In [1]:
```
import pandas as pd
```

In [2]:
```
df=pd.read_csv("winequality-red.csv")
```

In [3]:
```
df.head()
```

Out[3]:

	fixed acidity	volatile acidity	citric acid	residual sugar	chlorides	free sulfur dioxide	total sulfur dioxide	density	pH	sulphates	alcohol	qua
0	7.4	0.70	0.00	1.9	0.076	11.0	34.0	0.9978	3.51	0.56	9.4	
1	7.8	0.88	0.00	2.6	0.098	25.0	67.0	0.9968	3.20	0.68	9.8	
2	7.8	0.76	0.04	2.3	0.092	15.0	54.0	0.9970	3.26	0.65	9.8	
3	11.2	0.28	0.56	1.9	0.075	17.0	60.0	0.9980	3.16	0.58	9.8	
4	7.4	0.70	0.00	1.9	0.076	11.0	34.0	0.9978	3.51	0.56	9.4	

In [4]:
```
df.columns
```

Out[4]:
```
Index(['fixed acidity', 'volatile acidity', 'citric acid', 'residual sugar',
       'chlorides', 'free sulfur dioxide', 'total sulfur dioxide', 'density',
       'pH', 'sulphates', 'alcohol', 'quality'],
      dtype='object')
```

In [5]:
```
df.describe()
```

Out[5]:

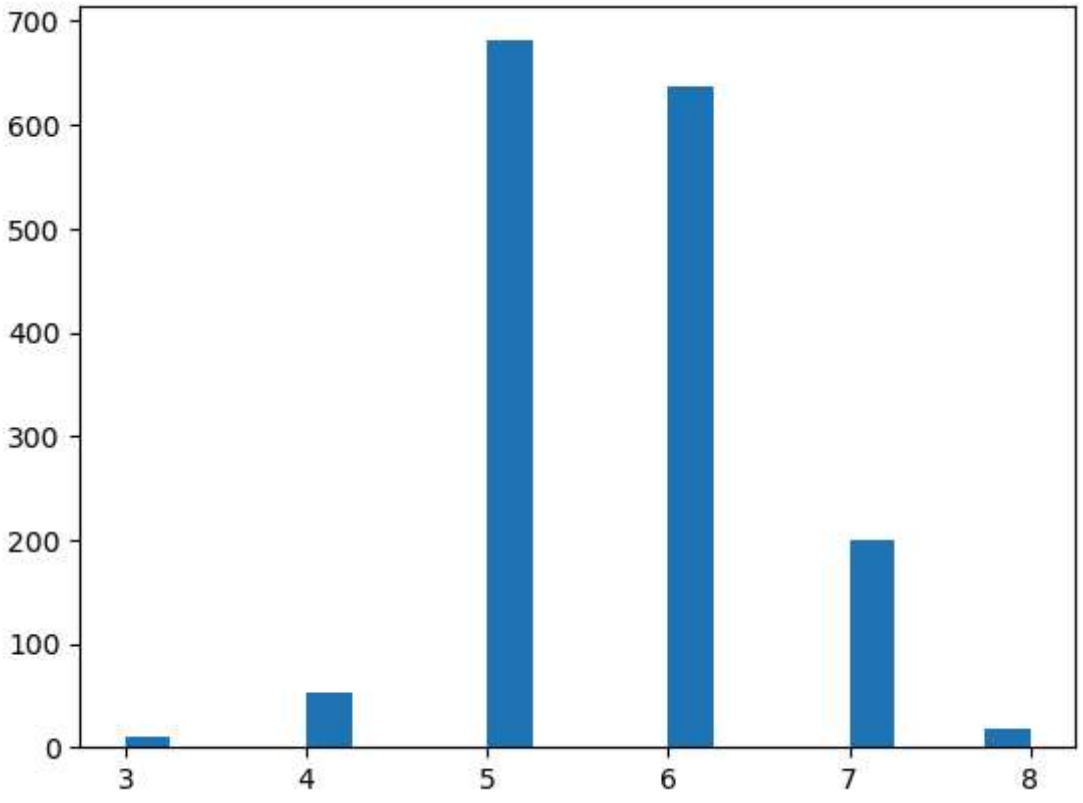
	fixed acidity	volatile acidity	citric acid	residual sugar	chlorides	free sulfur dioxide	total sulfur dioxide	
count	1599.000000	1599.000000	1599.000000	1599.000000	1599.000000	1599.000000	1599.000000	15
mean	8.319637	0.527821	0.270976	2.538806	0.087467	15.874922	46.467792	
std	1.741096	0.179060	0.194801	1.409928	0.047065	10.460157	32.895324	
min	4.600000	0.120000	0.000000	0.900000	0.012000	1.000000	6.000000	
25%	7.100000	0.390000	0.090000	1.900000	0.070000	7.000000	22.000000	
50%	7.900000	0.520000	0.260000	2.200000	0.079000	14.000000	38.000000	
75%	9.200000	0.640000	0.420000	2.600000	0.090000	21.000000	62.000000	
max	15.900000	1.580000	1.000000	15.500000	0.611000	72.000000	289.000000	

In [6]:
```
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 1599 entries, 0 to 1598
Data columns (total 12 columns):
 #   Column                Non-Null Count  Dtype  
---  ------                --------------  -----  
 0   fixed acidity         1599 non-null   float64
 1   volatile acidity      1599 non-null   float64
 2   citric acid           1599 non-null   float64
 3   residual sugar        1599 non-null   float64
 4   chlorides             1599 non-null   float64
 5   free sulfur dioxide   1599 non-null   float64
 6   total sulfur dioxide  1599 non-null   float64
 7   density               1599 non-null   float64
 8   pH                    1599 non-null   float64
 9   sulphates             1599 non-null   float64
 10  alcohol               1599 non-null   float64
 11  quality               1599 non-null   int64  
dtypes: float64(11), int64(1)
memory usage: 150.0 KB
```

In [7]:
```
import matplotlib.pyplot as plt
```

In [8]:
```
target_column=df["quality"]
plt.hist(target_column,bins=20)
plt.show()
```



In [9]:
```
from sklearn.model_selection import train_test_split

from sklearn.tree import DecisionTreeClassifier

from sklearn.metrics import accuracy_score, classification_report, confusion_matrix

from sklearn.preprocessing import OneHotEncoder, LabelEncoder
```

```
from sklearn.impute import SimpleImputer

from sklearn.compose import ColumnTransformer

from sklearn.pipeline import Pipeline

from sklearn.model_selection import cross_val_score

import matplotlib.pyplot as plt

from sklearn.tree import plot_tree

from sklearn.metrics import confusion_matrix, ConfusionMatrixDisplay
```

In [10]:
```
# Function for data preprocessing
def preprocess_data(data, target_column):
    # Separating features and target variable
    X = data.drop(columns=[target_column])
    y = data[target_column]

    # Handling missing values
    numerical_cols = X.select_dtypes(include=['number']).columns
    categorical_cols = X.select_dtypes(include=['object']).columns
    numerical_transformer = SimpleImputer(strategy='mean')  # Impute missing values wi
    categorical_transformer = Pipeline(steps=[
        ('imputer', SimpleImputer(strategy='most_frequent')),  # Impute missing values
        ('onehot', OneHotEncoder(handle_unknown='ignore'))  # One-hot encode categoric
    ])
    preprocessor = ColumnTransformer(
        transformers=[
            ('num', numerical_transformer, numerical_cols),
            ('cat', categorical_transformer, categorical_cols)
        ])

    # Splitting the dataset into training and testing sets
    X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.2, random_st

    # Preprocessing pipeline
    preprocess_pipeline = Pipeline(steps=[('preprocessor', preprocessor)])

    # Preprocessing training and testing data
    X_train_preprocessed = preprocess_pipeline.fit_transform(X_train)
    X_test_preprocessed = preprocess_pipeline.transform(X_test)

    return X_train_preprocessed, X_test_preprocessed, y_train, y_test
```

In [11]:
```
preprocess_data(df, target_column="quality")
```

Out[11]:
```
(array([[ 8.7 ,  0.69,  0.31, ...,  3.48,  0.74, 11.6 ],
        [ 6.1 ,  0.21,  0.4 , ...,  3.25,  0.59, 11.9 ],
        [10.9 ,  0.39,  0.47, ...,  3.3 ,  0.75,  9.8 ],
        ...,
        [ 7.2 ,  0.62,  0.06, ...,  3.51,  0.54,  9.5 ],
        [ 7.9 ,  0.2 ,  0.35, ...,  3.32,  0.8 , 11.9 ],
        [ 5.8 ,  0.29,  0.26, ...,  3.39,  0.54, 13.5 ]]),
 array([[ 7.7  ,  0.56 ,  0.08 , ...,  3.24 ,  0.66 ,  9.6  ],
        [ 7.8  ,  0.5  ,  0.17 , ...,  3.39 ,  0.48 ,  9.5  ],
        [10.7  ,  0.67 ,  0.22 , ...,  3.28 ,  0.98 ,  9.9  ],
        ...,
        [ 8.3  ,  0.6  ,  0.25 , ...,  3.15 ,  0.53 ,  9.8  ],
        [ 8.8  ,  0.27 ,  0.39 , ...,  3.15 ,  0.69 , 11.2  ],
        [ 9.1  ,  0.765,  0.04 , ...,  3.29 ,  0.54 ,  9.7  ]]),
 493     6
 354     6
 342     6
 834     5
 705     5
        ..
 1130    6
 1294    6
 860     5
 1459    7
 1126    6
 Name: quality, Length: 1279, dtype: int64,
 803     6
 124     5
 350     6
 682     5
 1326    6
        ..
 1259    6
 1295    5
 1155    5
 963     6
 704     4
 Name: quality, Length: 320, dtype: int64)
```

In [12]:
```
X_train,X_test,y_train,y_test=preprocess_data(df,target_column="quality")
```

In [13]:
```
# Function for building the decision tree classifier
def build_decision_tree(X_train, y_train, max_depth=None):
    classifier = DecisionTreeClassifier()
    classifier.fit(X_train, y_train)
    return classifier
```

In [14]:
```
classifier = build_decision_tree(X_train,y_train)
```

In [15]:
```
classifier
```

Out[15]:
```
▾ DecisionTreeClassifier
DecisionTreeClassifier()
```

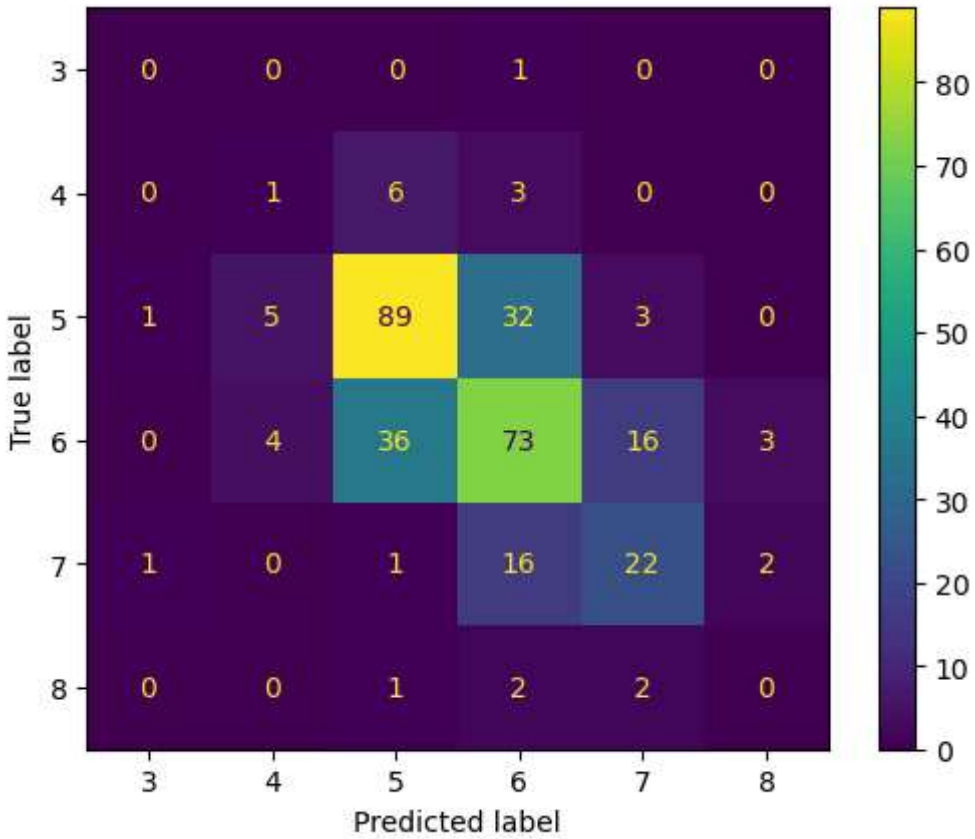
In [16]:
```
# Function for evaluating the model
def evaluate_model(classifier, X_test, y_test):
    y_pred = classifier.predict(X_test)
```

```
    accuracy = accuracy_score(y_test, y_pred)
    report = classification_report(y_test, y_pred)
    confusion_mat = confusion_matrix(y_test, y_pred)


    cm = confusion_matrix(y_test, y_pred, labels=classifier.classes_)
    disp = ConfusionMatrixDisplay(confusion_matrix=cm,
                                  display_labels=classifier.classes_)
    disp.plot()
    plt.plot()
    return accuracy, report, confusion_mat
```

In [17]:
```
evaluate_model(classifier, X_test, y_test)
```

Out[17]:
```
(0.578125,
 '              precision    recall  f1-score   support\n\n           3       0.00
0.00      0.00         1\n           4       0.10      0.10      0.10        10\n
5       0.67      0.68      0.68       130\n           6       0.57      0.55      0.
56       132\n           7       0.51      0.52      0.52        42\n           8
0.00      0.00      0.00         5\n\n    accuracy                           0.58
320\n   macro avg       0.31      0.31      0.31       320\nweighted avg       0.58
0.58      0.58       320\n',
 array([[ 0,  0,  0,  1,  0,  0],
        [ 0,  1,  6,  3,  0,  0],
        [ 1,  5, 89, 32,  3,  0],
        [ 0,  4, 36, 73, 16,  3],
        [ 1,  0,  1, 16, 22,  2],
        [ 0,  0,  1,  2,  2,  0]], dtype=int64))
```

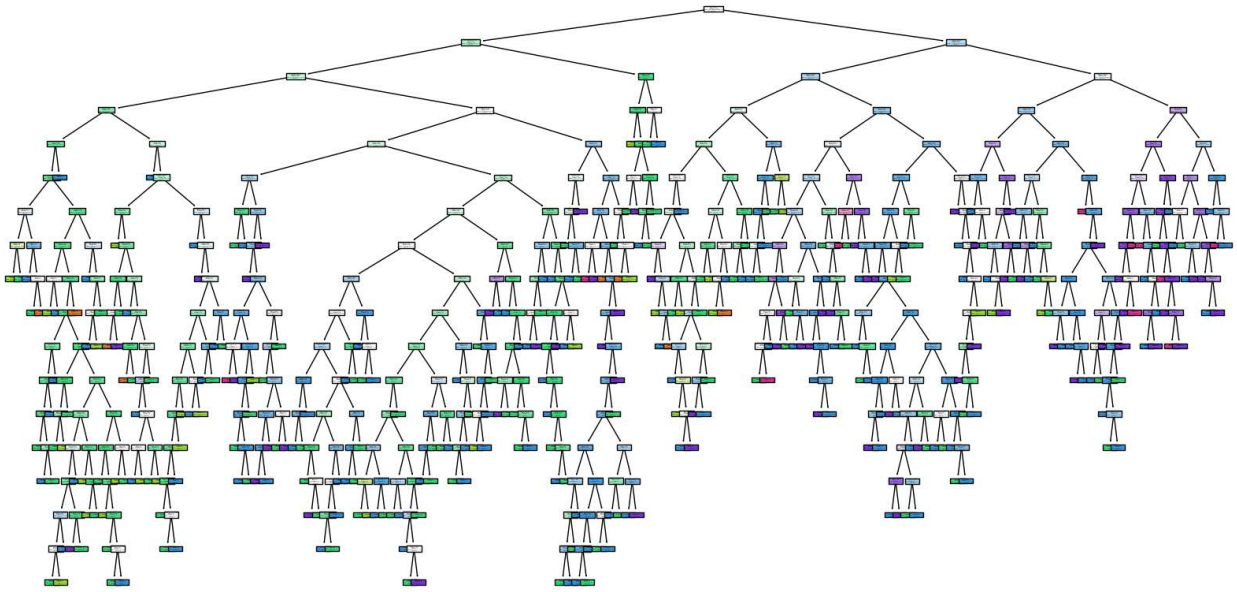


In [36]:
```
import matplotlib.pyplot as pl
```

In [37]:
```
def visualize_tree(classifier, feature_names):
    pl.figure(figsize=(20, 10))  # Set the figure size
```

```
    class_names = [str(cls) for cls in classifier.classes_]  # Convert class integers
    plot_tree(classifier, feature_names=feature_names.tolist(), class_names=class_name
    pl.show()
```

In [38]:
```
visualize_tree(classifier, df.columns[:-1])  # Assuming last column is the target vari
```



In [ ]: