CodeClause

Data Science Intern

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Project Name

Task-1 :Churn Prediction in Telecom Industry using Logistic Regression

Importing required libraries

In [7]:

```python
import pandas as pd
import numpy as np
import seaborn as sns
import matplotlib.pyplot as plt
import matplotlib.ticker as mtick
```

In [9]:

```python
telecom_cust = pd.read_csv("C:\\Users\\kankk\\OneDrive\\Desktop\\WA_Fn-UseC_-Telco-Customer-Churn.csv")
```

In [10]:

```python
telecom_cust.head(10)
```

Out[10]:

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

10 rows × 21 columns

In [11]:

```python
telecom_cust.columns.values
```

Out[11]:

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

In [12]:

```python
# Checking the data types of all the columns
telecom_cust.dtypes
```

Out[12]:

```
customerID           object
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         object
Churn                object
dtype: object
```

In [13]:

```
# Converting Total Charges to a numerical data type.
telecom_cust.TotalCharges = pd.to_numeric(telecom_cust.TotalCharges, errors='coerce')
telecom_cust.isnull().sum()
```

Out[13]:

```
customerID           0
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        11
Churn                0
dtype: int64
```

In [14]:

```
#Removing missing values
telecom_cust.dropna(inplace = True)
#Remove customer IDs from the data set
df2 = telecom_cust.iloc[:,1:]
#Convertin the predictor variable in a binary numeric variable
df2['Churn'].replace(to_replace='Yes', value=1, inplace=True)
df2['Churn'].replace(to_replace='No',  value=0, inplace=True)

#Let's convert all the categorical variables into dummy variables
df_dummies = pd.get_dummies(df2)
df_dummies.head()
```

Out[14]:

| | SeniorCitizen | tenure | MonthlyCharges | TotalCharges | Churn | gender_Female | gender_Male | Partner_No | Partner_Yes | Dependents_No | ... |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **0** | 0 | 1 | 29.85 | 29.85 | 0 | 1 | 0 | 0 | 1 | 1 | ... |
| **1** | 0 | 34 | 56.95 | 1889.50 | 0 | 0 | 1 | 1 | 0 | 1 | ... |
| **2** | 0 | 2 | 53.85 | 108.15 | 1 | 0 | 1 | 1 | 0 | 1 | ... |
| **3** | 0 | 45 | 42.30 | 1840.75 | 0 | 0 | 1 | 1 | 0 | 1 | ... |
| **4** | 0 | 2 | 70.70 | 151.65 | 1 | 1 | 0 | 1 | 0 | 1 | ... |

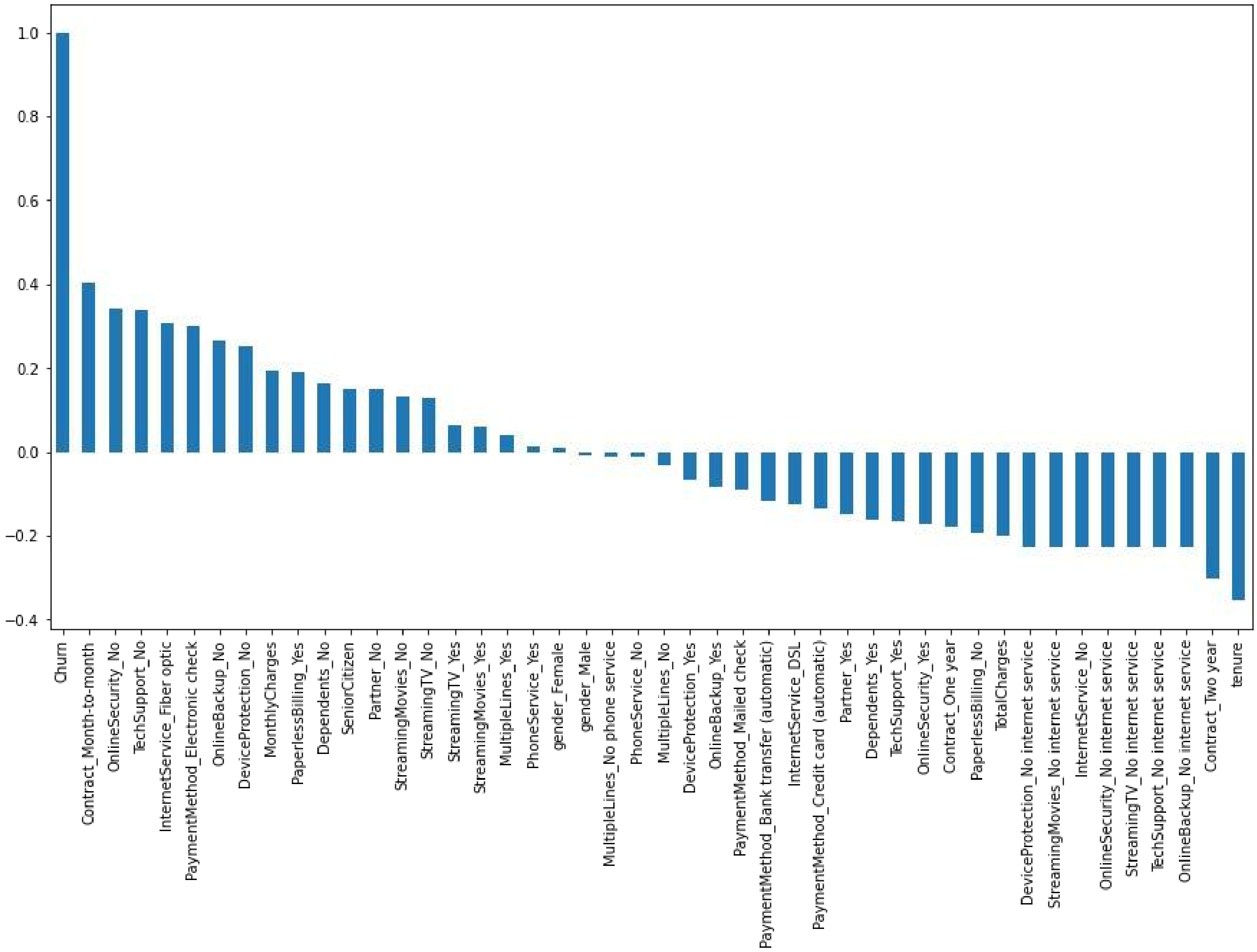
5 rows × 46 columns

In [15]:

```
#Get Correlation of "Churn" with other variables:
plt.figure(figsize=(15,8))
df_dummies.corr()['Churn'].sort_values(ascending = False).plot(kind='bar')
```

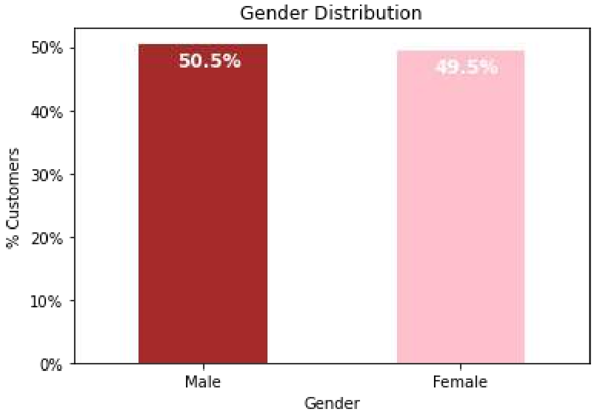
Out[15]:

```
<AxesSubplot:>
```



In [16]:

```
colors = ['brown','pink']
ax = (telecom_cust['gender'].value_counts()*100.0 /len(telecom_cust)).plot(kind='bar',
                                                                           stacked = True,
                                                                          rot = 0,
                                                                          color = colors)
ax.yaxis.set_major_formatter(mtick.PercentFormatter())
ax.set_ylabel('% Customers')
ax.set_xlabel('Gender')
ax.set_ylabel('% Customers')
ax.set_title('Gender Distribution')

# create a list to collect the plt.patches data
totals = []

# find the values and append to list
for i in ax.patches:
    totals.append(i.get_width())

# set individual bar lables using above list
total = sum(totals)

for i in ax.patches:
    # get_width pulls left or right; get_y pushes up or down
    ax.text(i.get_x()+.15, i.get_height()-3.5, \
            str(round((i.get_height()/total), 1))+'%',
            fontsize=12,
            color='white',
           weight = 'bold')
```

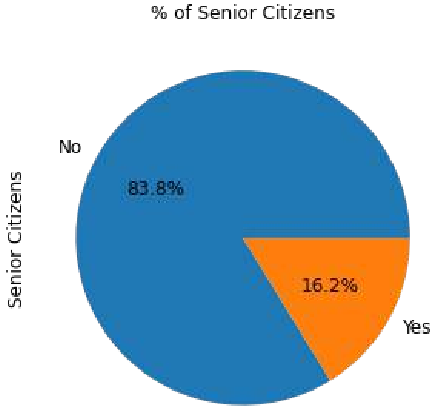


In [17]:

```
ax = (telecom_cust['SeniorCitizen'].value_counts()*100.0 /len(telecom_cust))\
.plot.pie(autopct='%.1f%%', labels = ['No', 'Yes'],figsize =(5,5), fontsize = 12 )
ax.yaxis.set_major_formatter(mtick.PercentFormatter())
ax.set_ylabel('Senior Citizens',fontsize = 12)
ax.set_title('% of Senior Citizens', fontsize = 12)
```

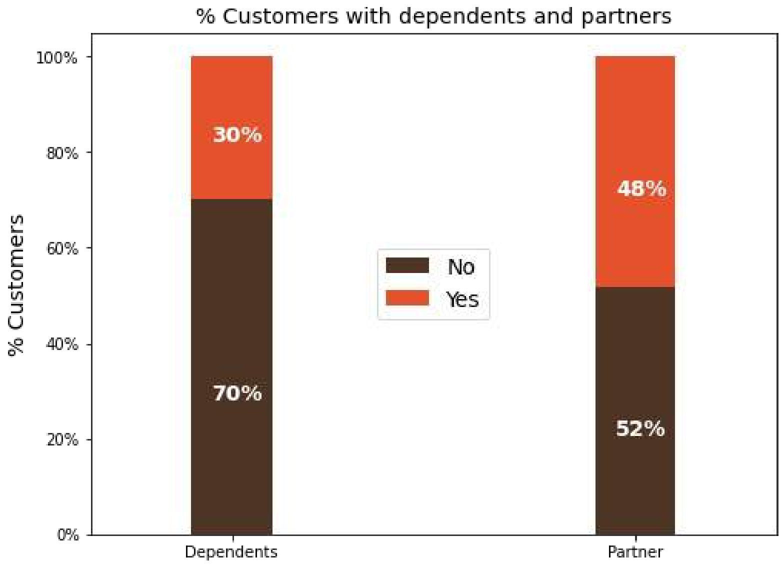
Out[17]:

```
Text(0.5, 1.0, '% of Senior Citizens')
```

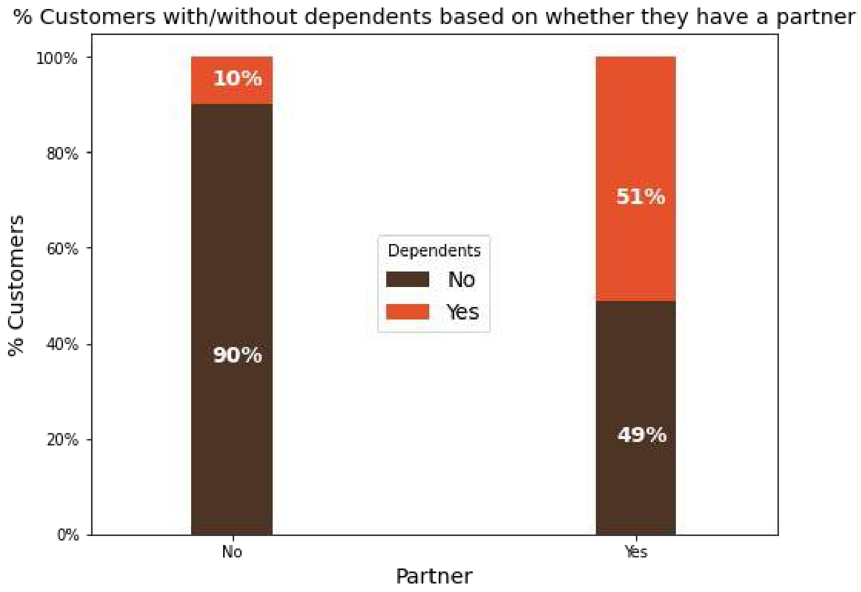


In [18]:

```
df2 = pd.melt(telecom_cust, id_vars=['customerID'], value_vars=['Dependents','Partner'])
df3 = df2.groupby(['variable','value']).count().unstack()
df3 = df3*100/len(telecom_cust)
colors = ['#4D3425','#E4512B']
ax = df3.loc[:,'customerID'].plot.bar(stacked=True, color=colors,
                                      figsize=(8,6),rot = 0,
                                     width = 0.2)

ax.yaxis.set_major_formatter(mtick.PercentFormatter())
ax.set_ylabel('% Customers',size = 14)
ax.set_xlabel('')
ax.set_title('% Customers with dependents and partners',size = 14)
ax.legend(loc = 'center',prop={'size':14})

for p in ax.patches:
    width, height = p.get_width(), p.get_height()
    x, y = p.get_xy()
    ax.annotate('{:.0f}%'.format(height), (p.get_x()+.25*width, p.get_y()+.4*height),
                color = 'white',
               weight = 'bold',
               size = 14)
```



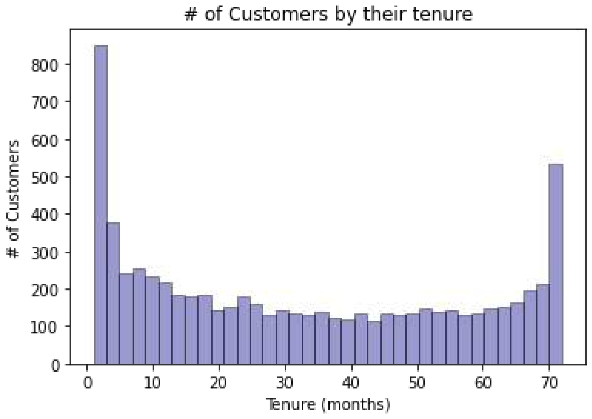
In [19]:
```
colors = ['#4D3425','#E4512B']
partner_dependents = telecom_cust.groupby(['Partner','Dependents']).size().unstack()

ax = (partner_dependents.T*100.0 / partner_dependents.T.sum()).T.plot(kind='bar',
                                                                width = 0.2,
                                                                stacked = True,
                                                                rot = 0,
                                                                figsize = (8,6),
                                                                color = colors)
ax.yaxis.set_major_formatter(mtick.PercentFormatter())
ax.legend(loc='center',prop={'size':14},title = 'Dependents',fontsize =14)
ax.set_ylabel('% Customers',size = 14)
ax.set_title('% Customers with/without dependents based on whether they have a partner',size = 14)
ax.xaxis.label.set_size(14)

# Code to add the data labels on the stacked bar chart
for p in ax.patches:
    width, height = p.get_width(), p.get_height()
    x, y = p.get_xy()
    ax.annotate('{:.0f}%'.format(height), (p.get_x()+.25*width, p.get_y()+.4*height),
                color = 'white',
               weight = 'bold',
               size = 14)
```



In [20]:
```
ax = sns.distplot(telecom_cust['tenure'], hist=True, kde=False,
             bins=int(180/5), color = 'darkblue',
             hist_kws={'edgecolor':'black'},
             kde_kws={'linewidth': 4})
ax.set_ylabel('# of Customers')
ax.set_xlabel('Tenure (months)')
ax.set_title('# of Customers by their tenure')
```

```
C:\Users\kankk\anaconda3\lib\site-packages\seaborn\distributions.py:2619: FutureWarning: `distplot` is a deprec
ated function and will be removed in a future version. Please adapt your code to use either `displot` (a figure
-level function with similar flexibility) or `histplot` (an axes-level function for histograms).
  warnings.warn(msg, FutureWarning)
```

Out[20]:
```
Text(0.5, 1.0, '# of Customers by their tenure')
```



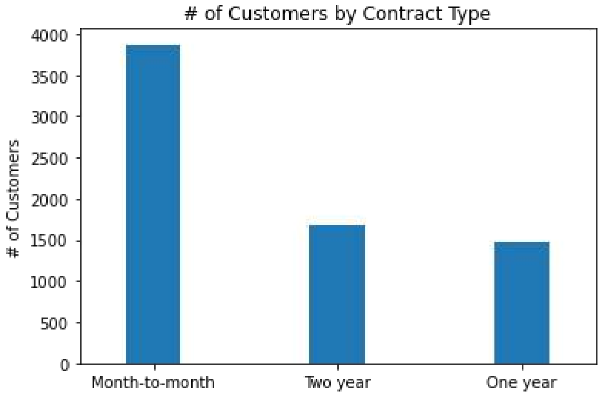
# of Customers by their tenure

In [21]:

```python
ax = telecom_cust['Contract'].value_counts().plot(kind = 'bar',rot = 0, width = 0.3)
ax.set_ylabel('# of Customers')
ax.set_title('# of Customers by Contract Type')
```

Out[21]:

```
Text(0.5, 1.0, '# of Customers by Contract Type')
```



# of Customers by Contract Type

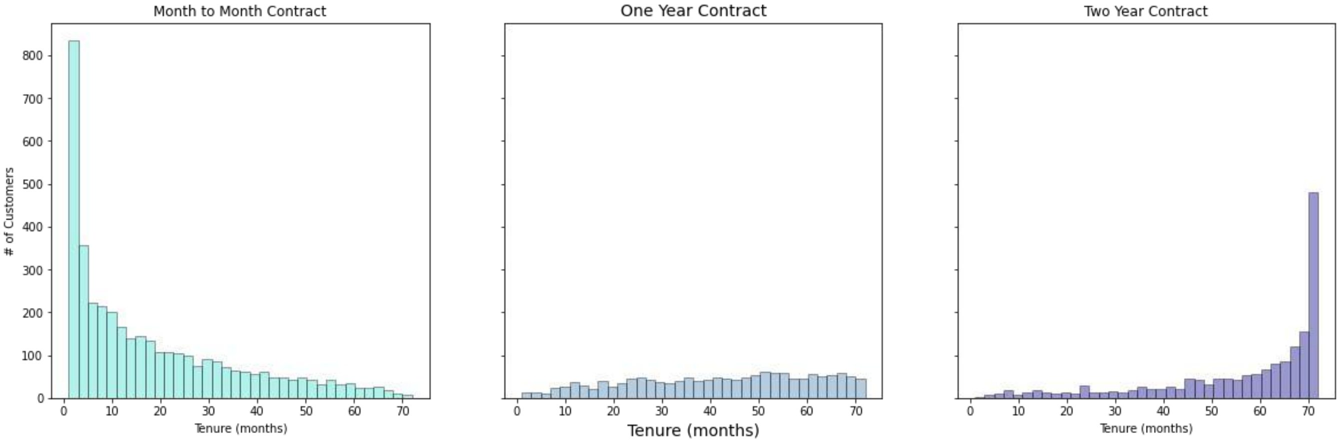
In [22]:

```python
fig, (ax1,ax2,ax3) = plt.subplots(nrows=1, ncols=3, sharey = True, figsize = (20,6))

ax = sns.distplot(telecom_cust[telecom_cust['Contract']=='Month-to-month']['tenure'],
                   hist=True, kde=False,
                   bins=int(180/5), color = 'turquoise',
                   hist_kws={'edgecolor':'black'},
                   kde_kws={'linewidth': 4},
                 ax=ax1)
ax.set_ylabel('# of Customers')
ax.set_xlabel('Tenure (months)')
ax.set_title('Month to Month Contract')

ax = sns.distplot(telecom_cust[telecom_cust['Contract']=='One year']['tenure'],
                   hist=True, kde=False,
                   bins=int(180/5), color = 'steelblue',
                   hist_kws={'edgecolor':'black'},
                   kde_kws={'linewidth': 4},
                 ax=ax2)
ax.set_xlabel('Tenure (months)',size = 14)
ax.set_title('One Year Contract',size = 14)

ax = sns.distplot(telecom_cust[telecom_cust['Contract']=='Two year']['tenure'],
                   hist=True, kde=False,
                   bins=int(180/5), color = 'darkblue',
                   hist_kws={'edgecolor':'black'},
                   kde_kws={'linewidth': 4},
                 ax=ax3)

ax.set_xlabel('Tenure (months)')
ax.set_title('Two Year Contract')
```

```
C:\Users\kankk\anaconda3\lib\site-packages\seaborn\distributions.py:2619: FutureWarning: `distplot` is a deprec
ated function and will be removed in a future version. Please adapt your code to use either `displot` (a figure
-level function with similar flexibility) or `histplot` (an axes-level function for histograms).
  warnings.warn(msg, FutureWarning)
```

Out[22]:

```
Text(0.5, 1.0, 'Two Year Contract')
```



Let us now look at the distribution of various services used by customers

In [23]:

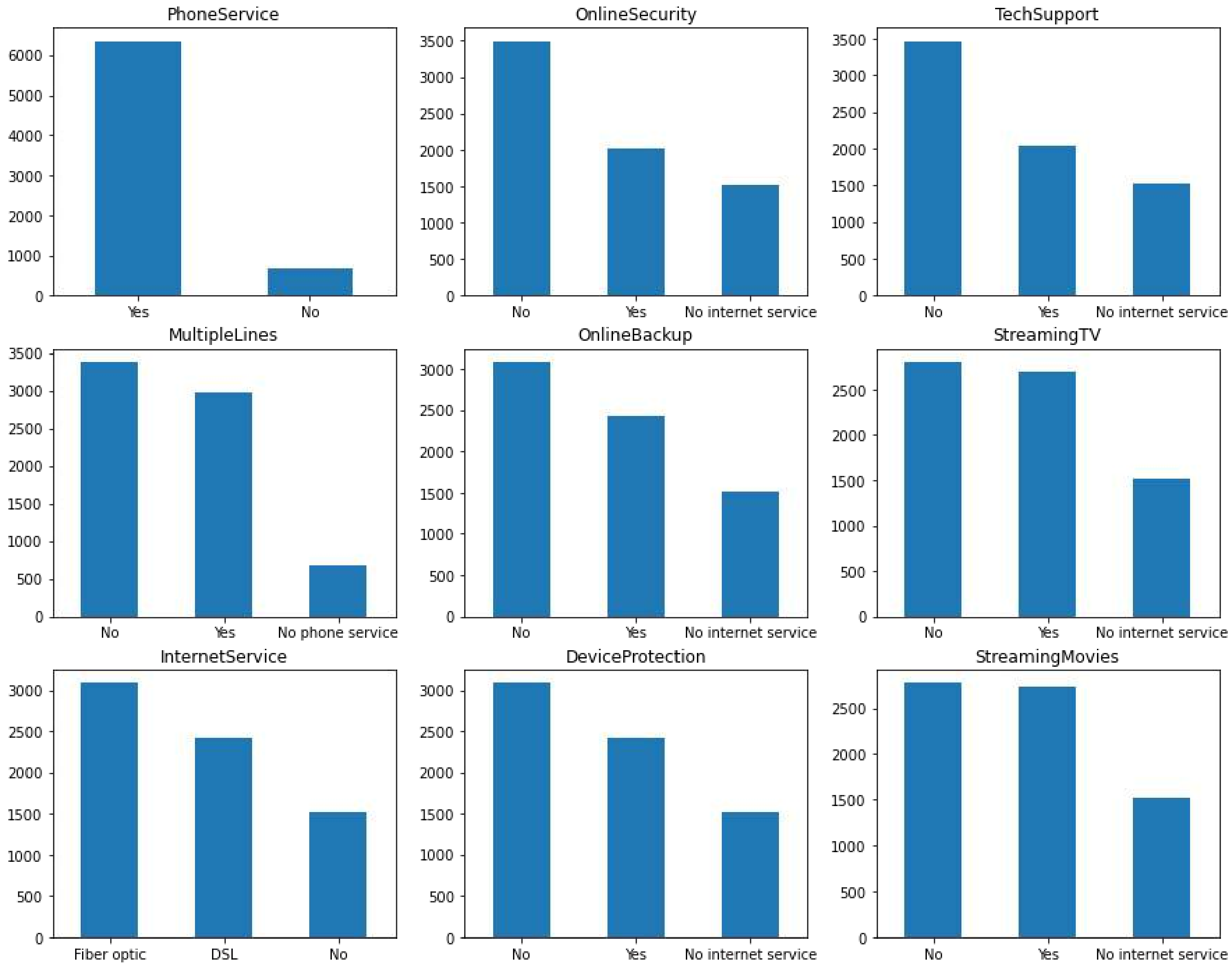
```
telecom_cust.columns.values
```

Out[23]:

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

In [24]:

```
services = ['PhoneService','MultipleLines','InternetService','OnlineSecurity',
           'OnlineBackup','DeviceProtection','TechSupport','StreamingTV','StreamingMovies']

fig, axes = plt.subplots(nrows = 3,ncols = 3,figsize = (15,12))
for i, item in enumerate(services):
    if i < 3:
        ax = telecom_cust[item].value_counts().plot(kind = 'bar',ax=axes[i,0],rot = 0)

    elif i >=3 and i < 6:
        ax = telecom_cust[item].value_counts().plot(kind = 'bar',ax=axes[i-3,1],rot = 0)

    elif i < 9:
        ax = telecom_cust[item].value_counts().plot(kind = 'bar',ax=axes[i-6,2],rot = 0)
    ax.set_title(item)
```

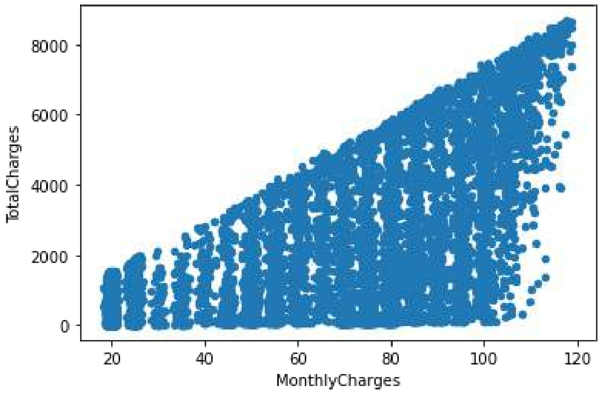


In [25]:

```
telecom_cust[['MonthlyCharges', 'TotalCharges']].plot.scatter(x = 'MonthlyCharges',
                                                              y='TotalCharges')
```

Out[25]:

```
<AxesSubplot:xlabel='MonthlyCharges', ylabel='TotalCharges'>
```



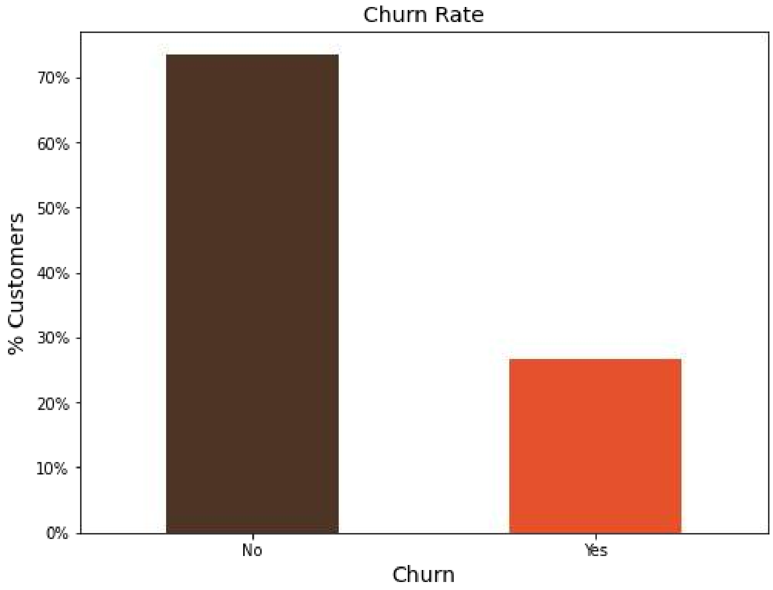
Finally, let's take a look at out predictor variable (Churn) and understand its interaction with other important variables as was found out in the correlation plot.

In [26]:

```
colors = ['#4D3425','#E4512B']
ax = (telecom_cust['Churn'].value_counts()*100.0 /len(telecom_cust)).plot(kind='bar',
                                                                           stacked = True,
                                                                          rot = 0,
                                                                          color = colors,
                                                                         figsize = (8,6))
ax.yaxis.set_major_formatter(mtick.PercentFormatter())
ax.set_ylabel('% Customers',size = 14)
ax.set_xlabel('Churn',size = 14)
ax.set_title('Churn Rate', size = 14)

# create a list to collect the plt.patches data
totals = []

# find the values and append to list
for i in ax.patches:
    totals.append(i.get_width())
```

```python
# set individual bar lables using above list
total = sum(totals)

for i in ax.patches:
    # get_width pulls left or right; get_y pushes up or down
    ax.text(i.get_x()+.15, i.get_height()-4.0, \
            str(round((i.get_height()/total), 1))+'%',
            fontsize=12,
            color='white',
           weight = 'bold',
           size = 14)
```

```
---------------------------------------------------------------------------
TypeError                                 Traceback (most recent call last)
Input In [26], in <cell line: 22>()
     20 total = sum(totals)
     22 for i in ax.patches:
     23     # get_width pulls left or right; get_y pushes up or down
---> 24     ax.text(i.get_x()+.15, i.get_height()-4.0, \
     25             str(round((i.get_height()/total), 1))+'%',
     26             fontsize=12,
     27             color='white',
     28            weight = 'bold',
     29            size = 14)

File ~\anaconda3\lib\site-packages\matplotlib\axes\_axes.py:659, in Axes.text(self, x, y, s, fontdict, **kwargs
)
    598 """
    599 Add text to the Axes.
    600
   (...)
    649     >>> text(x, y, s, bbox=dict(facecolor='red', alpha=0.5))
    650 """
    651 effective_kwargs = {
    652     'verticalalignment': 'baseline',
    653     'horizontalalignment': 'left',
   (...)
    657     **kwargs,
    658 }
--> 659 t = mtext.Text(x, y, text=s, **effective_kwargs)
    660 t.set_clip_path(self.patch)
    661 self._add_text(t)

File ~\anaconda3\lib\site-packages\matplotlib\text.py:160, in Text.__init__(self, x, y, text, color, verticalal
ignment, horizontalalignment, multialignment, fontproperties, rotation, linespacing, rotation_mode, usetex, wra
p, transform_rotates_text, parse_math, **kwargs)
    158 self._linespacing = linespacing
    159 self.set_rotation_mode(rotation_mode)
--> 160 self.update(kwargs)

File ~\anaconda3\lib\site-packages\matplotlib\text.py:164, in Text.update(self, kwargs)
    162 def update(self, kwargs):
    163     # docstring inherited
--> 164     kwargs = cbook.normalize_kwargs(kwargs, Text)
    165     sentinel = object()  # bbox can be None, so use another sentinel.
    166     # Update fontproperties first, as it has lowest priority.

File ~\anaconda3\lib\site-packages\matplotlib\cbook\__init__.py:1739, in normalize_kwargs(kw, alias_mapping)
   1737 canonical = to_canonical.get(k, k)
   1738 if canonical in canonical_to_seen:
-> 1739     raise TypeError(f"Got both {canonical_to_seen[canonical]!r} and "
   1740                     f"{k!r}, which are aliases of one another")
   1741 canonical_to_seen[canonical] = k
   1742 ret[canonical] = v

TypeError: Got both 'fontsize' and 'size', which are aliases of one another
```

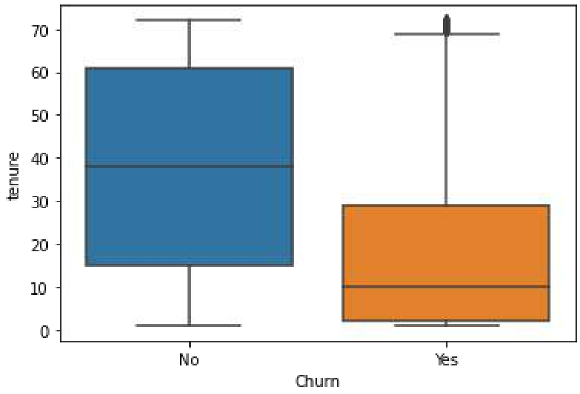


In [27]:

```
sns.boxplot(x = telecom_cust.Churn, y = telecom_cust.tenure)
```

Out[27]:

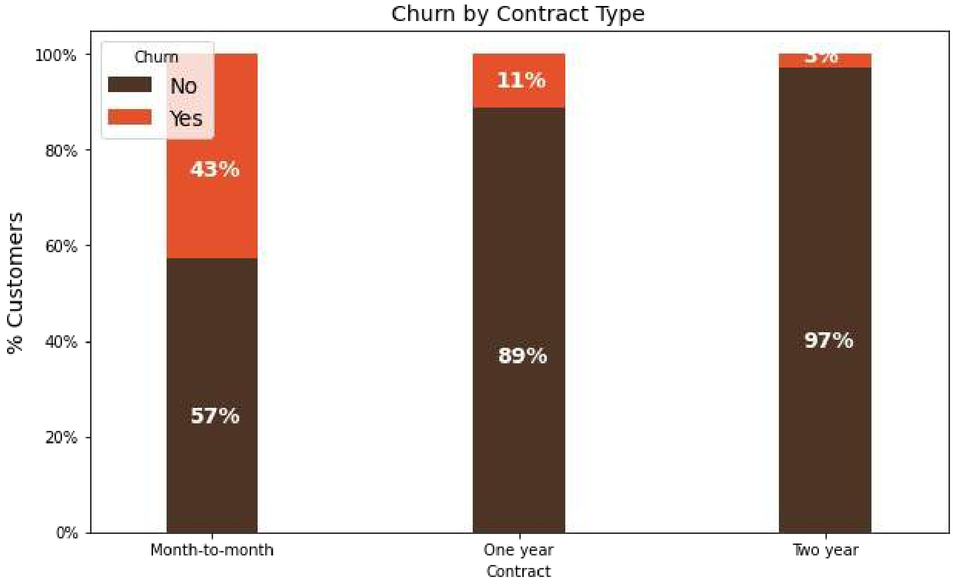
```
<AxesSubplot:xlabel='Churn', ylabel='tenure'>
```



Churn by Contract Type

In [28]:

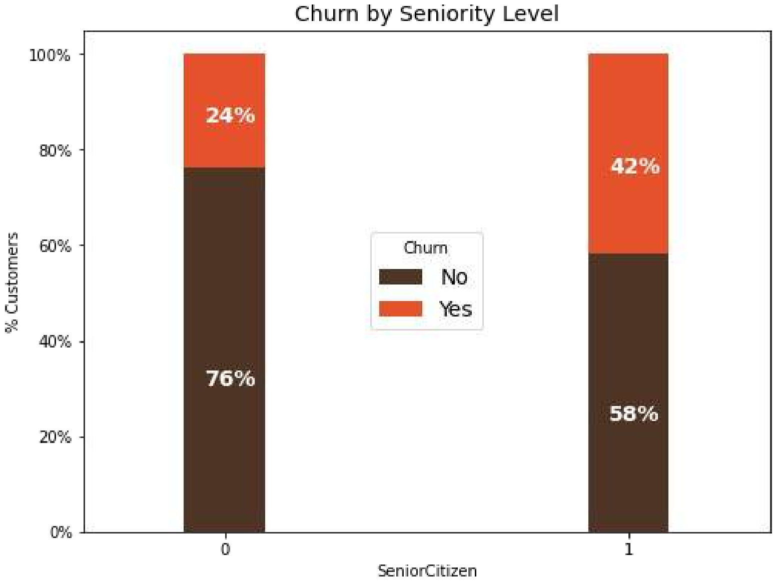
```
colors = ['#4D3425','#E4512B']
contract_churn = telecom_cust.groupby(['Contract','Churn']).size().unstack()

ax = (contract_churn.T*100.0 / contract_churn.T.sum()).T.plot(kind='bar',
                                                                width = 0.3,
                                                                stacked = True,
                                                                rot = 0,
                                                                figsize = (10,6),
                                                                color = colors)
ax.yaxis.set_major_formatter(mtick.PercentFormatter())
ax.legend(loc='best',prop={'size':14},title = 'Churn')
ax.set_ylabel('% Customers',size = 14)
ax.set_title('Churn by Contract Type',size = 14)

# Code to add the data labels on the stacked bar chart
for p in ax.patches:
    width, height = p.get_width(), p.get_height()
    x, y = p.get_xy()
    ax.annotate('{:.0f}%'.format(height), (p.get_x()+.25*width, p.get_y()+.4*height),
                color = 'white',
               weight = 'bold',
               size = 14)
```



Churn by Seniority

In [29]:

```
colors = ['#4D3425','#E4512B']
seniority_churn = telecom_cust.groupby(['SeniorCitizen','Churn']).size().unstack()

ax = (seniority_churn.T*100.0 / seniority_churn.T.sum()).T.plot(kind='bar',
                                                                width = 0.2,
                                                                stacked = True,
                                                                rot = 0,
                                                                figsize = (8,6),
                                                                color = colors)
ax.yaxis.set_major_formatter(mtick.PercentFormatter())
ax.legend(loc='center',prop={'size':14},title = 'Churn')
ax.set_ylabel('% Customers')
ax.set_title('Churn by Seniority Level',size = 14)

# Code to add the data labels on the stacked bar chart
for p in ax.patches:
    width, height = p.get_width(), p.get_height()
    x, y = p.get_xy()
    ax.annotate('{:.0f}%'.format(height), (p.get_x()+.25*width, p.get_y()+.4*height),
                color = 'white',
               weight = 'bold',size =14)
```



Churn by Monthly Charges

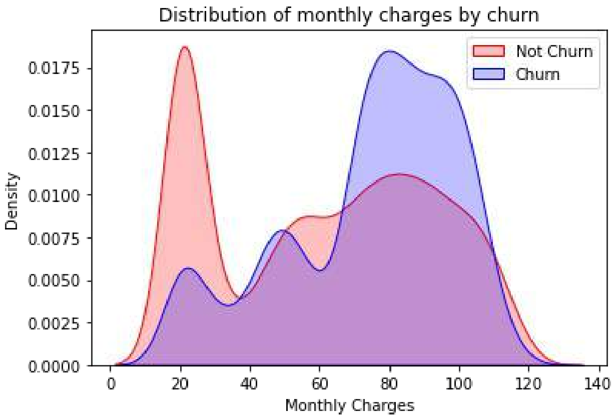
In [31]:

```
ax = sns.kdeplot(telecom_cust.MonthlyCharges[(telecom_cust["Churn"] == 'No') ],
                color="Red", shade = True)
ax = sns.kdeplot(telecom_cust.MonthlyCharges[(telecom_cust["Churn"] == 'Yes') ],
                ax =ax, color="Blue", shade= True)
```

```
ax.legend(["Not Churn","Churn"],loc='upper right')
ax.set_ylabel('Density')
ax.set_xlabel('Monthly Charges')
ax.set_title('Distribution of monthly charges by churn')
```

Out[31]:

```
Text(0.5, 1.0, 'Distribution of monthly charges by churn')
```



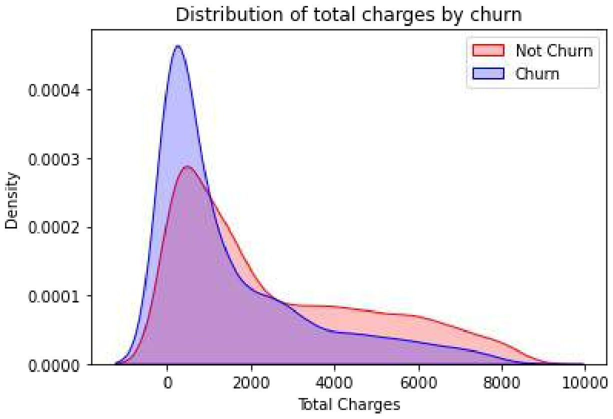
Churn by Total Charges

In [32]:

```
ax = sns.kdeplot(telecom_cust.TotalCharges[(telecom_cust["Churn"] == 'No') ],
                color="Red", shade = True)
ax = sns.kdeplot(telecom_cust.TotalCharges[(telecom_cust["Churn"] == 'Yes') ],
                ax =ax, color="Blue", shade= True)
ax.legend(["Not Churn","Churn"],loc='upper right')
ax.set_ylabel('Density')
ax.set_xlabel('Total Charges')
ax.set_title('Distribution of total charges by churn')
```

Out[32]:

```
Text(0.5, 1.0, 'Distribution of total charges by churn')
```



After going through the above EDA we wil develop some predictive models and compare them. We will develop Logistic Regression, Random Forest, SVM, ADA Boost, XG Boost 1.Logistic Regresion

In [33]:

```
y = df_dummies['Churn'].values
X = df_dummies.drop(columns = ['Churn'])

# Scaling all the variables to a range of 0 to 1
from sklearn.preprocessing import MinMaxScaler
features = X.columns.values
scaler = MinMaxScaler(feature_range = (0,1))
scaler.fit(X)
X = pd.DataFrame(scaler.transform(X))
X.columns = features
```

In [36]:

```
# Create Train & Test Data
from sklearn.model_selection import train_test_split
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.3, random_state=101)
```

In [37]:

```
# Running logistic regression model
from sklearn.linear_model import LogisticRegression
model = LogisticRegression()
result = model.fit(X_train, y_train)
```

In [38]:

```
from sklearn import metrics
prediction_test = model.predict(X_test)
# Print the prediction accuracy
print (metrics.accuracy_score(y_test, prediction_test))
```

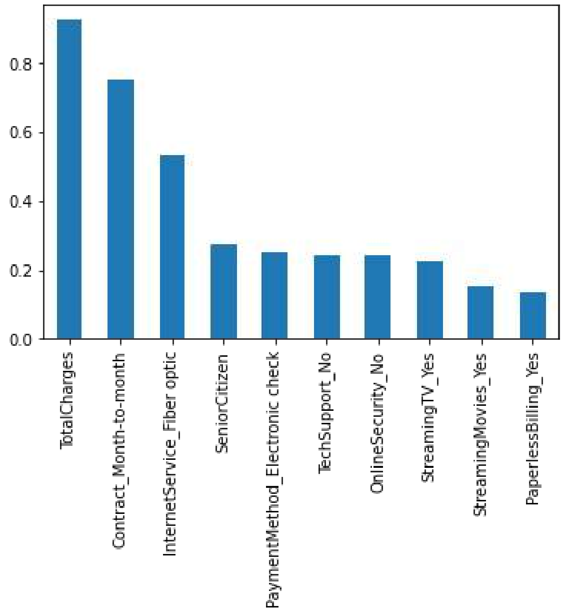
```
0.8075829383886256
```

In [39]:

```
# To get the weights of all the variables
```

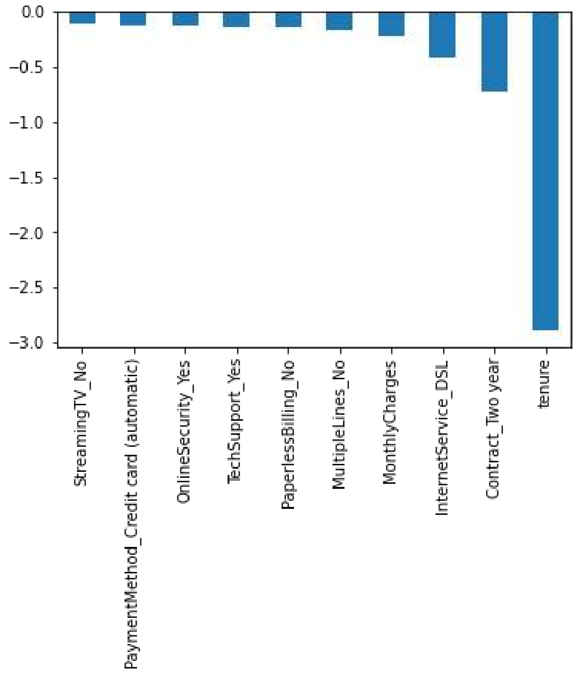
```
In [39]: # To get the weights of all the variables
weights = pd.Series(model.coef_[0],
                    index=X.columns.values)
print (weights.sort_values(ascending = False)[:10].plot(kind='bar'))
```

```
AxesSubplot(0.125,0.125;0.775x0.755)
```



```
In [40]: print(weights.sort_values(ascending = False)[-10:].plot(kind='bar'))
```

```
AxesSubplot(0.125,0.125;0.775x0.755)
```



Observtions We can see that some variables have a negative relation to our predicted variable (Churn), while some have positive relation. Negative relation means that likeliness of churn decreases with that variable. Let us summarize some of the interesting features below:

As we saw in our EDA, having a 2 month contract reduces chances of churn. 2 month contract along with tenure have the most negative relation with Churn as predicted by logistic regressions

Having DSL internet service also reduces the proability of Churn

Lastly, total charges, monthly contracts, fibre optic internet services and seniority can lead to higher churn rates. This is interesting because although fibre optic services are faster, customers are likely to churn because of it. I think we need to explore more to better understad why this is happening.

Any hypothesis on the above would be really helpful!

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