798463e-01  | -1.984653e-02 | -5.433583e- |
| 75%   | 139320.500000 | 1.315642e+00  | 8.037239e-01  | 1.027196e+00  | 7.433413e-01  | 6.119264e-  |
| max   | 172792.000000 | 2.454930e+00  | 2.205773e+01  | 9.382558e+00  | 1.687534e+01  | 3.480167e+  |

8 rows × 31 columns



In [9]:

```
data.duplicated().sum()
```

Out[9]:

1081

In [10]:

```
data = data.drop_duplicates()
```

In [11]:



```
data.isnull().sum()
```

Out[11]:

```
Time      0
V1        0
V2        0
V3        0
V4        0
V5        0
V6        0
V7        0
V8        0
V9        0
V10       0
V11       0
V12       0
V13       0
V14       0
V15       0
V16       0
V17       0
V18       0
V19       0
V20       0
V21       0
V22       0
V23       0
V24       0
V25       0
V26       0
V27       0
V28       0
Amount    0
Class     0
dtype: int64
```

In [12]:



```
data['Class'].unique()
```

Out[12]:

```
array([0, 1], dtype=int64)
```

In [13]:



```
data['Class'].value_counts()
```

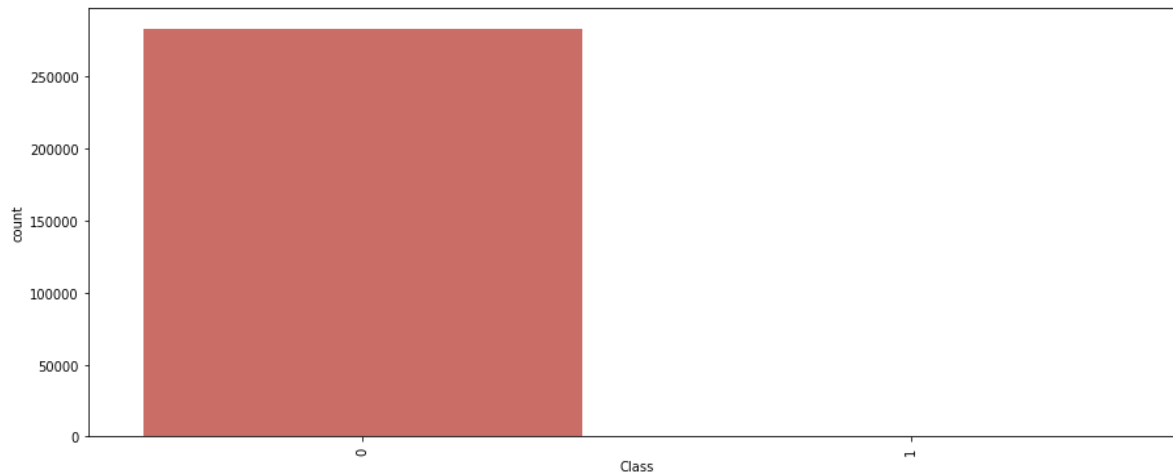
Out[13]:

```
0    283253
1      473
Name: Class, dtype: int64
```

In [14]:



```
plt.figure(figsize=(15,6))
sns.countplot(data['Class'], data = data,
              palette='hls')
plt.xticks(rotation = 90)
plt.show()
```



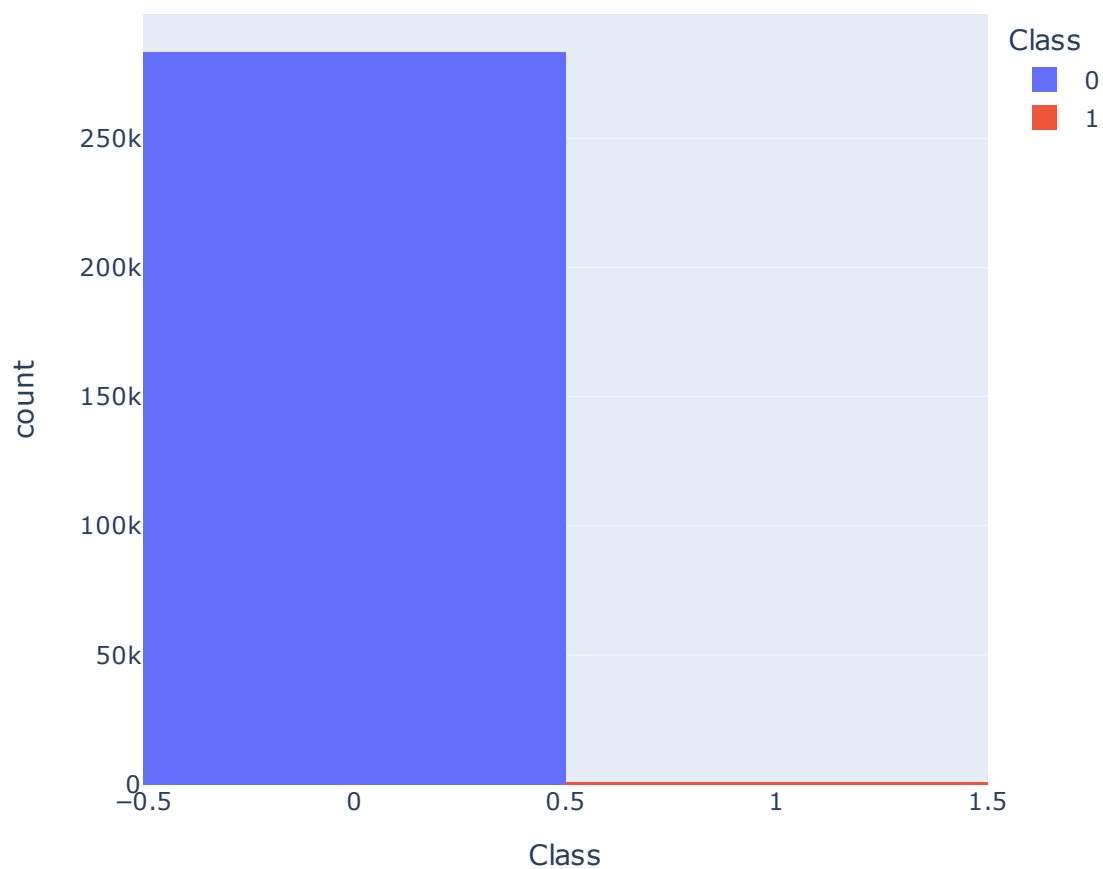
In [15]:



```
import plotly.express as px
```

In [16]:

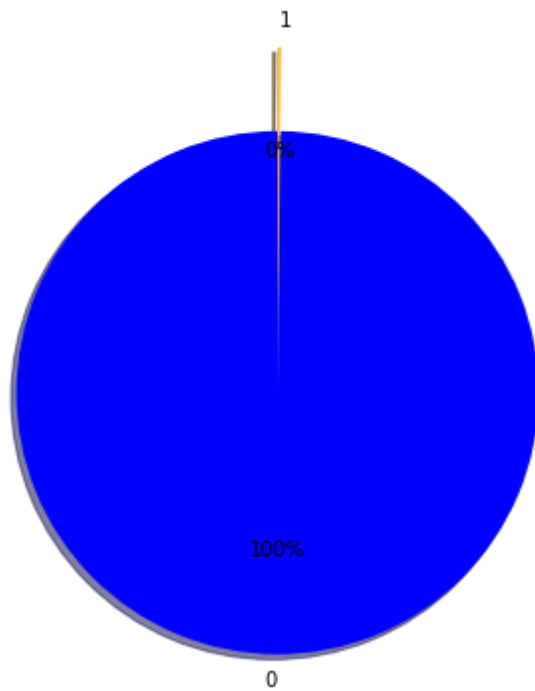
```
fig1 = px.histogram(data, x = 'Class', color = 'Class')  
fig1.show()
```



In [18]:



```
plt.figure(figsize=(15,6))
colors = sns.color_palette('bright')
explode = [0.3, 0.02]
plt.pie(data['Class'].value_counts(), colors = ['blue', 'orange'],
        labels = [0,1],
        explode = explode, autopct = '%0.0f%%', shadow = 'True',
        startangle = 90)
plt.show()
```

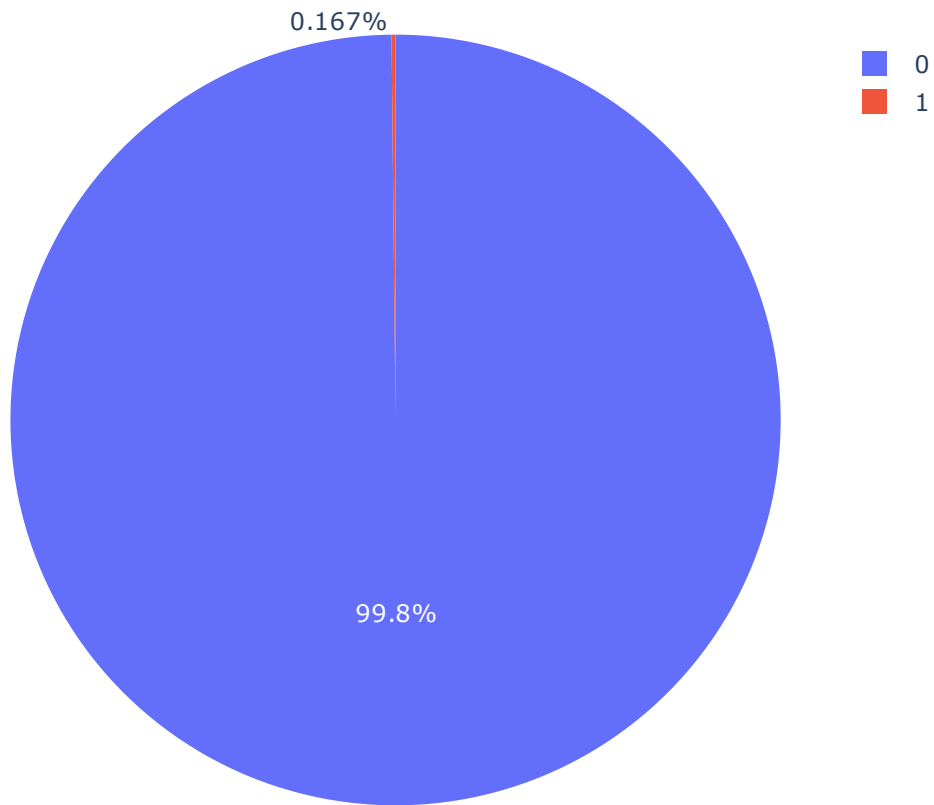




In [19]:



```
fig2 = px.pie(values=data['Class'].value_counts(), names= [0,1])  
fig2.show()
```

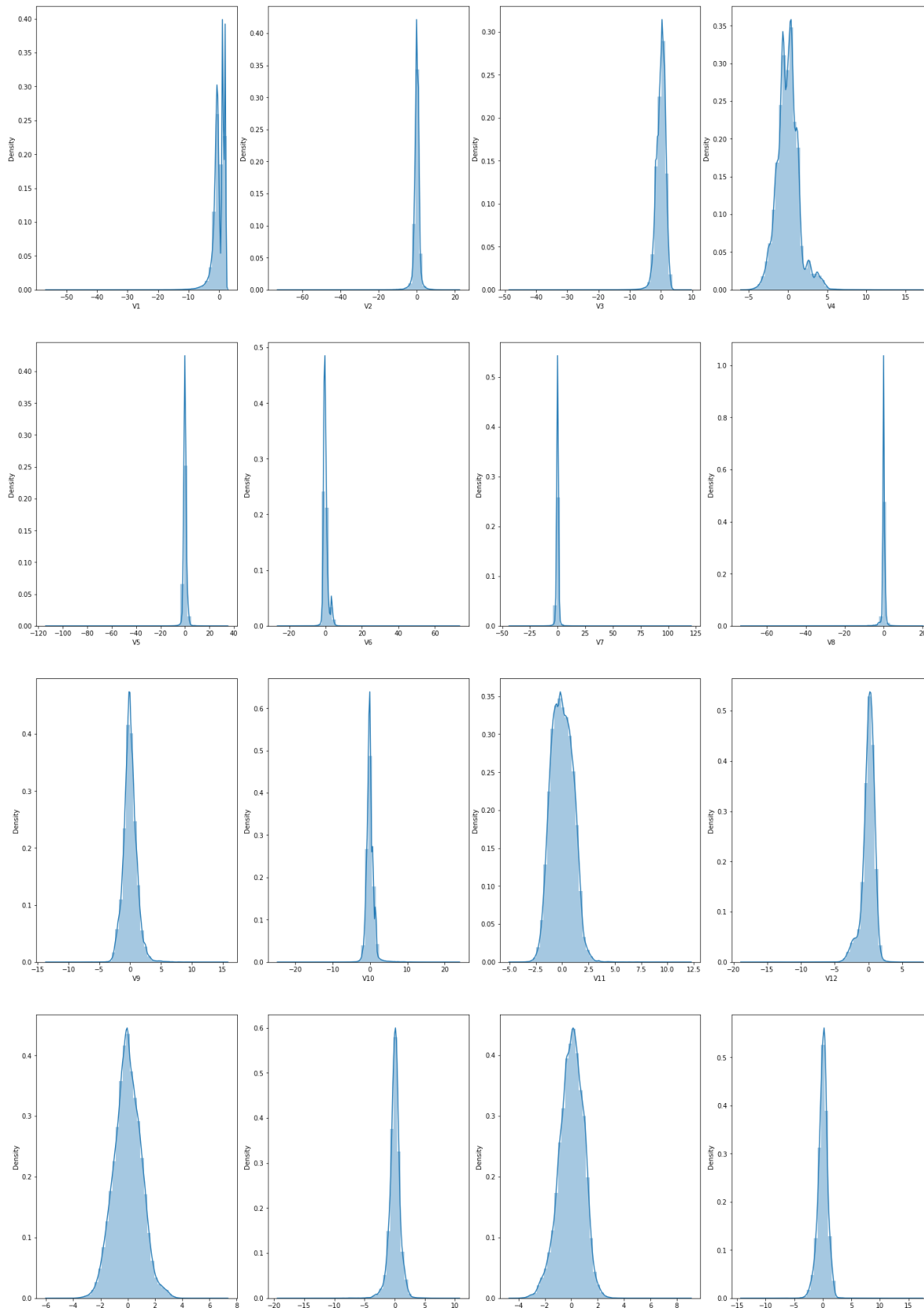


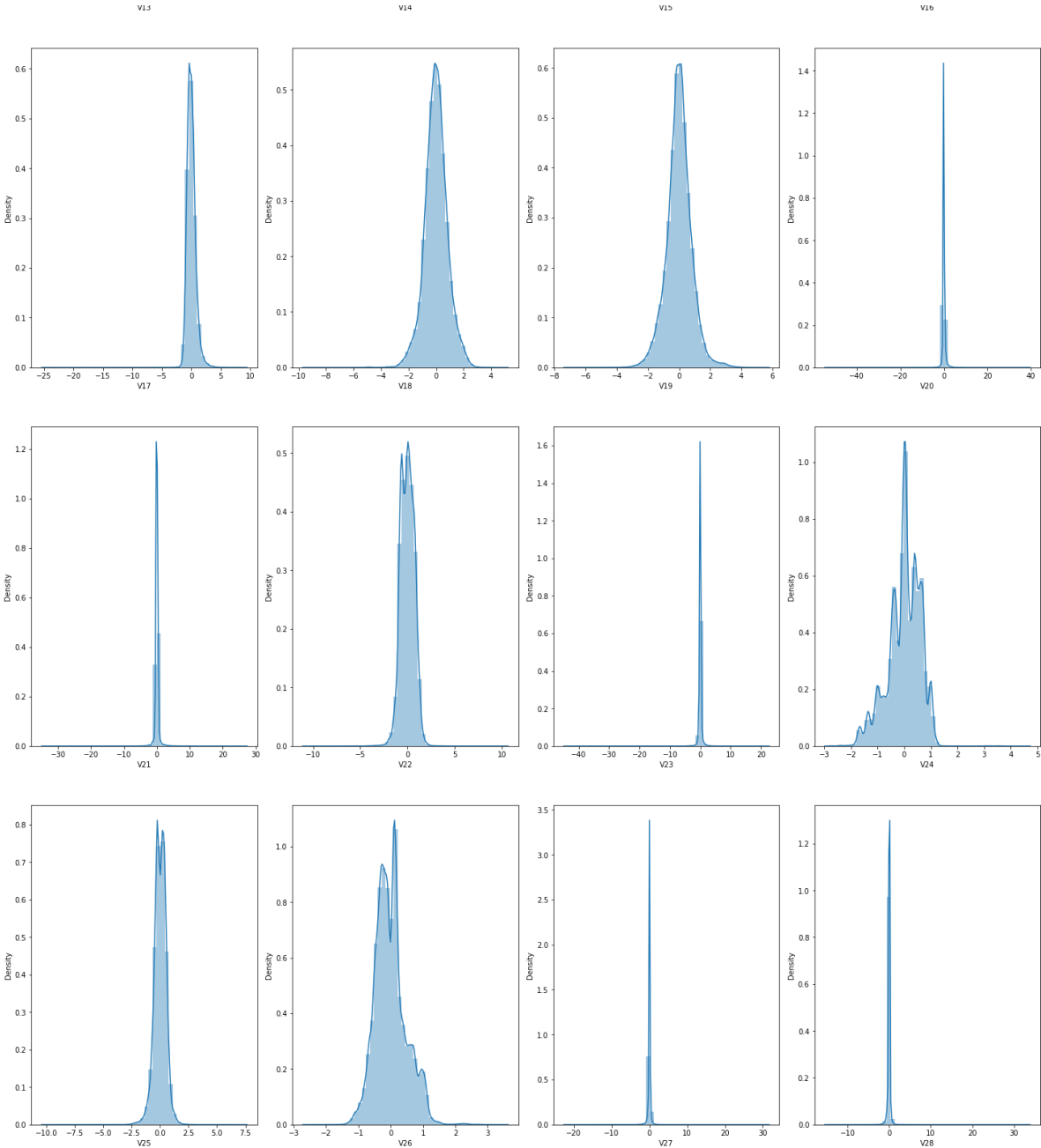
In [17]:

```

data1 = data.drop(columns=['Time', 'Amount', 'Class'], axis=1)
fig, ax = plt.subplots(ncols=4, nrows=7, figsize=(20, 50))
index = 0
ax = ax.flatten()
for col in data1.columns:
    sns.distplot(data1[col], ax=ax[index])
    index += 1
plt.tight_layout(pad=0.5, w_pad=0.5, h_pad=5)

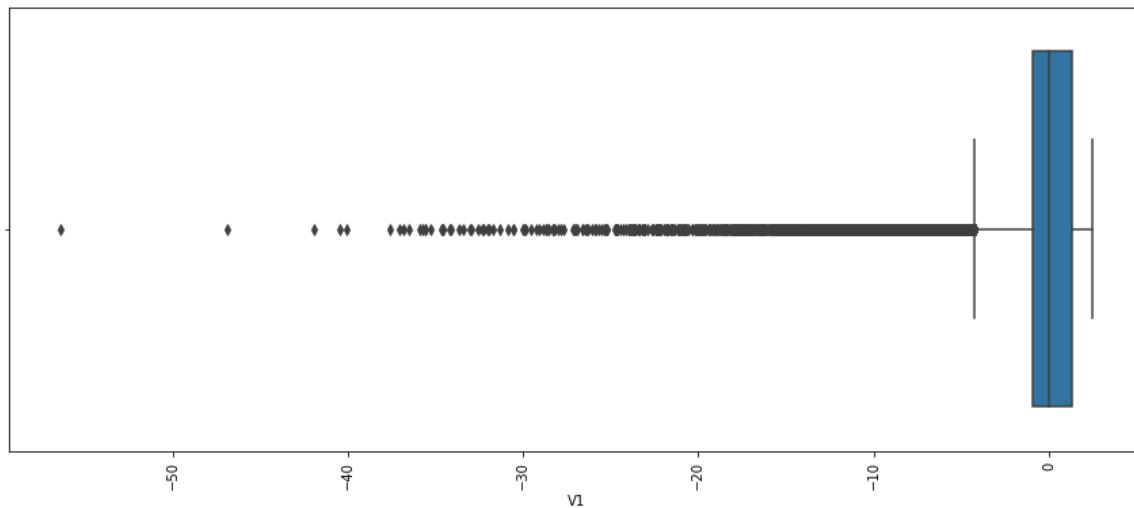
```





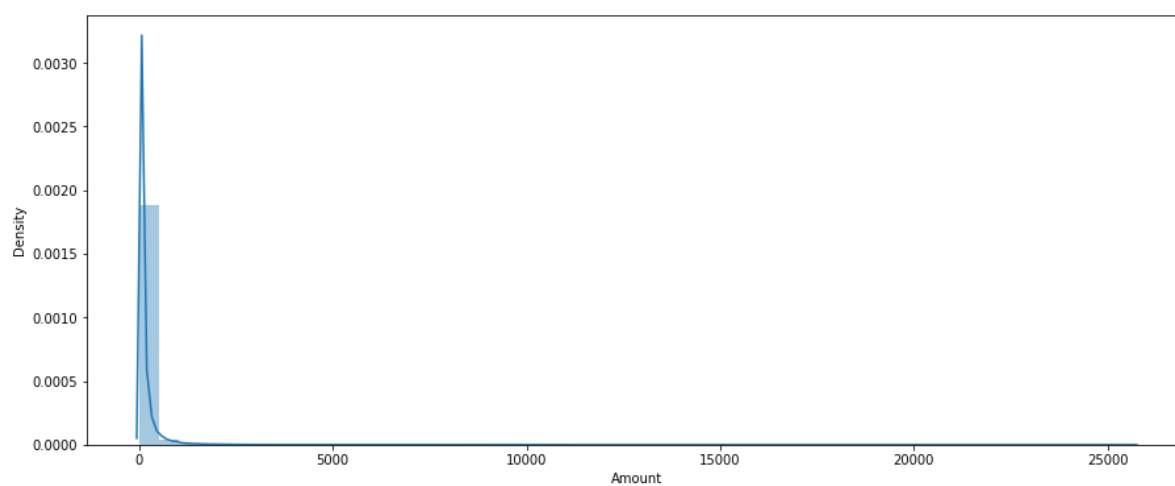
In [20]:

```
for i in data1.columns:  
    plt.figure(figsize=(15,6))  
    sns.boxplot(data1[i])  
    plt.xticks(rotation = 90)  
    plt.show()
```



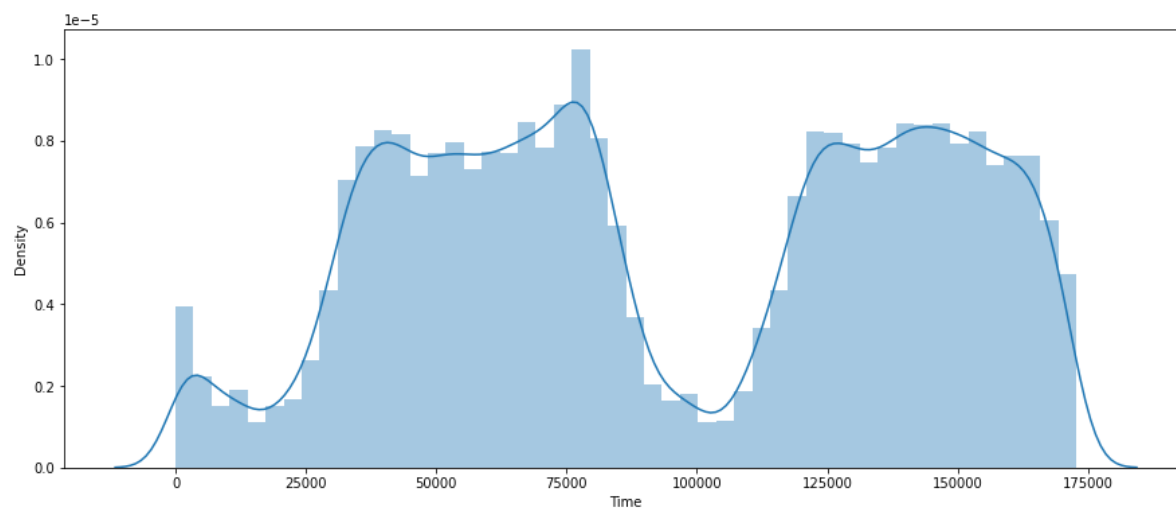
In [21]:

```
plt.figure(figsize=(15,6))  
sns.distplot(data['Amount'])  
plt.show()
```



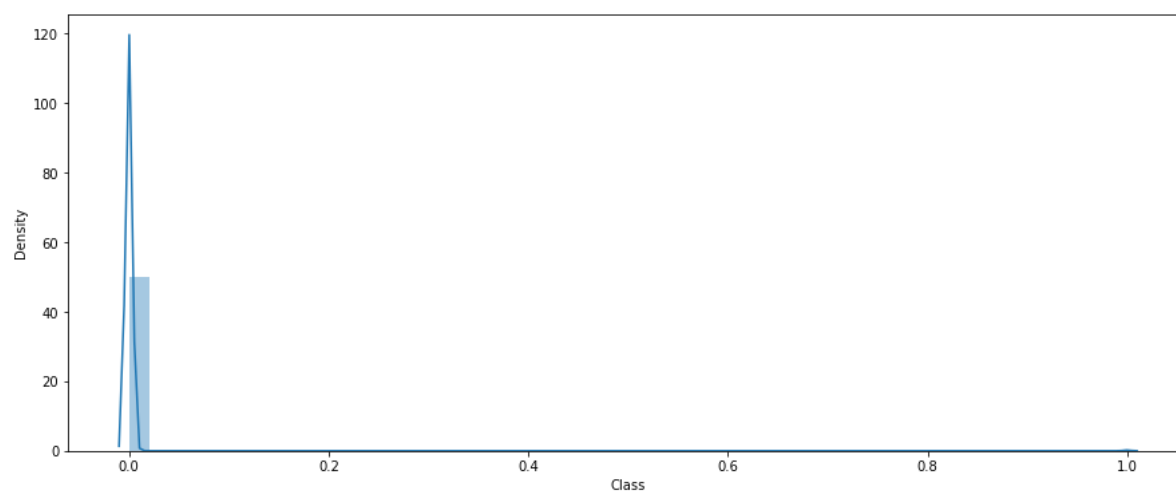
In [22]:

```
plt.figure(figsize=(15,6))  
sns.distplot(data['Time'])  
plt.show()
```



In [29]:

```
plt.figure(figsize=(15,6))  
sns.distplot(data['Class'])  
plt.show()
```



In [23]:

```
x = data.drop(columns=['Class'], axis=1)
y = data['Class']
```

In [24]:

```
from sklearn.preprocessing import StandardScaler
```

In [25]:

```
sc = StandardScaler()
x_scaler = sc.fit_transform(x)
```

In [26]:

```
x_scaler [-1]
```

Out[26]:

```
array([ 1.64236181, -0.27686005, -0.1127094 ,  0.46512487, -0.35589839,
        -0.01043804, -0.48687097,  1.28309413, -0.35095639,  0.44525779,
        -0.84910935, -1.02153857, -0.03096322, -0.18956298, -0.08881285,
         0.04403866, -0.34769819, -0.78402639,  0.19813651, -0.31455594,
         0.49710317,  0.36113414,  0.88757737,  0.60378078,  0.01417241,
        -0.90828607, -1.69777619, -0.01055821,  0.03994074,  0.51329005])
```

In [27]:

```
from sklearn.model_selection import train_test_split
```

In [28]:

```
x_train, x_test, y_train, y_test = train_test_split(x_scaler, y,
                                                    test_size=0.20,
                                                    random_state=42,
                                                    stratify=y)
```

In [30]:

```
from sklearn.linear_model import LogisticRegression
```

In [31]:

```
model = LogisticRegression()
model.fit(x_train, y_train)
```

Out[31]:

```
LogisticRegression()
```

In [32]:

```
y_pred = model.predict(x_test)
```

In [33]:

```
print("Training Accuracy :", model.score(x_train, y_train))
print("Testing Accuracy :", model.score(x_test, y_test))
```

Training Accuracy : 0.999242223984492

Testing Accuracy : 0.9991188806259472

In [34]:

```
from sklearn.metrics import classification_report, f1_score
```

In [35]:

```
print(classification_report(y_test, y_pred))
```

|              | precision | recall | f1-score | support |
|--------------|-----------|--------|----------|---------|
| 0            | 1.00      | 1.00   | 1.00     | 56651   |
| 1            | 0.85      | 0.58   | 0.69     | 95      |
| accuracy     |           |        | 1.00     | 56746   |
| macro avg    | 0.92      | 0.79   | 0.84     | 56746   |
| weighted avg | 1.00      | 1.00   | 1.00     | 56746   |

In [36]:

```
print("F1 Score:", f1_score(y_test, y_pred))
```

F1 Score: 0.6875

In [37]:

```
from sklearn.ensemble import RandomForestClassifier
```

In [38]:

```
model1 = RandomForestClassifier()
model1.fit(x_train, y_train)
```

Out[38]:

RandomForestClassifier()

In [39]:

```
y_pred = model1.predict(x_test)
```

In [40]:

```
print("Training Accuracy :", model1.score(x_train, y_train))
print("Testing Accuracy :", model1.score(x_test, y_test))
```

Training Accuracy : 1.0  
Testing Accuracy : 0.9995241955380115

In [41]:

```
print(classification_report(y_test, y_pred))
```

|              | precision | recall | f1-score | support |
|--------------|-----------|--------|----------|---------|
| 0            | 1.00      | 1.00   | 1.00     | 56651   |
| 1            | 0.97      | 0.74   | 0.84     | 95      |
| accuracy     |           |        | 1.00     | 56746   |
| macro avg    | 0.99      | 0.87   | 0.92     | 56746   |
| weighted avg | 1.00      | 1.00   | 1.00     | 56746   |

In [42]:

```
print("F1 Score:", f1_score(y_test, y_pred))
```

F1 Score: 0.8383233532934131

In [43]:

```
from xgboost import XGBClassifier
```

In [44]:

```
model2 = XGBClassifier(n_jobs=-1)
model2.fit(x_train, y_train)
```

Out[44]:

```
XGBClassifier(base_score=0.5, booster='gbtree', callbacks=None,
              colsample_bylevel=1, colsample_bynode=1, colsample_bytrees=1,
              early_stopping_rounds=None, enable_categorical=False,
              eval_metric=None, gamma=0, gpu_id=-1, grow_policy='depthwis
e',
              importance_type=None, interaction_constraints='',
              learning_rate=0.300000012, max_bin=256, max_cat_to_onehot=4,
              max_delta_step=0, max_depth=6, max_leaves=0, min_child_weigh
t=1,
              missing=nan, monotone_constraints='()', n_estimators=100,
              n_jobs=-1, num_parallel_tree=1, predictor='auto', random_sta
te=0,
              reg_alpha=0, reg_lambda=1, ...)
```



In [45]:

```
y_pred = model2.predict(x_test)
```

In [46]:

```
print(classification_report(y_test, y_pred))
```

|              | precision | recall | f1-score | support |
|--------------|-----------|--------|----------|---------|
| 0            | 1.00      | 1.00   | 1.00     | 56651   |
| 1            | 0.97      | 0.75   | 0.85     | 95      |
| accuracy     |           |        | 1.00     | 56746   |
| macro avg    | 0.99      | 0.87   | 0.92     | 56746   |
| weighted avg | 1.00      | 1.00   | 1.00     | 56746   |

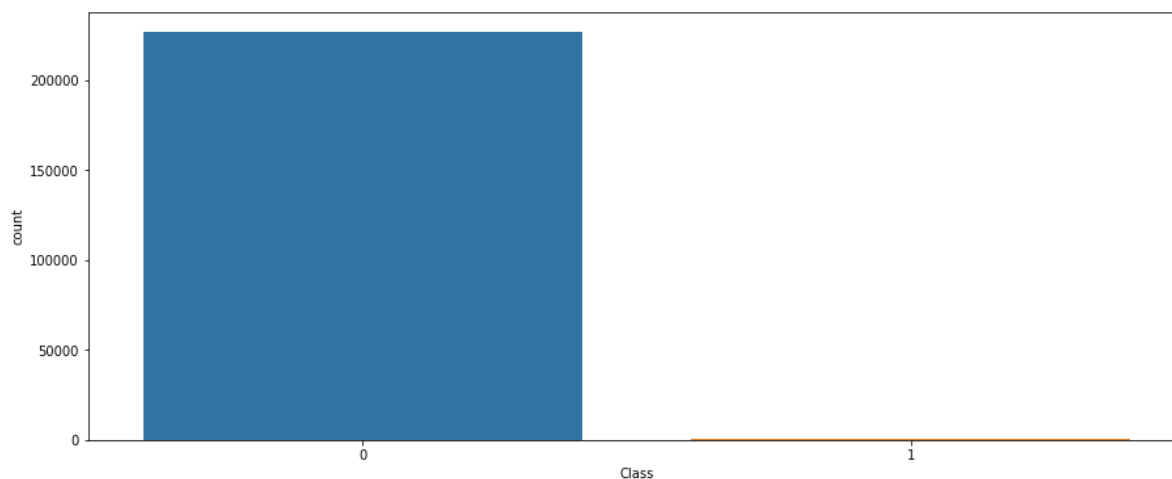
In [47]:

```
print("F1 Score:", f1_score(y_test, y_pred))
```

F1 Score: 0.8452380952380952

In [48]:

```
plt.figure(figsize=(15,6))  
sns.countplot(y_train)  
plt.show()
```

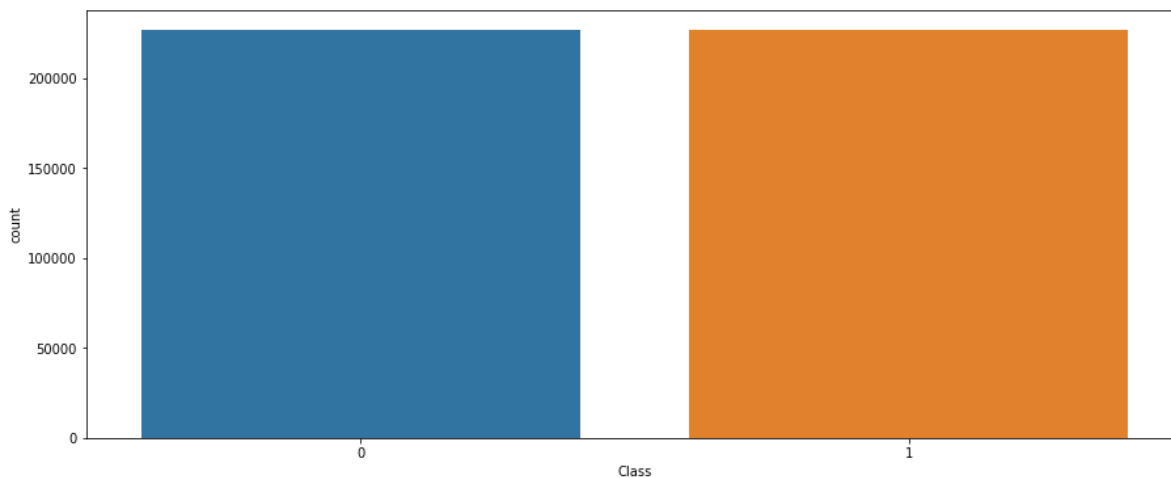


In [49]:

```
from imblearn.over_sampling import SMOTE  
over_sample = SMOTE()  
x_smote, y_smote = over_sample.fit_resample(x_train, y_train)
```

In [50]:

```
plt.figure(figsize=(15,6))
sns.countplot(y_smote)
plt.show()
```



In [51]:

```
from xgboost import XGBClassifier
```

In [52]:

```
model3 = XGBClassifier(n_jobs=-1)
model3.fit(x_smote, y_smote)
```

Out[52]:

```
XGBClassifier(base_score=0.5, booster='gbtree', callbacks=None,
              colsample_bylevel=1, colsample_bynode=1, colsample_bytree=1,
              early_stopping_rounds=None, enable_categorical=False,
              eval_metric=None, gamma=0, gpu_id=-1, grow_policy='depthwis
e',
              importance_type=None, interaction_constraints='',
              learning_rate=0.300000012, max_bin=256, max_cat_to_onehot=4,
              max_delta_step=0, max_depth=6, max_leaves=0, min_child_weigh
t=1,
              missing=nan, monotone_constraints='()', n_estimators=100,
              n_jobs=-1, num_parallel_tree=1, predictor='auto', random_sta
te=0,
              reg_alpha=0, reg_lambda=1, ...)
```

In [53]:

```
y_pred = model3.predict(x_test)
```

In [54]:



```
print("Training Accuracy :", model3.score(x_train, y_train))  
print("Testing Accuracy :", model3.score(x_test, y_test))
```

Training Accuracy : 1.0

Testing Accuracy : 0.9992246149508336

In [55]:



```
print(classification_report(y_test, y_pred))
```

|              | precision | recall | f1-score | support |
|--------------|-----------|--------|----------|---------|
| 0            | 1.00      | 1.00   | 1.00     | 56651   |
| 1            | 0.76      | 0.79   | 0.77     | 95      |
| accuracy     |           |        | 1.00     | 56746   |
| macro avg    | 0.88      | 0.89   | 0.89     | 56746   |
| weighted avg | 1.00      | 1.00   | 1.00     | 56746   |

In [56]:



```
print("F1 Score:", f1_score(y_test, y_pred))
```

F1 Score: 0.7731958762886598