In [150]:
```
import pandas as pd
import numpy as num
import matplotlib.pyplot as mat
import seaborn as sea
from sklearn.preprocessing import LabelEncoder
from sklearn.preprocessing import MinMaxScaler
from sklearn.model_selection import train_test_split
from sklearn.tree import DecisionTreeRegressor
from sklearn.linear_model import LogisticRegression
from sklearn.tree import DecisionTreeClassifier
from sklearn.ensemble import RandomForestClassifier
from sklearn.naive_bayes import GaussianNB
from sklearn.neighbors import KNeighborsClassifier
from sklearn.metrics import accuracy_score, precision_score, recall_score,f1_s
```

In [121]:
```
df = pd.read_csv('C:/Users/mohieldine/Desktop/Python Tutorial/Telecom Customer
df.head(10)
```

Out[121]:

	customerID	gender	SeniorCitizen	Partner	Dependents	tenure	PhoneService	MultipleLines
0	7590-VHVEG	Female	0	Yes	No	1	No	No phone service
1	5575-GNVDE	Male	0	No	No	34	Yes	No
2	3668-QPYBK	Male	0	No	No	2	Yes	No
3	7795-CFOCW	Male	0	No	No	45	No	No phone service
4	9237-HQITU	Female	0	No	No	2	Yes	No
5	9305-CDSKC	Female	0	No	No	8	Yes	Yes
6	1452-KIOVK	Male	0	No	Yes	22	Yes	Yes
7	6713-OKOMC	Female	0	No	No	10	No	No phone service
8	7892-POOKP	Female	0	Yes	No	28	Yes	Yes
9	6388-TABGU	Male	0	No	Yes	62	Yes	No

10 rows × 21 columns

In [161]:
```
#Data_Cleaning
df.columns
```

Out[161]:
```
Index(['customerID', 'gender', 'SeniorCitizen', 'Partner', 'Dependents',
       'tenure', 'PhoneService', 'MultipleLines', 'InternetService',
       'OnlineSecurity', 'OnlineBackup', 'DeviceProtection', 'TechSupport',
       'StreamingTV', 'StreamingMovies', 'Contract', 'PaperlessBilling',
       'PaymentMethod', 'MonthlyCharges', 'TotalCharges', 'Churn'],
      dtype='object')
```

In [162]:
```
#To remove customerID column
df.drop(columns='customerID',inplace = True)
```

In [163]:
```
df.head()
```

Out[163]:

	gender	SeniorCitizen	Partner	Dependents	tenure	PhoneService	MultipleLines	InternetServ
0	Female	0	Yes	No	1	No	No phone service	D
1	Male	0	No	No	34	Yes	No	D
2	Male	0	No	No	2	Yes	No	D
3	Male	0	No	No	45	No	No phone service	D
4	Female	0	No	No	2	Yes	No	Fiber o

In [164]:
```
duplicate_columns = df.columns[df.apply(lambda x: x.duplicated()).any()]

print("Columns with duplicate values:", duplicate_columns)
```

```
Columns with duplicate values: Index(['gender', 'SeniorCitizen', 'Partner',
'Dependents', 'tenure',
       'PhoneService', 'MultipleLines', 'InternetService', 'OnlineSecurity',
       'OnlineBackup', 'DeviceProtection', 'TechSupport', 'StreamingTV',
       'StreamingMovies', 'Contract', 'PaperlessBilling', 'PaymentMethod',
       'MonthlyCharges', 'TotalCharges', 'Churn'],
      dtype='object')
```

In [165]:
```
df.shape
```

Out[165]:
```
(7043, 20)
```

In [166]:
```
df.dtypes
```

Out[166]:
```
gender              object
SeniorCitizen        int64
Partner             object
Dependents          object
tenure               int64
PhoneService        object
MultipleLines       object
InternetService     object
OnlineSecurity      object
OnlineBackup        object
DeviceProtection    object
TechSupport         object
StreamingTV         object
StreamingMovies     object
Contract            object
PaperlessBilling    object
PaymentMethod       object
MonthlyCharges     float64
TotalCharges       float64
Churn               object
dtype: object
```

In [167]:
```
# to convert the data type of total charges to numeric
df['TotalCharges'] = pd.to_numeric(df['TotalCharges'], errors='coerce').fillna
```

In [302]:
```
df.dtypes
```

Out[302]:
```
gender              int32
SeniorCitizen       int64
Partner             int32
Dependents          int32
tenure              int64
PhoneService        int32
MultipleLines       int32
InternetService     int32
OnlineSecurity      int32
OnlineBackup        int32
DeviceProtection    int32
TechSupport         int32
StreamingTV         int32
StreamingMovies     int32
Contract            int32
PaperlessBilling    int32
PaymentMethod       int32
MonthlyCharges    float64
TotalCharges      float64
Churn               int32
dtype: object
```

In [169]:
```
df.isnull().sum()
```

Out[169]:
```
gender              0
SeniorCitizen       0
Partner             0
Dependents          0
tenure              0
PhoneService        0
MultipleLines       0
InternetService     0
OnlineSecurity      0
OnlineBackup        0
DeviceProtection    0
TechSupport         0
StreamingTV         0
StreamingMovies     0
Contract            0
PaperlessBilling    0
PaymentMethod       0
MonthlyCharges      0
TotalCharges        0
Churn               0
dtype: int64
```

In [170]:
```
df.nunique()
```

Out[170]:
```
gender                2
SeniorCitizen         2
Partner               2
Dependents            2
tenure               73
PhoneService          2
MultipleLines         3
InternetService       3
OnlineSecurity        3
OnlineBackup          3
DeviceProtection      3
TechSupport           3
StreamingTV           3
StreamingMovies       3
Contract              3
PaperlessBilling      2
PaymentMethod         4
MonthlyCharges     1585
TotalCharges       6531
Churn                 2
dtype: int64
```

In [171]:
```
# To show the unique values in each column
for column in df.columns:
    unique_values = df[column].unique()
    print(f'Unique values in {column}:')
    print(unique_values)
    print()
```

```
Unique values in gender:
['Female' 'Male']

Unique values in SeniorCitizen:
[0 1]

Unique values in Partner:
['Yes' 'No']

Unique values in Dependents:
['No' 'Yes']

Unique values in tenure:
[ 1 34  2 45  8 22 10 28 62 13 16 58 49 25 69 52 71 21 12 30 47 72 17 27
  5 46 11 70 63 43 15 60 18 66  9  3 31 50 64 56  7 42 35 48 29 65 38 68
 32 55 37 36 41  6  4 33 67 23 57 61 14 20 53 40 59 24 44 19 54 51 26  0
 39]

Unique values in PhoneService:
['No' 'Yes']

Unique values in MultipleLines:
['No phone service' 'No' 'Yes']

Unique values in InternetService:
['DSL' 'Fiber optic' 'No']

Unique values in OnlineSecurity:
['No' 'Yes' 'No internet service']

Unique values in OnlineBackup:
['Yes' 'No' 'No internet service']

Unique values in DeviceProtection:
['No' 'Yes' 'No internet service']

Unique values in TechSupport:
['No' 'Yes' 'No internet service']

Unique values in StreamingTV:
['No' 'Yes' 'No internet service']

Unique values in StreamingMovies:
['No' 'Yes' 'No internet service']

Unique values in Contract:
['Month-to-month' 'One year' 'Two year']

Unique values in PaperlessBilling:
['Yes' 'No']

Unique values in PaymentMethod:
['Electronic check' 'Mailed check' 'Bank transfer (automatic)'
 'Credit card (automatic)']

Unique values in MonthlyCharges:
[29.85 56.95 53.85 ... 63.1  44.2  78.7 ]
```

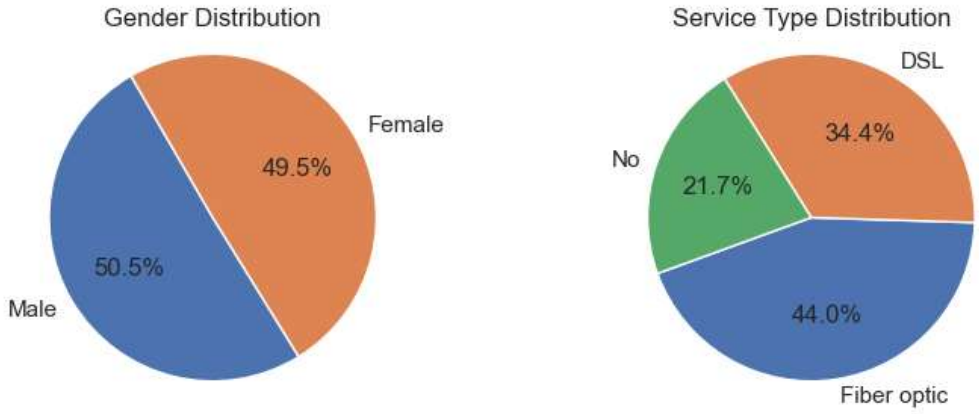
```
Unique values in TotalCharges:
[  29.85 1889.5   108.15 ...  346.45  306.6  6844.5 ]

Unique values in Churn:
['No' 'Yes']
```

In [172]:
```
#Descriptive_Statistics
df.describe()
```

Out[172]:

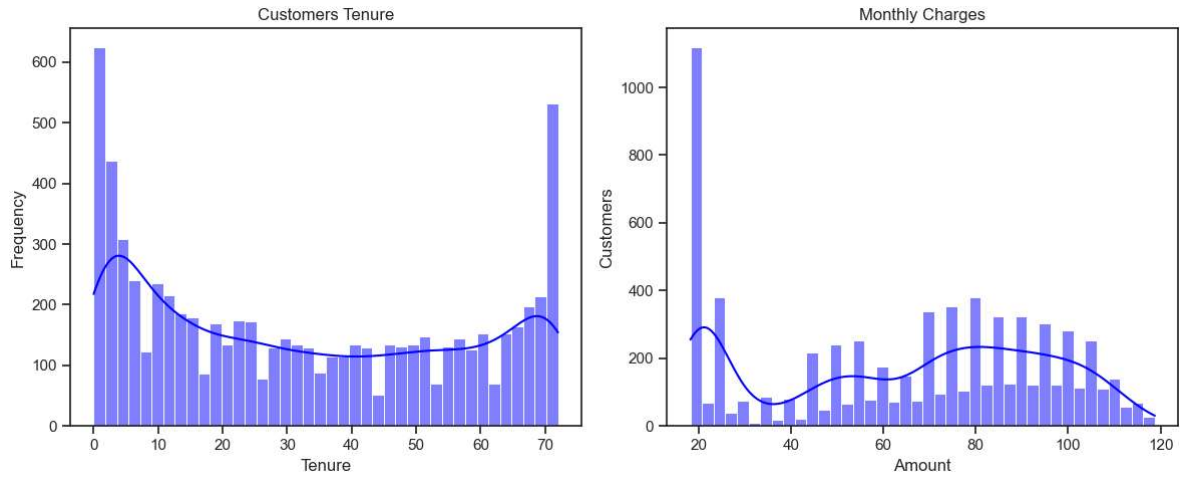
	SeniorCitizen	tenure	MonthlyCharges	TotalCharges
count	7043.000000	7043.000000	7043.000000	7043.000000
mean	0.162147	32.371149	64.761692	2279.734304
std	0.368612	24.559481	30.090047	2266.794470
min	0.000000	0.000000	18.250000	0.000000
25%	0.000000	9.000000	35.500000	398.550000
50%	0.000000	29.000000	70.350000	1394.550000
75%	0.000000	55.000000	89.850000	3786.600000
max	1.000000	72.000000	118.750000	8684.800000

In [173]:
```
#Exploratory_Data_Analysis


#pie chart to represent the contriution of the gender and geography
data_gender = df['gender'].value_counts()
labels_gender = data_gender.index

data_geography = df['InternetService'].value_counts()
labels_geography = data_geography.index

fig, axes = mat.subplots(1, 2, figsize=(8, 3))

axes[0].pie(data_gender, labels=labels_gender, autopct='%1.1f%%', startangle=1
axes[0].set_title("Gender Distribution")

axes[1].pie(data_geography, labels=labels_geography, autopct='%1.1f%%', starta
axes[1].set_title("Service Type Distribution")

for ax in axes:
    ax.axis('equal')

mat.tight_layout()
mat.show()
```

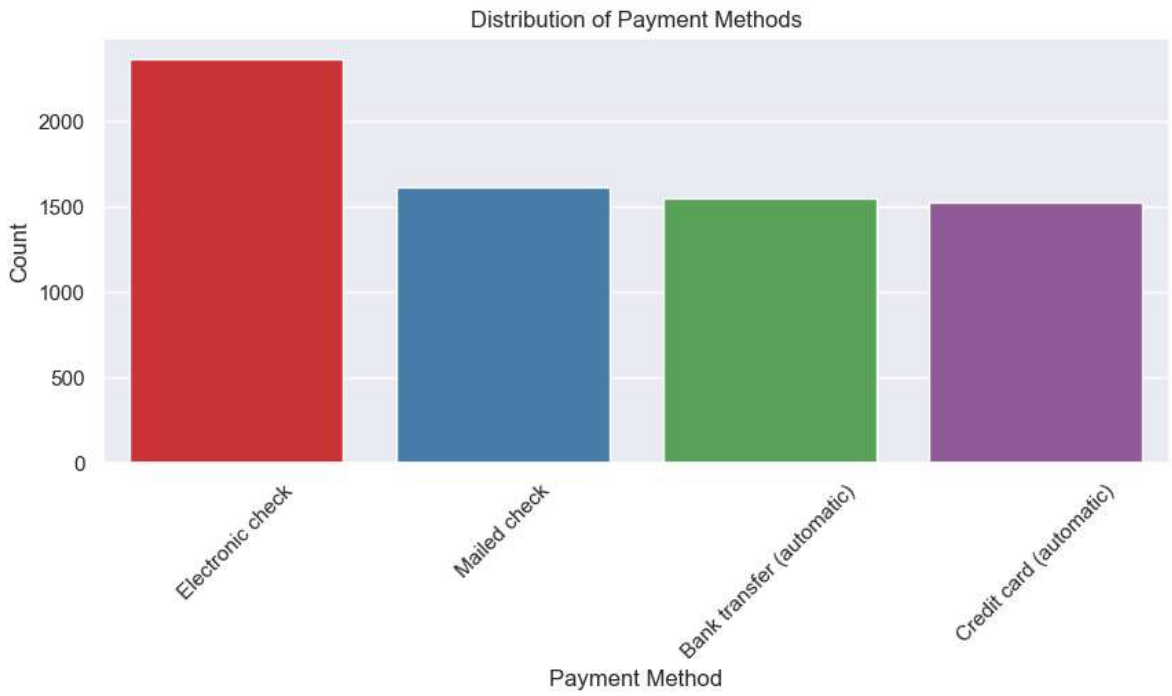


In [174]:

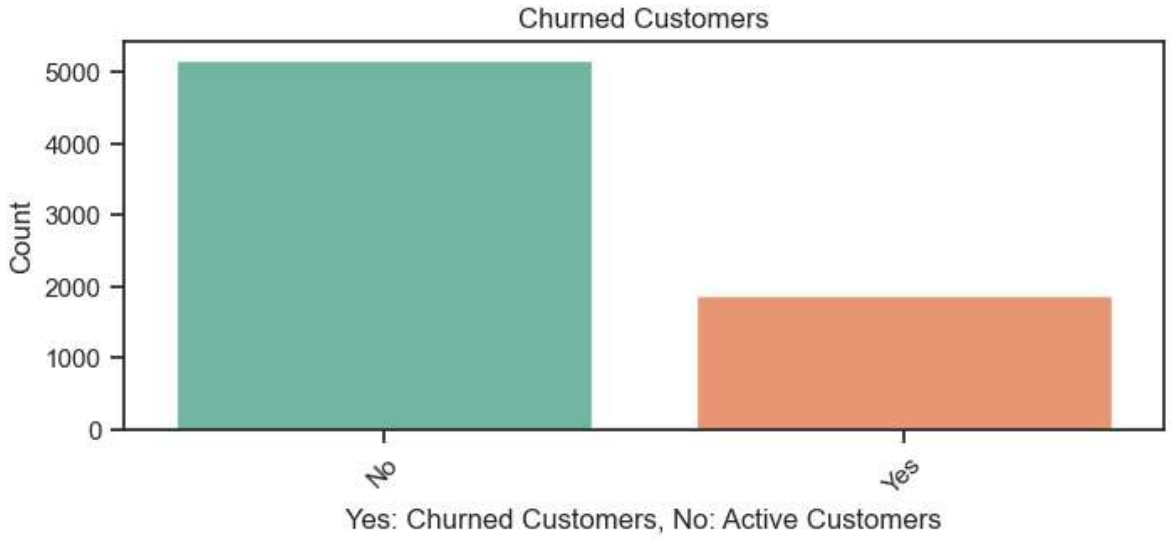
```
# Create a figure with two subplots
fig, axes = mat.subplots(1, 2, figsize=(12, 5))

# First subplot: Histogram for 'Tenure'
sea.histplot(data=df, x='tenure', bins=40, kde=True, color='blue', ax=axes[0])

# Set labels and title for the first subplot
axes[0].set_xlabel('Tenure')
axes[0].set_ylabel('Frequency')
axes[0].set_title('Customers Tenure')

# Second subplot: Histogram for 'MonthlyCharges'
sea.histplot(data=df, x='MonthlyCharges', bins=40, kde=True, color='blue', ax=

# Set labels and title for the second subplot
axes[1].set_xlabel('Amount')
axes[1].set_ylabel('Customers')
axes[1].set_title('Monthly Charges')

# Adjust spacing between subplots
mat.tight_layout()

# Show the combined plot
mat.show()
```



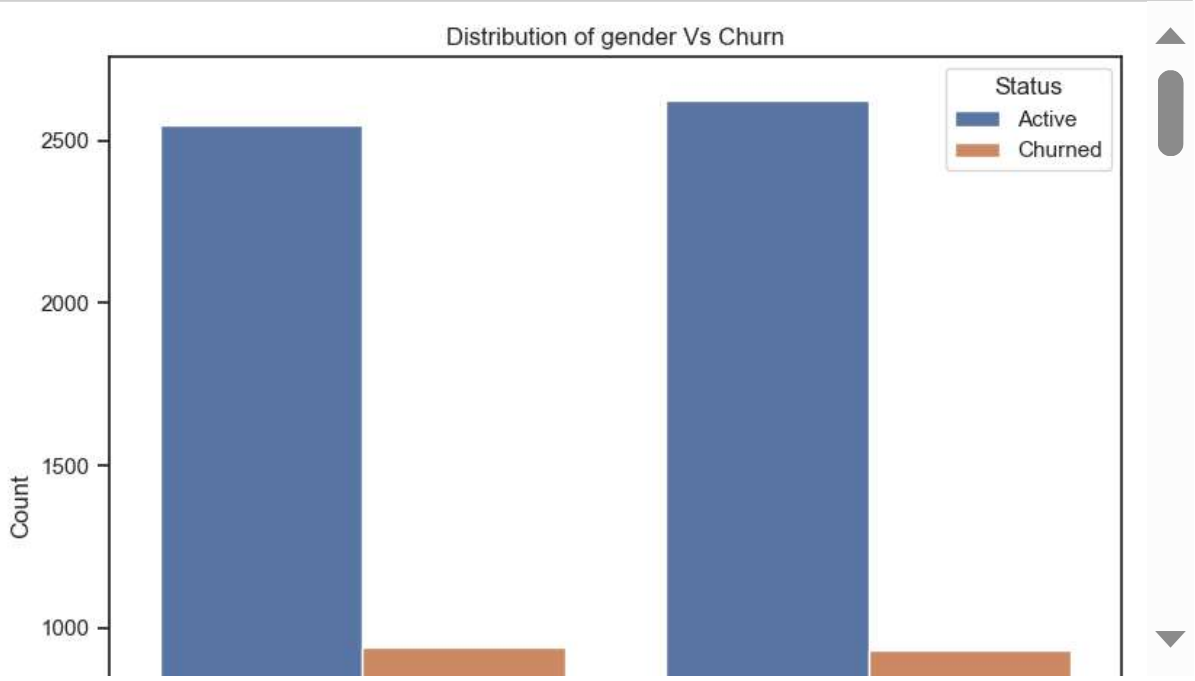
In [175]:
```
sea.set(style="darkgrid")
mat.figure(figsize=(10, 4))  # Adjust the figure size as needed
sea.countplot(data=df, x='PaymentMethod', palette='Set1')  # Use your preferre

# Set plot labels and title
mat.xlabel('Payment Method')
mat.ylabel('Count')
mat.title('Distribution of Payment Methods')

# Rotate x-axis labels for better readability if needed
mat.xticks(rotation=45)

# Show the plot
mat.show()
```



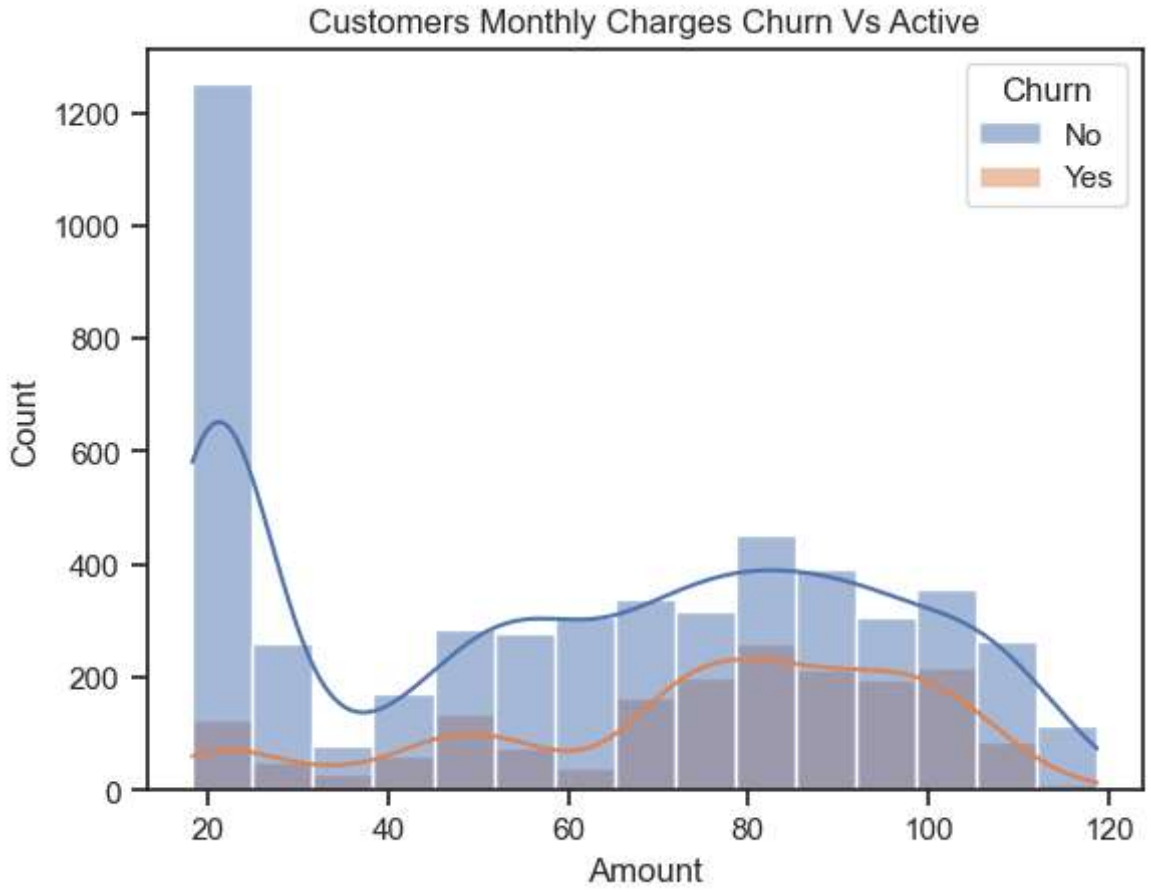
In [176]:
```
sea.set(style="ticks")
mat.figure(figsize=(8, 3))  # Adjust the figure size as needed
sea.countplot(data=df, x='Churn', palette='Set2')  # Use your preferred color

# Set plot labels and title
mat.xlabel('Yes: Churned Customers, No: Active Customers')
mat.ylabel('Count')
mat.title('Churned Customers')

# Rotate x-axis labels for better readability if needed
mat.xticks(rotation=45)

# Show the plot
mat.show()
```



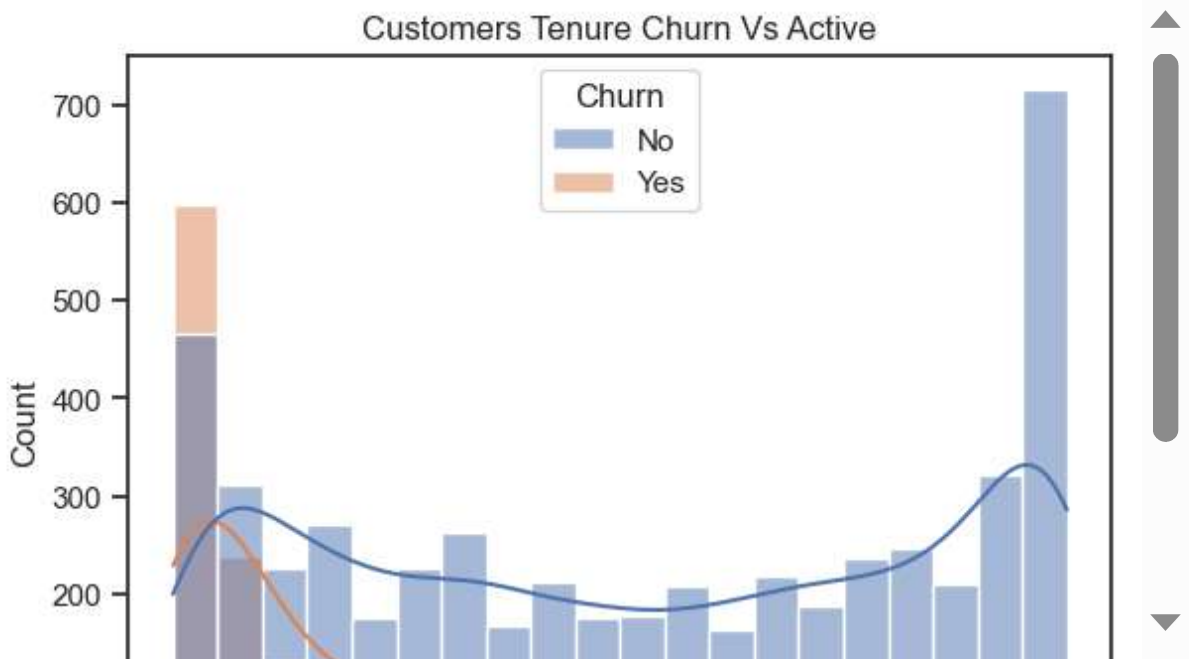
In [177]:
```
categorical_features_1 = ['gender','InternetService','Contract','PaymentMethod

for column in categorical_features_1:
    mat.figure(figsize=(9, 8))
    sea.countplot(data=df, x=column, hue='Churn')
    mat.title(f'Distribution of {column} Vs Churn')
    mat.xlabel(column)
    mat.ylabel('Count')
    mat.legend(title='Status', loc='upper right', labels=['Active', 'Churned']
    mat.show()
```



In [178]:
```
sea.histplot(data=df, x='MonthlyCharges', bins=15, kde=True, color='blue', hue

# Set plot labels and title
mat.xlabel('Amount')
mat.ylabel('Count')
mat.title('Customers Monthly Charges Churn Vs Active')

# Show the plot
mat.show()
```

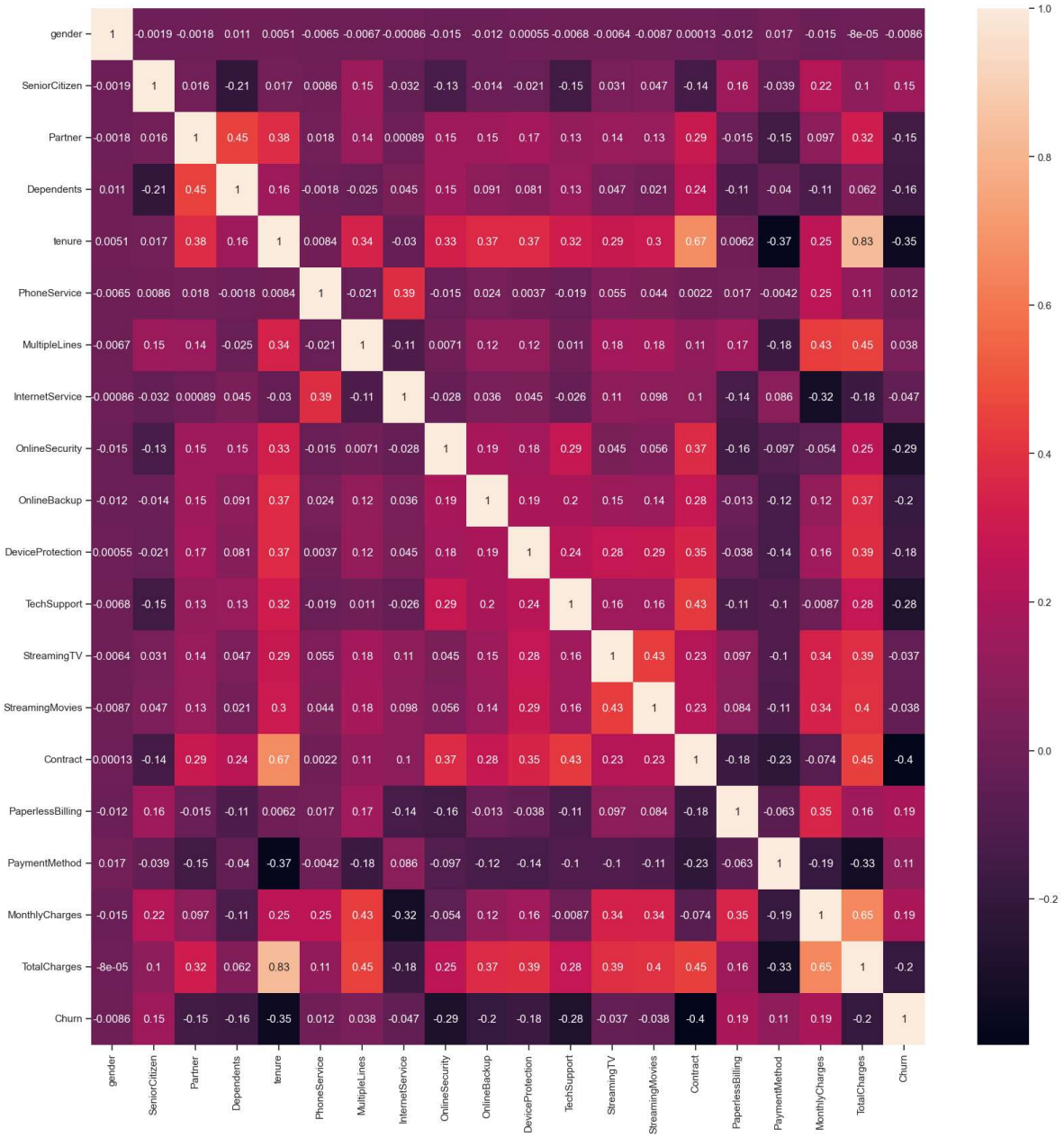


In [295]:
```
sea.histplot(data=df, x='tenure', bins=20, kde=True, color='blue', hue='Churn'

# Set plot labels and title
mat.xlabel('Tenure')
mat.ylabel('Count')
mat.title('Customers Tenure Churn Vs Active')

# Show the plot
mat.show()
```



In [299]:
```
mat.figure(figsize=(20,20))
sea.heatmap(df.corr(), annot=True)
```

Out[299]: <Axes: >



In [304]:
```
Min_Max = MinMaxScaler()

df['MonthlyCharges'] = Min_Max.fit_transform(df['MonthlyCharges'].values.resha
df['TotalCharges']= Min_Max.fit_transform(df['TotalCharges'].values.reshape(-1
df['tenure']= Min_Max.fit_transform(df['tenure'].values.reshape(-1,1))
```

In [305]:
```
#define the training and learning model
X_train, X_test, y_train, y_test = train_test_split(df.drop(columns='Churn'),
```

In [307]:
```
from sklearn.model_selection import GridSearchCV

#Decision_Tree_Classifier
dtree  = DecisionTreeClassifier()
param_grid = {
    'max_depth': [2,4,6,8,10],
    'min_samples_leaf': [2,4,6,8,10],
    'min_samples_split': [2,4,6,8,10],
    'criterion': ['gini', 'entropy'],
    'random_state': [0,42]
}

#Grid Search Object with Decision Tree Classifier
grid_search = GridSearchCV(estimator = dtree, param_grid = param_grid, cv = 3,

#Fitting the data
grid_search.fit(X_train, y_train)

#Best parameters
print(grid_search.best_params_)
```

```
Fitting 3 folds for each of 500 candidates, totalling 1500 fits
{'criterion': 'entropy', 'max_depth': 6, 'min_samples_leaf': 6, 'min_samples
_split': 2, 'random_state': 0}
```

In [308]:
```
#Decision Tree Classifier accuracy
dtree  = DecisionTreeClassifier(criterion='gini', max_depth=6, min_samples_lea

#Fitting the data
dtree.fit(X_train, y_train)

#Training accuracy
print('Training Accuracy: ', dtree.score(X_train, y_train))

#Predicting the values
d_pred = dtree.predict(X_test)
```

```
Training Accuracy:  0.8077742279020235
```

In [310]:
```
from sklearn.model_selection import GridSearchCV

#Random_forest_clasifier
rfc = RandomForestClassifier()
param_grid = {
    'max_depth': [2,4,6,8,10],
    'min_samples_leaf': [2,4,6,8,10],
    'min_samples_split': [2,4,6,8,10],
    'criterion': ['gini', 'entropy'],
    'random_state': [0,42]
}

#Grid Search Object with Random Forest Classifier
grid_search = GridSearchCV(estimator = rfc, param_grid = param_grid, cv = 3, r

#Fitting the data
grid_search.fit(X_train, y_train)

#Best parameters
print(grid_search.best_params_)
```

```
Fitting 3 folds for each of 500 candidates, totalling 1500 fits
{'criterion': 'gini', 'max_depth': 8, 'min_samples_leaf': 6, 'min_samples_sp
lit': 2, 'random_state': 42}
```

In [311]:
```
#Random Forest Classifier accuracy
rfc = RandomForestClassifier(criterion='entropy', max_depth=10, min_samples_le

#Fitting the data
rfc.fit(X_train, y_train)

#Training accuracy
print('Training Accuracy: ', rfc.score(X_train, y_train))

#Predicting the values
r_pred = rfc.predict(X_test)
```

```
Training Accuracy:  0.8313809016684416
```

In [312]:
```
from sklearn.model_selection import GridSearchCV

#K Nearst Classifier
knn = KNeighborsClassifier()
param_grid = {
    'n_neighbors': [2,4,6,8,10],
    'weights': ['uniform', 'distance'],
    'algorithm': ['auto', 'ball_tree', 'kd_tree', 'brute']
}

#Grid Search Object with KNN Classifier
grid_search = GridSearchCV(estimator = knn, param_grid = param_grid, cv = 3, r

#Fitting the data
grid_search.fit(X_train, y_train)

#Best parameters
print(grid_search.best_params_)
```

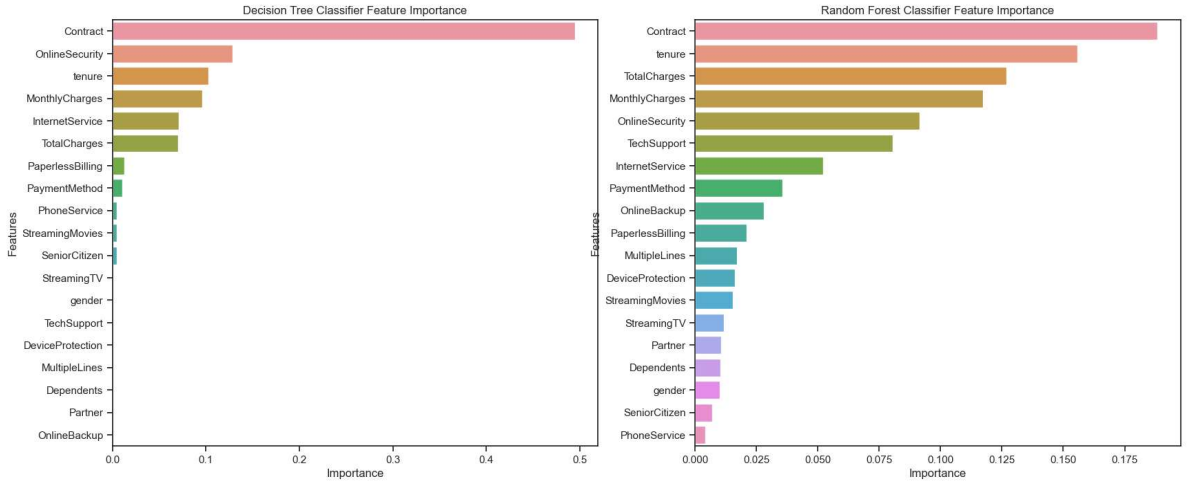
```
Fitting 3 folds for each of 40 candidates, totalling 120 fits
{'algorithm': 'kd_tree', 'n_neighbors': 10, 'weights': 'uniform'}
```

In [313]:
```
#KNN Classifier Acurracy
knn = KNeighborsClassifier(algorithm='ball_tree', n_neighbors=6, weights='unif

#Fitting the data
knn.fit(X_train, y_train)

#Training accuracy
print('Training Accuracy: ', knn.score(X_train, y_train))

#Predicting the values
k_pred = knn.predict(X_test)
```

```
Training Accuracy:  0.8249911253106141
```

In [319]:
```
fig, ax = mat.subplots(1, 2, figsize=(20, 8))
# Decision Tree Classifier Feature Importance
feature_df = pd.DataFrame({'Features': X_train.columns, 'Importance': dtree.fe
feature_df.sort_values('Importance', ascending=False, inplace=True)
sea.barplot(x = 'Importance', y = 'Features', data = feature_df, ax=ax[0]).set

# Random Forest Classifier Feature Importance
feature_df = pd.DataFrame({'Features': X_train.columns, 'Importance': rfc.feat
feature_df.sort_values('Importance', ascending=False, inplace=True)
sea.barplot(x = 'Importance', y = 'Features', data = feature_df, ax=ax[1]).set
```

Out[319]: Text(0.5, 1.0, 'Random Forest Classifier Feature Importance')



In [ ]: