In [6]:
```
import numpy as np # linear algebra
import pandas as pd # data processing, CSV file I/O (e.g. pd.read_csv)
import seaborn as sns # For creating plots
import matplotlib.ticker as mtick # For specifying the axes tick format
import matplotlib.pyplot as plt

sns.set(style = 'white')

# Input data files are available in the "../input/" directory.

import os
```

In [7]:
```
telecom_cust = pd.read_csv('WA_Fn-UseC_-Telco-Customer-Churn.csv')
```

In [8]:
```
telecom_cust.head()
```

Out[8]:

	customerID	gender	SeniorCitizen	Partner	Dependents	tenure	PhoneService	MultipleLines	InternetService	OnlineSecurity	...	DeviceProtection	Tecl
0	7590-VHVEG	Female	0	Yes	No	1	No	No phone service	DSL	No	...	No	
1	5575-GNVDE	Male	0	No	No	34	Yes	No	DSL	Yes	...	Yes	
2	3668-QPYBK	Male	0	No	No	2	Yes	No	DSL	Yes	...	No	
3	7795-CFOCW	Male	0	No	No	45	No	No phone service	DSL	Yes	...	Yes	
4	9237-HQITU	Female	0	No	No	2	Yes	No	Fiber optic	No	...	No	

5 rows × 21 columns

In [9]:
```
telecom_cust.columns.values
```

Out[9]:
```
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 [10]:
```
telecom_cust.dtypes
```

Out[10]:
```
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 [11]:
```
telecom_cust.TotalCharges = pd.to_numeric(telecom_cust.TotalCharges, errors='coerce')
telecom_cust.isnull().sum()
```

Out[11]:
```
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 [12]:

```
#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()
```

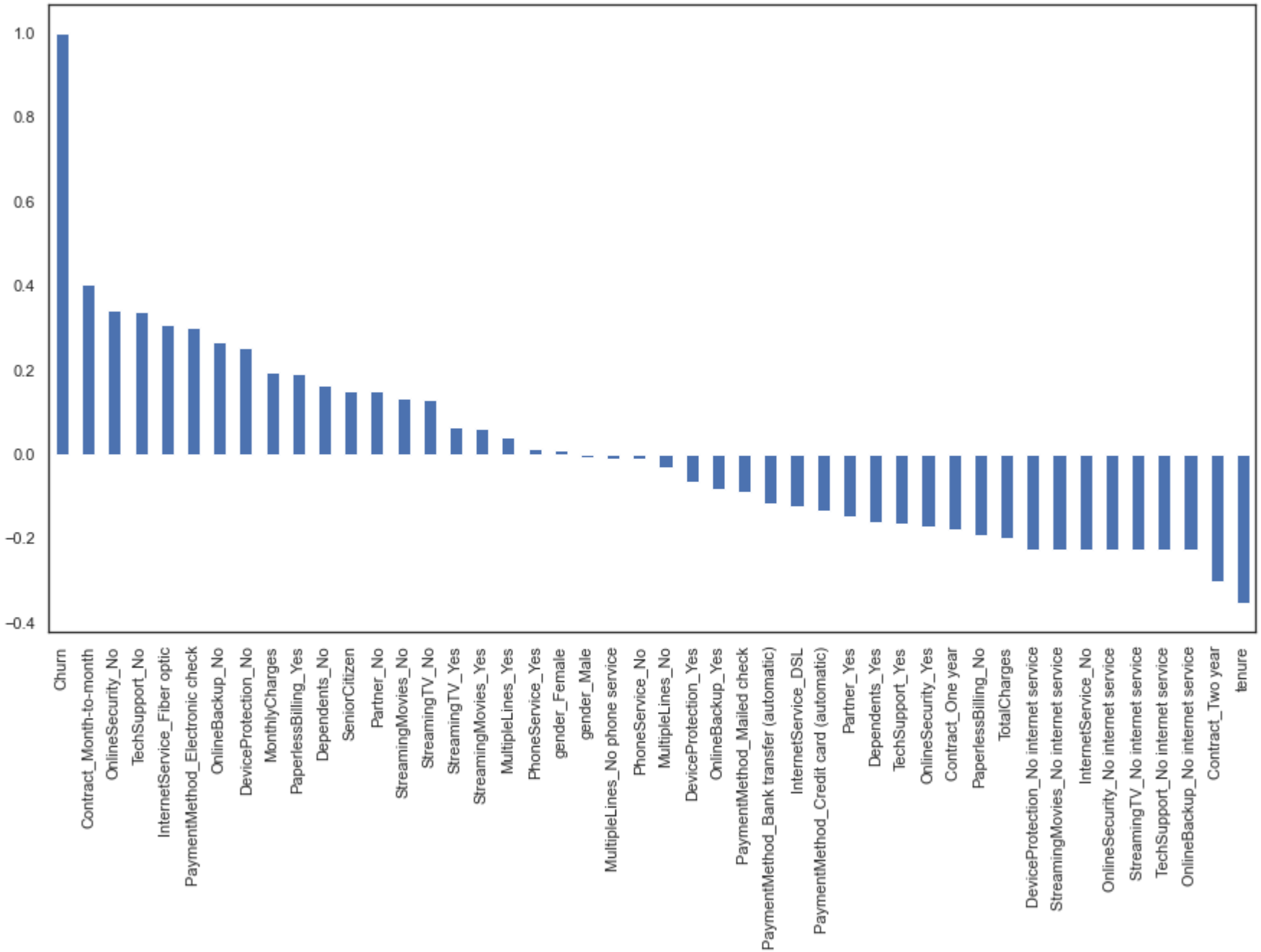
Out[12]:

	SeniorCitizen	tenure	MonthlyCharges	TotalCharges	Churn	gender_Female	gender_Male	Partner_No	Partner_Yes	Dependents_No	...	StreamingMovi
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

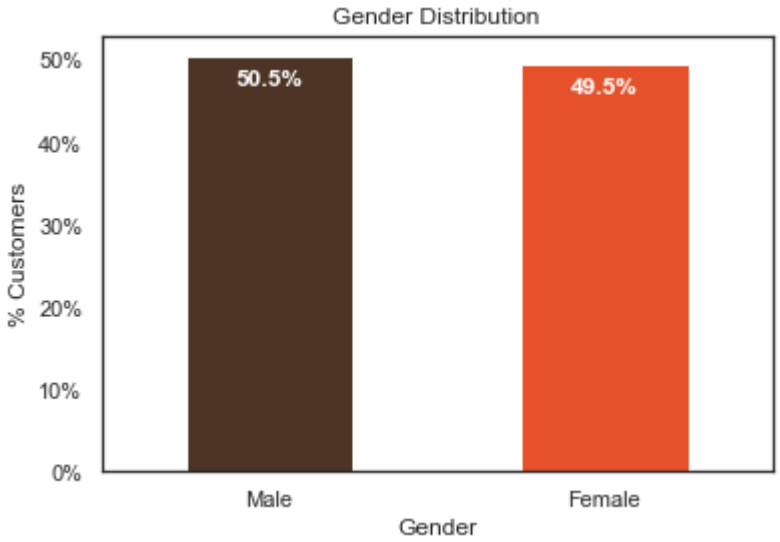
In [13]:
```
plt.figure(figsize=(15,8))
df_dummies.corr()['Churn'].sort_values(ascending = False).plot(kind='bar')
```

Out[13]:
```
<AxesSubplot:>
```


1.0
0.8
0.6
0.4
0.2
0.0
−0.2
−0.4
Churn
Contract_Month-to-month
OnlineSecurity_No
TechSupport_No
InternetService_Fiber optic
PaymentMethod_Electronic check
OnlineBackup_No
DeviceProtection_No
MonthlyCharges
PaperlessBilling_Yes
Dependents_No
SeniorCitizen
Partner_No
StreamingMovies_No
StreamingTV_No
StreamingTV_Yes
StreamingMovies_Yes
MultipleLines_Yes
PhoneService_Yes
gender_Female
gender_Male
MultipleLines_No phone service
PhoneService_No
MultipleLines_No
DeviceProtection_Yes
OnlineBackup_Yes
PaymentMethod_Mailed check
PaymentMethod_Bank transfer (automatic)
InternetService_DSL
PaymentMethod_Credit card (automatic)
Partner_Yes
Dependents_Yes
TechSupport_Yes
OnlineSecurity_Yes
Contract_One year
PaperlessBilling_No
TotalCharges
DeviceProtection_No internet service
StreamingMovies_No internet service
InternetService_No
OnlineSecurity_No internet service
StreamingTV_No internet service
TechSupport_No internet service
OnlineBackup_No internet service
Contract_Two year
tenure

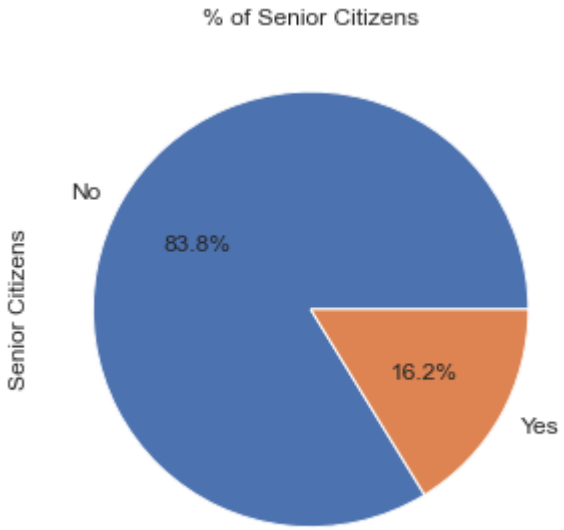
In [14]:

```
colors = ['#4D3425','#E4512B']
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')
```



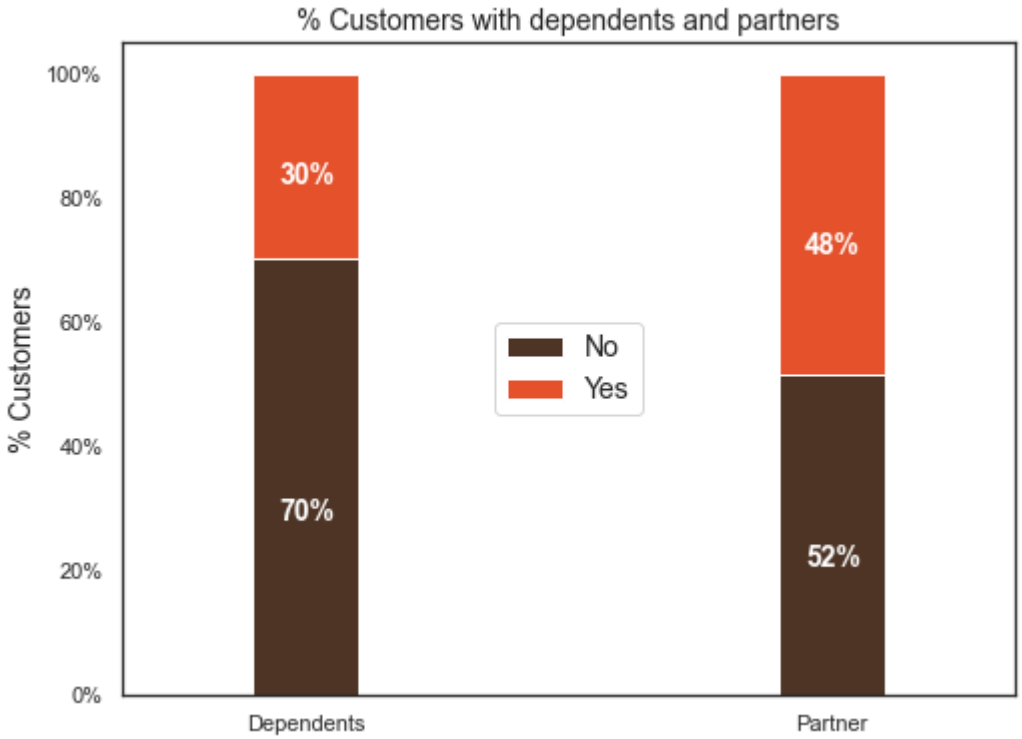
In [15]:
```
ax = (telecom_cust['SeniorCitizen'].value_counts()*100.0 /len(telecom_cust))\
.plot.pie(autopct='%.1f%%', labels = ['No', 'Yes'],figsize =(5,5), fontsize = 12 )
ax.yaxis.set_major_formatter(mtick.PercentFormatter())
ax.set_ylabel('Senior Citizens',fontsize = 12)
ax.set_title('% of Senior Citizens', fontsize = 12)
```

Out[15]:
```
Text(0.5, 1.0, '% of Senior Citizens')
```



In [16]:

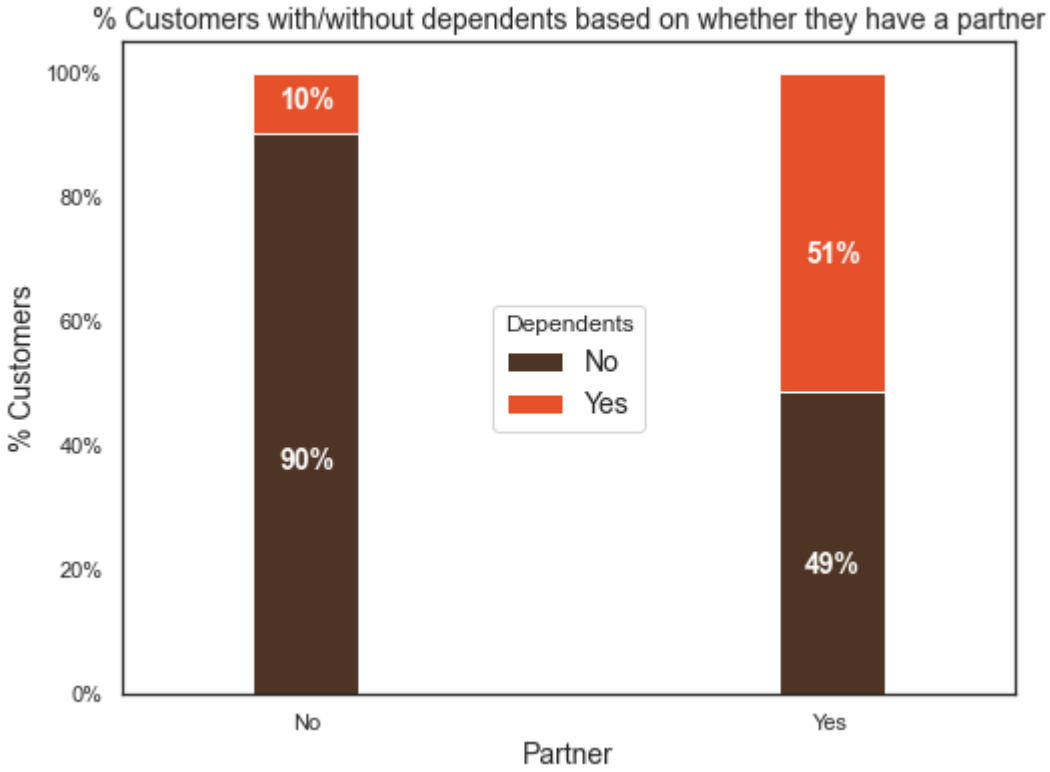
```
df2 = pd.melt(telecom_cust, id_vars=['customerID'], value_vars=['Dependents','Partner'])
df3 = df2.groupby(['variable','value']).count().unstack()
df3 = df3*100/len(telecom_cust)
colors = ['#4D3425','#E4512B']
ax = df3.loc[:,'customerID'].plot.bar(stacked=True, color=colors,
                                      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 [17]:

```
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)
```

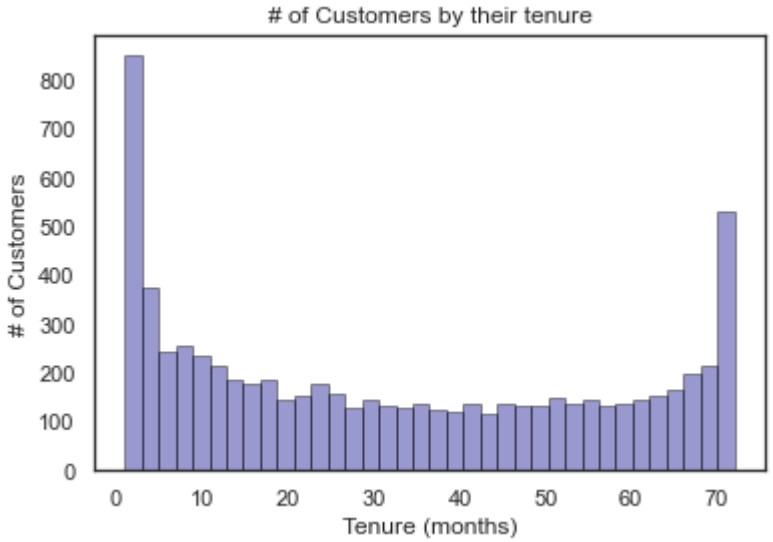


In [18]:

```
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')
```

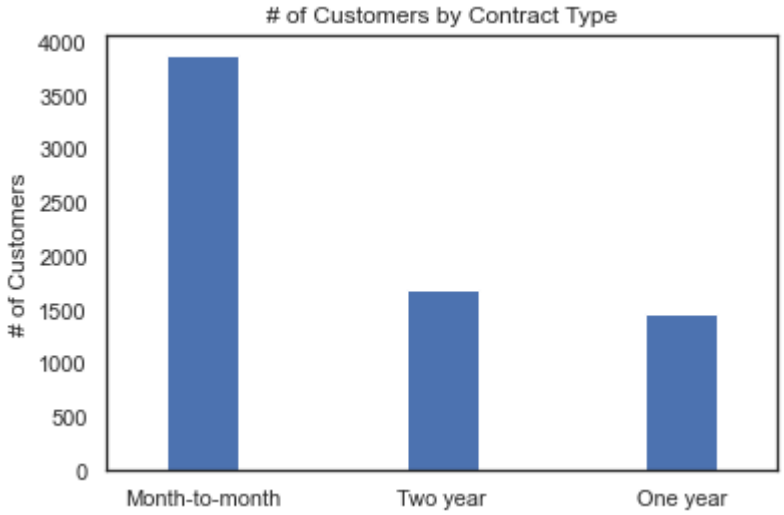
```
C:\Users\Jaideep\anaconda3\lib\site-packages\seaborn\distributions.py:2619: FutureWarning: `distplot` is a deprecated function and will be removed in a future version. Please adapt your code to use either `displot` (a figure-level function with similar flexibility) or `histplot` (an axes-level function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

Out[18]:
```
Text(0.5, 1.0, '# of Customers by their tenure')
```



In [19]:
```
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[19]:
```
Text(0.5, 1.0, '# of Customers by Contract Type')
```

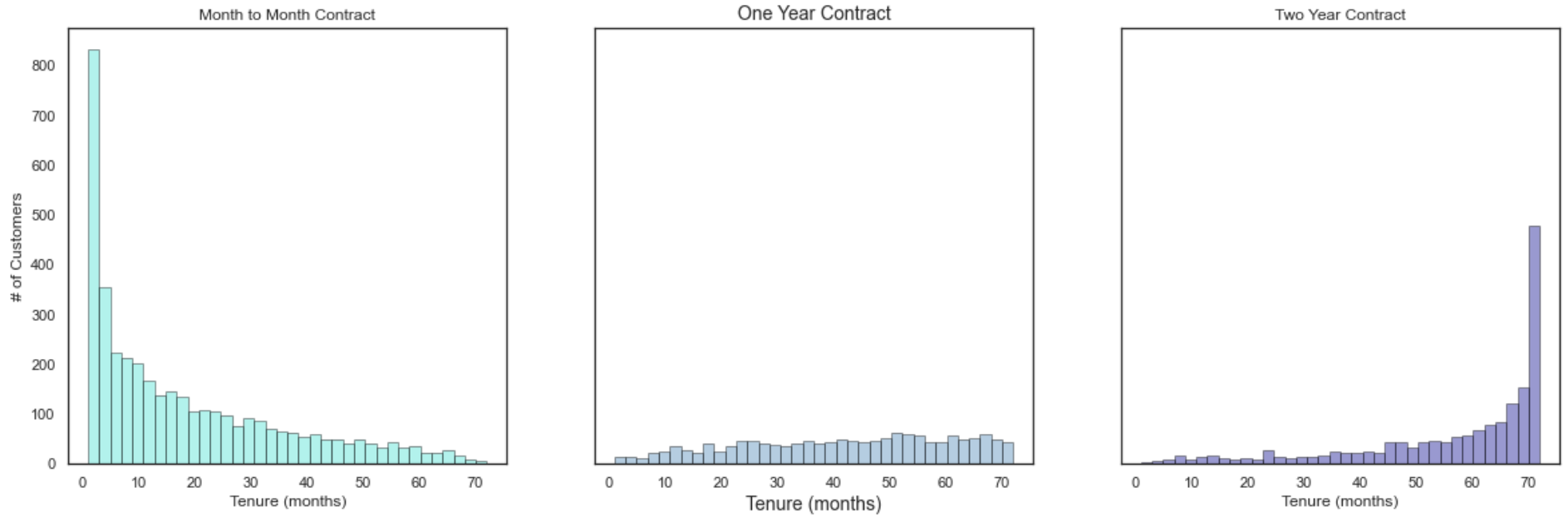


In [20]:

```
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')
```

Out[20]:

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

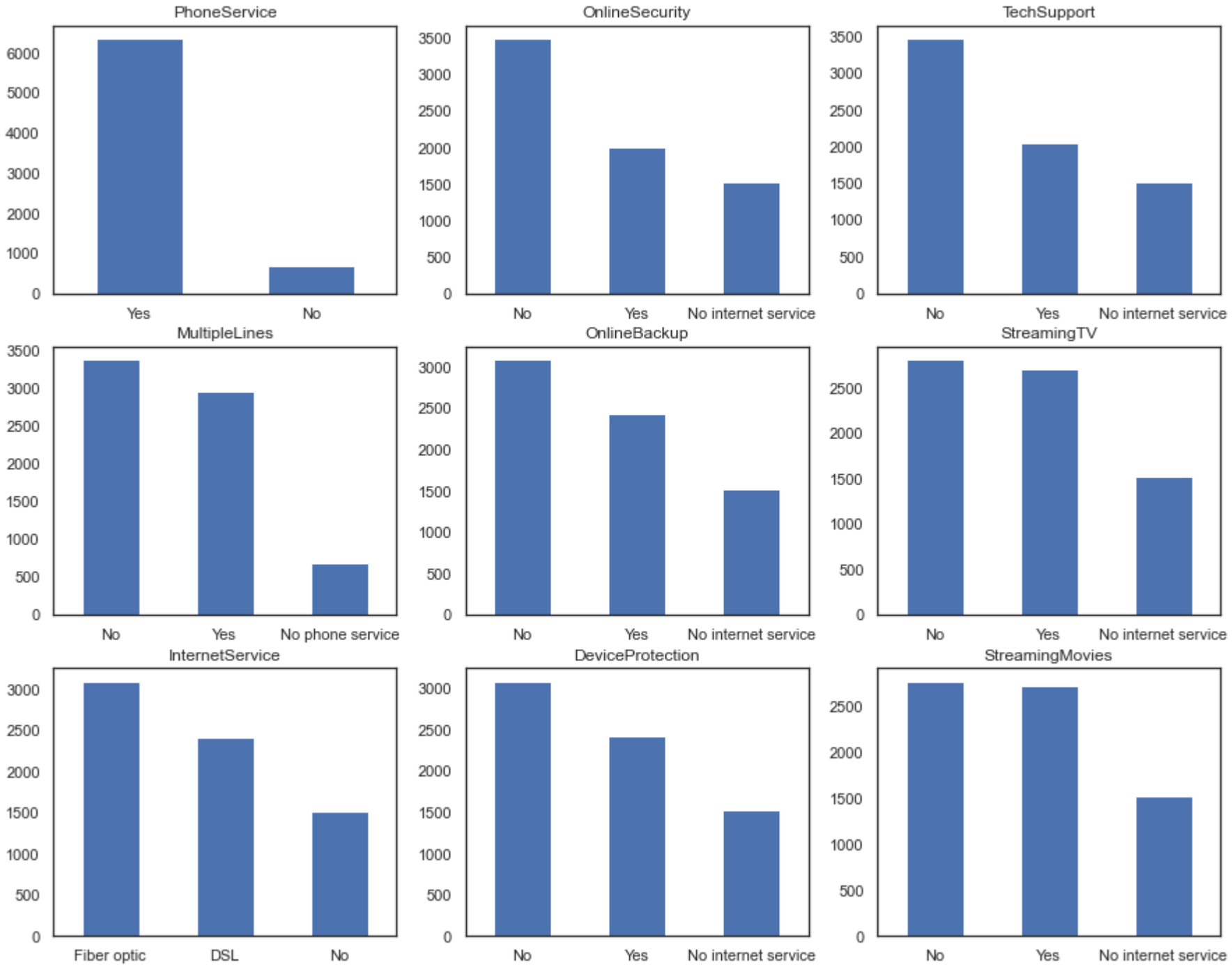


In [21]:
```
telecom_cust.columns.values
```

Out[21]:
```
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 [22]:
```
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:
```

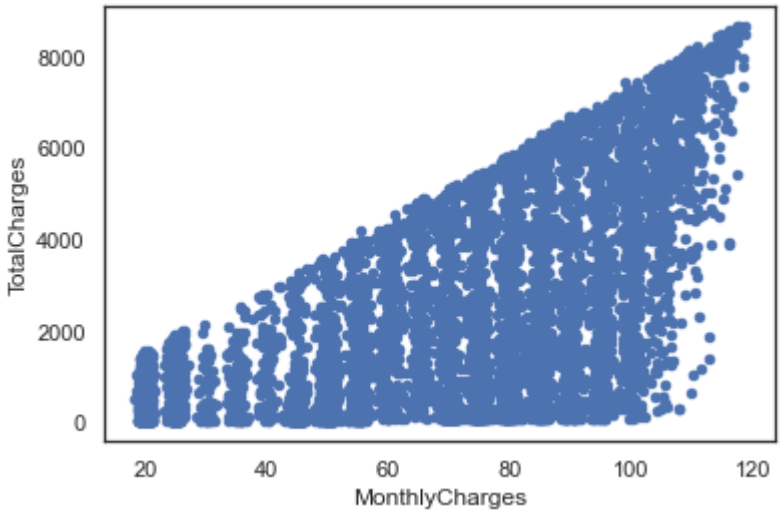
```
        ax = telecom_cust[item].value_counts().plot(kind = 'bar',ax=axes[i-6,2],rot = 0)
    ax.set_title(item)
```


PhoneService
Yes
No
OnlineSecurity
No
Yes
No internet service
TechSupport
No
Yes
No internet service
MultipleLines
No
Yes
No phone service
OnlineBackup
No
Yes
No internet service
StreamingTV
No
Yes
No internet service
InternetService
Fiber optic
DSL
No
DeviceProtection
No
Yes
No internet service
StreamingMovies
No
Yes
No internet service

In [23]:
```
telecom_cust[['MonthlyCharges', 'TotalCharges']].plot.scatter(x = 'MonthlyCharges',
                                                              y='TotalCharges')
```

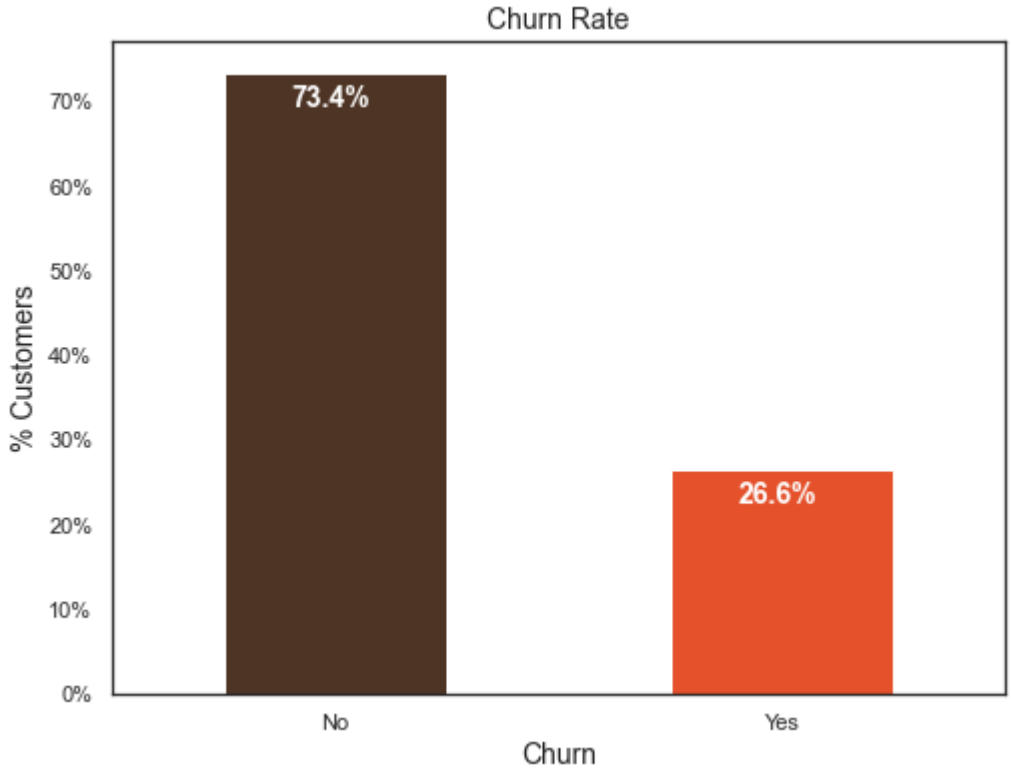
```
*c* argument looks like a single numeric RGB or RGBA sequence, which should be avoided as value-mapping will have precedence in cas
e its length matches with *x* & *y*.  Please use the *color* keyword-argument or provide a 2D array with a single row if you intend
to specify the same RGB or RGBA value for all points.
```

Out[23]:
```
<AxesSubplot:xlabel='MonthlyCharges', ylabel='TotalCharges'>
```



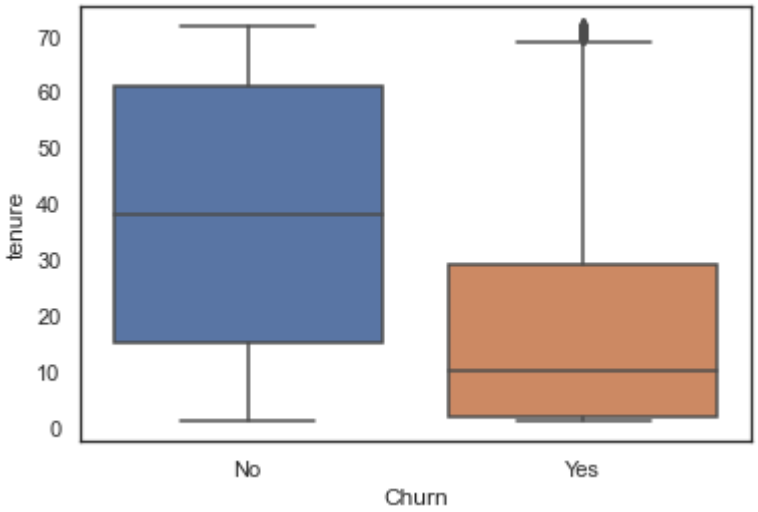
In [24]:
```
colors = ['#4D3425','#E4512B']
ax = (telecom_cust['Churn'].value_counts()*100.0 /len(telecom_cust)).plot(kind='bar',
                                                                          stacked = True,
                                                                         rot = 0,
                                                                         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())

# 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)
```



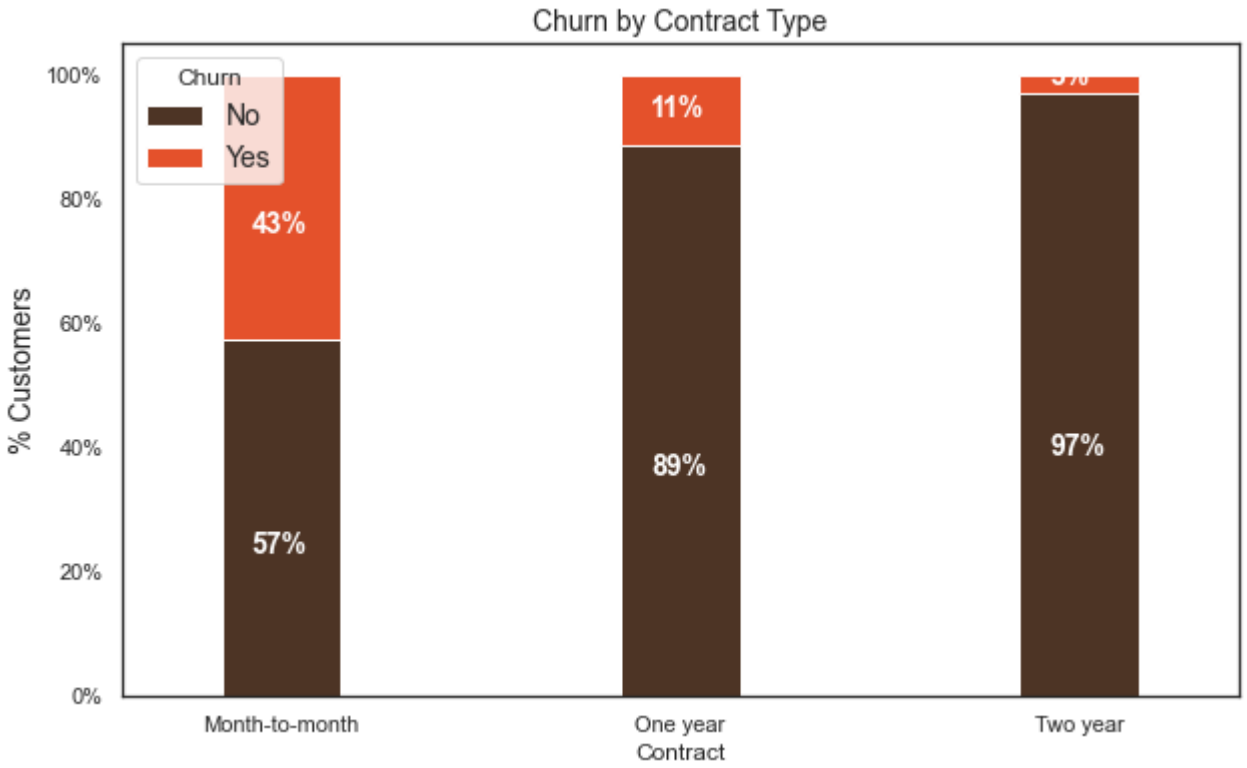
In [25]:
```
sns.boxplot(x = telecom_cust.Churn, y = telecom_cust.tenure)
```

Out[25]:
```
<AxesSubplot:xlabel='Churn', ylabel='tenure'>
```



In [26]:

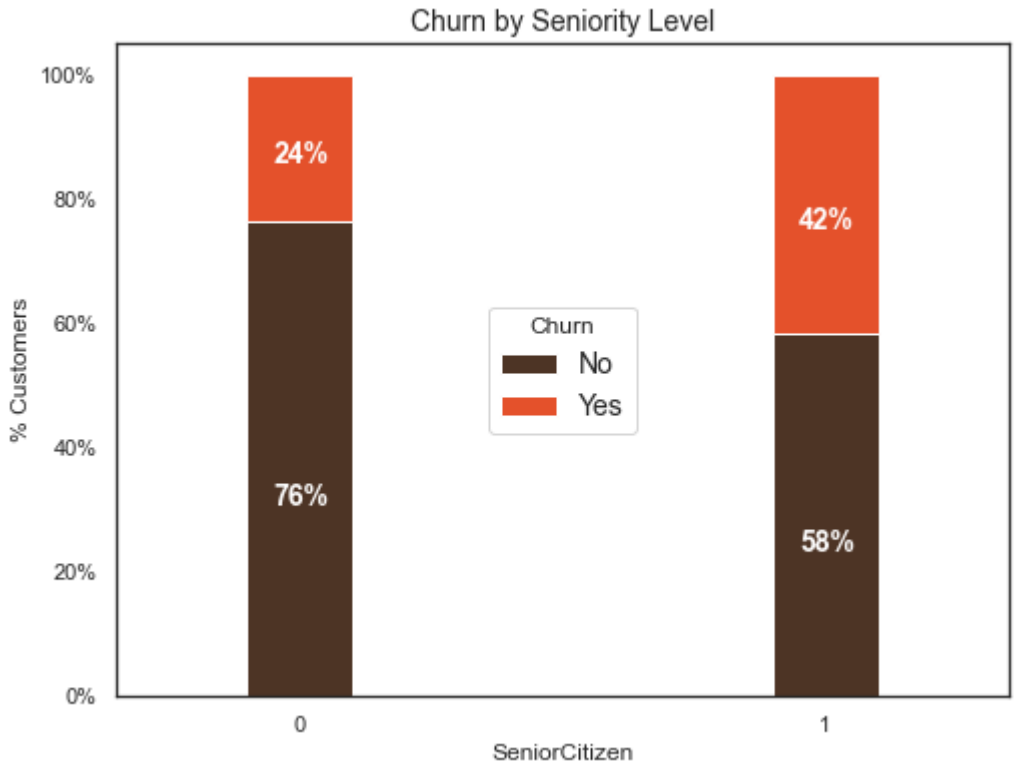
```
colors = ['#4D3425','#E4512B']
contract_churn = telecom_cust.groupby(['Contract','Churn']).size().unstack()

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)
```



In [27]:

```
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)
```

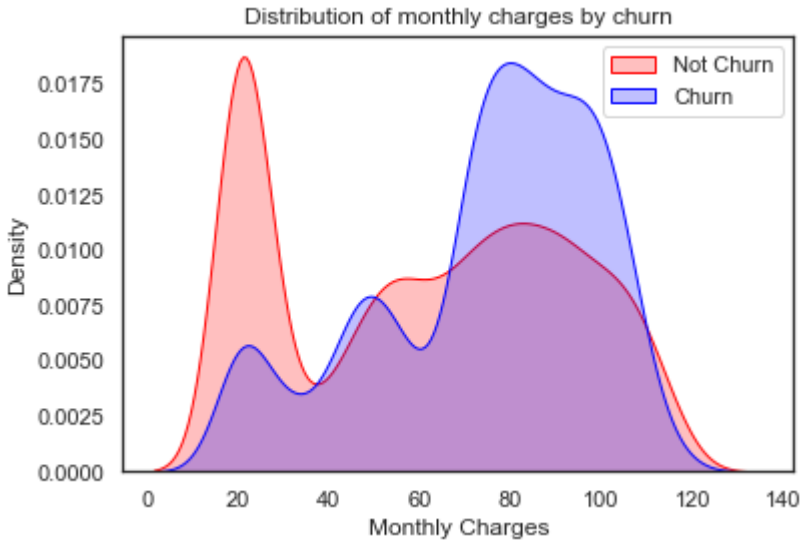


In [28]:

```
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')
```

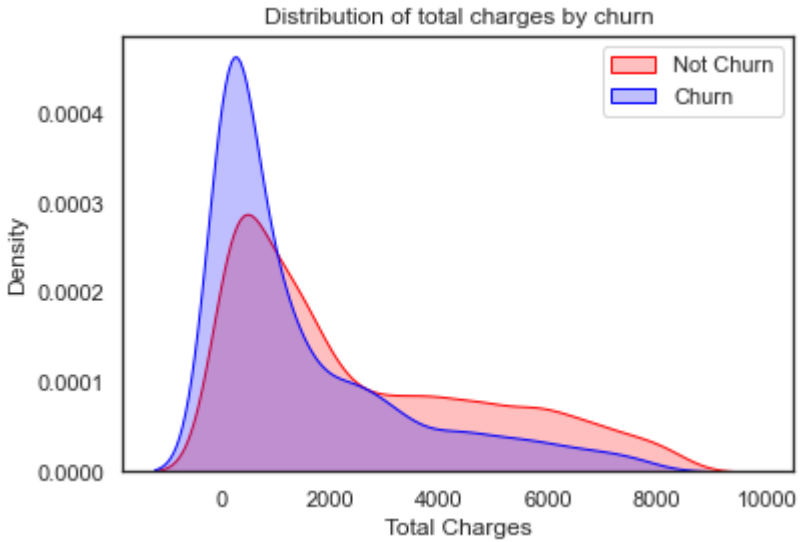
Out[28]:

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



In [29]:
```
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[29]:
```
Text(0.5, 1.0, 'Distribution of total charges by churn')
```



In [30]:
```
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 [31]:
```
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 [32]:
```
from sklearn.linear_model import LogisticRegression
model = LogisticRegression()
result = model.fit(X_train, y_train)
```

In [33]:
```
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 [ ]:

In [ ]:

In [ ]:

In [ ]:

In [ ]:

In [ ]:

In [ ]: