Support Vector Classifier

In [1]:
```
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
```

Create linear separable dataset

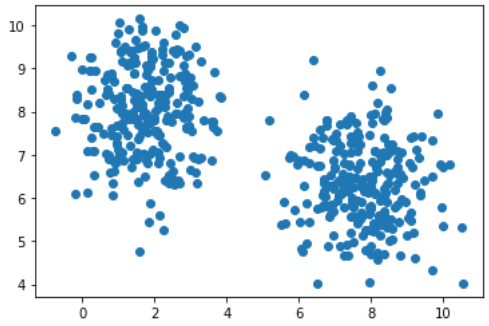
In [2]:
```
from sklearn.datasets import make_blobs

X, y = make_blobs(n_samples = 500, centers = 2, random_state = 20)
X
```

Out[2]:
```
array([[ 6.05487413e+00,  4.83917799e+00],
       [ 3.30025999e+00,  6.92264204e+00],
       [ 5.51231580e+00,  5.37854819e+00],
       [ 6.69042999e+00,  6.42759884e+00],
       [ 2.29034449e+00,  8.11011278e+00],
       [ 2.43925569e+00,  8.78538034e+00],
       [ 7.46559415e+00,  6.01476085e+00],
       [ 7.50098576e+00,  4.98996139e+00],
       [ 8.17041088e+00,  4.56323138e+00],
       [ 7.58527327e+00,  7.73963658e+00],
       [ 8.39610912e+00,  6.12838910e+00],
       [ 1.49704227e+00,  6.91368146e+00],
       [ 1.65394605e+00,  9.87490521e+00],
       [ 8.04398719e+00,  8.61892674e+00],
       [ 2.11618757e+00,  8.74298179e+00],
       [ 7.98001100e+00,  4.88780791e+00],
       [-1.78650270e-01,  8.29570927e+00],
       [ 7.73680293e+00,  5.90731969e+00],
       [ 2.23353713e+00,  9.60175963e+00],
```

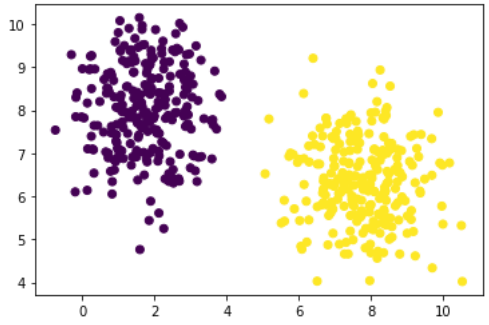
In [3]:
```
y
```

Out[3]:
```
array([1, 0, 1, 1, 0, 0, 1, 1, 1, 1, 1, 0, 0, 1, 0, 1, 0, 1, 0, 0, 1, 1,
       0, 0, 0, 0, 1, 0, 1, 1, 0, 0, 0, 0, 1, 0, 1, 1, 0, 0, 1, 0, 1, 0,
       0, 0, 1, 1, 1, 1, 0, 1, 0, 0, 0, 1, 1, 0, 0, 0, 1, 1, 1, 0, 1, 1,
       1, 1, 1, 0, 0, 0, 1, 0, 0, 1, 1, 1, 1, 1, 1, 0, 0, 1, 1, 1, 0, 1, 1,
       1, 0, 1, 0, 0, 1, 1, 1, 0, 1, 0, 1, 0, 1, 0, 1, 1, 1, 1, 0, 0, 1,
       1, 1, 1, 1, 1, 0, 0, 1, 0, 1, 0, 0, 0, 1, 1, 1, 0, 1, 0, 1, 1, 0,
       0, 1, 0, 0, 1, 1, 1, 0, 0, 1, 0, 0, 0, 0, 1, 1, 1, 0, 1, 1, 1, 1,
       1, 0, 0, 1, 0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 0, 0, 1,
       0, 0, 1, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 1, 1,
       0, 0, 1, 0, 0, 0, 1, 1, 0, 0, 1, 0, 1, 1, 0, 0, 1, 1, 0, 0, 1, 1,
       1, 1, 1, 1, 1, 1, 0, 1, 0, 1, 0, 1, 1, 1, 1, 1, 0, 0, 1, 0, 0, 1,
       0, 0, 1, 0, 1, 1, 0, 1, 0, 0, 1, 1, 0, 0, 0, 0, 0, 1, 0, 0, 1, 1,
       1, 1, 1, 0, 0, 1, 0, 0, 1, 0, 1, 0, 1, 1, 0, 0, 0, 0, 0, 1, 0, 1,
       1, 1, 1, 1, 0, 1, 0, 0, 1, 0, 1, 1, 0, 1, 0, 1, 0, 1, 1, 1, 0, 0,
       1, 1, 1, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 1, 1, 0, 0, 1, 0, 1,
       0, 0, 0, 0, 1, 1, 1, 0, 0, 0, 1, 1, 0, 1, 1, 0, 1, 0, 1, 0, 1, 1,
       0, 0, 1, 0, 1, 0, 0, 1, 0, 1, 0, 0, 1, 1, 1, 1, 0, 0, 0, 0, 0, 1,
       1, 1, 1, 1, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 1, 0, 1, 1, 1, 1, 0, 0, 1,
       0, 1, 1, 1, 1, 0, 0, 0, 0, 0, 1, 0, 0, 0, 1, 1, 1, 0, 1, 1, 1, 0,
       0, 1, 0, 1, 0, 0, 0, 1, 0, 1, 1, 1, 1, 0, 0, 1, 1, 0, 0, 1, 0, 0, 0,
       0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 1, 1, 1, 1, 1, 1, 0, 0, 1, 1, 1,
       1, 1, 1, 0, 0, 0, 1, 1, 1, 0, 0, 1, 0, 1, 1, 0, 1, 0, 0, 0, 1, 1,
       1, 1, 0, 1, 1, 1, 1, 0, 0, 0, 0, 1, 0, 0, 0, 0])
```

In [5]:
```
plt.scatter(X[:, 0], X[:, 1]);
```



In [6]:
```
<aplt.scatter(X[:, 0], X[:, 1], c = y);
```

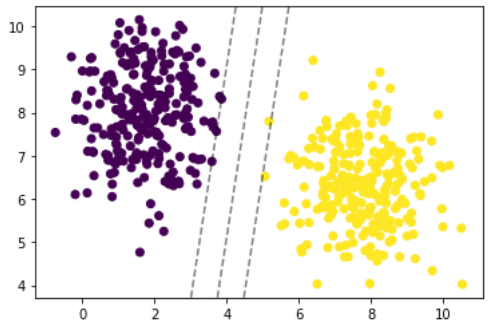


SVC - Linear

In [9]:
```
from sklearn.svm import SVC
svc_lin = SVC(kernel = 'linear')
svc_lin = svc_lin.fit(X, y)
```

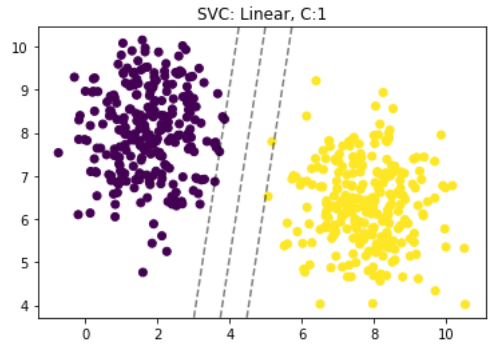
In [8]:
```
# Plotting the surface

def plot_SVC_surface(model):

    # Identifying Axis

    ax=plt.gca()

    x_lim=ax.get_xlim()
    y_lim=ax.get_ylim()



    # Creating a collection of x and y values wihtin this range

    xx=np.linspace(x_lim[0],x_lim[1],50)
    yy=np.linspace(y_lim[0],y_lim[1],50)

    # Creating a meshgrid using these xx and yy

    XX,YY=np.meshgrid(xx,yy)

    # Creatign a stack of these

    xy=np.vstack([XX.ravel(),YY.ravel()]).T



    # Creating decision boundary using these values

    Z=model.decision_function(xy).reshape(XX.shape)


    ax.contour(XX, YY, Z,colors='k', levels=[-1, 0, 1], alpha=0.5,
               linestyles=['--', '--'])

    # plotting  support vectors obtained
    ax.scatter(model.support_vectors_[:, 0], model.support_vectors_[:, 1], s=200,
               linewidth=1, facecolors='none', edgecolors='none')
    plt.show()
```

In [11]:
```
plt.scatter(X[:, 0], X[:, 1], c = y)
plot_SVC_surface(svc_lin);
```



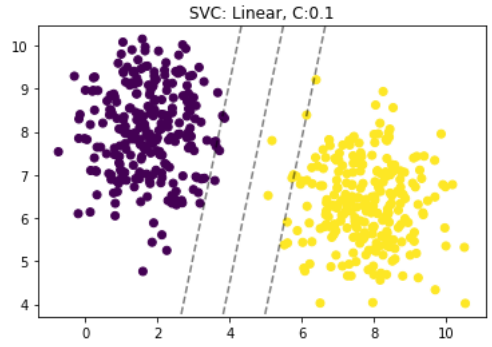
Regularisation parameter

In [13]:
```
svc_lin = SVC(kernel = 'linear', C=1) # default value of C is 1
svc_lin = svc_lin.fit(X, y)
plt.scatter(X[:, 0], X[:, 1], c = y)
plt.title('SVC: Linear, C:1')
plot_SVC_surface(svc_lin)
```

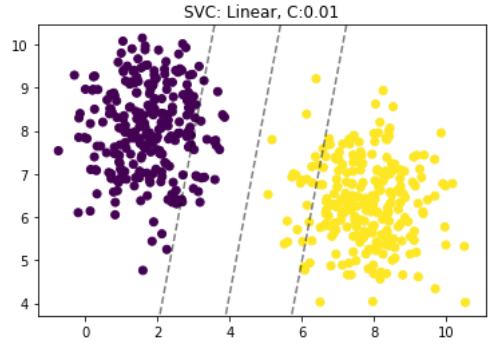


hard margin classifier

In [14]:
```
svc_lin = SVC(kernel = 'linear', C=0.1) # changing C to 0.1
svc_lin = svc_lin.fit(X, y)
plt.scatter(X[:, 0], X[:, 1], c = y)
plt.title('SVC: Linear, C:0.1')
plot_SVC_surface(svc_lin)
```

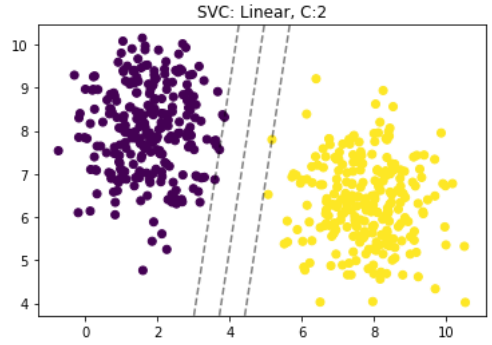


In [15]:
```
svc_lin = SVC(kernel = 'linear', C=0.01) # changing C to 0.01
svc_lin = svc_lin.fit(X, y)
plt.scatter(X[:, 0], X[:, 1], c = y)
plt.title('SVC: Linear, C:0.01')
plot_SVC_surface(svc_lin)
```



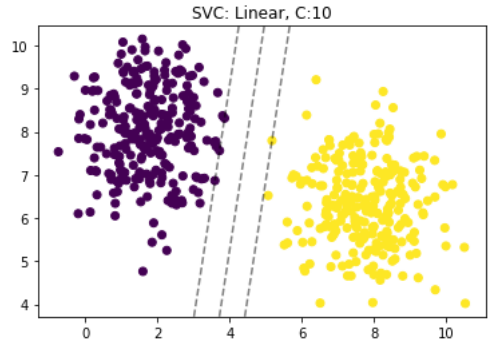
much more flexible

In [18]:
```
svc_lin = SVC(kernel = 'linear', C=2) # changing C to 2
svc_lin = svc_lin.fit(X, y)
plt.scatter(X[:, 0], X[:, 1], c = y)
plt.title('SVC: Linear, C:2')
plot_SVC_surface(svc_lin)
```



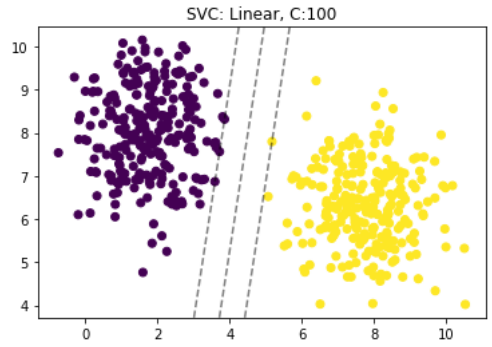
no significant change

In [19]:
```
svc_lin = SVC(kernel = 'linear', C=10) # changing C to 10
svc_lin = svc_lin.fit(X, y)
plt.scatter(X[:, 0], X[:, 1], c = y)
plt.title('SVC: Linear, C:10')
plot_SVC_surface(svc_lin)
```



no significant change

In [20]:
```
svc_lin = SVC(kernel = 'linear', C=100) # changing C to 100
svc_lin = svc_lin.fit(X, y)
plt.scatter(X[:, 0], X[:, 1], c = y)
plt.title('SVC: Linear, C:100')
plot_SVC_surface(svc_lin)
```



no significant change

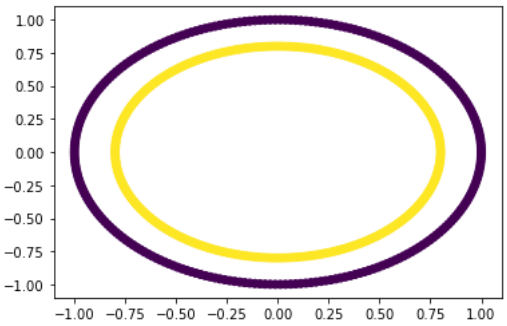
The margins cannot be reduced beyond the support vectors

Creating a non-linear dataset

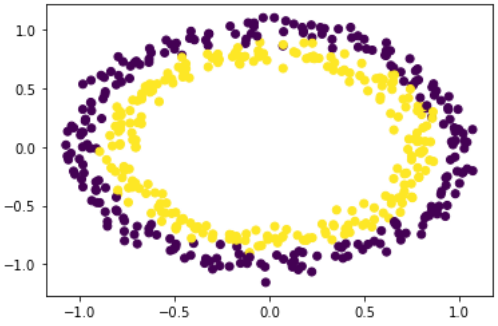
In [24]:
```
from sklearn.datasets import make_circles

X, y = make_circles(n_samples = 500, random_state = 30)
X
```

Out[24]:
```
array([[ 8.63923417e-01,  5.03623202e-01],
       [ 9.62027672e-01, -2.72951936e-01],
       [-8.50994482e-01,  5.25174630e-01],
       [ 6.70022432e-01,  4.37115477e-01],
       [ 8.50994482e-01,  5.25174630e-01],
       [ 7.11535677e-01,  7.02649970e-01],
       [ 5.96752916e-01, -5.32809494e-01],
       [ 5.96752916e-01,  5.32809494e-01],
       [ 5.69228542e-01,  5.62119976e-01],
       [-8.09016994e-01,  5.87785252e-01],
       [ 1.69605688e-01, -7.81814499e-01],
       [ 1.69605688e-01,  7.81814499e-01],
       [-7.45941145e-01, -6.66011867e-01],
       [ 1.00000000e+00,  0.00000000e+00],
       [-9.47098305e-01, -3.20943610e-01],
       [ 9.47098305e-01, -3.20943610e-01],
       [ 4.94287690e-01, -6.29030746e-01],
       [-1.87381315e-01, -9.82287251e-01],
       [ 7.93990399e-01,  6.07930298e-01],
```

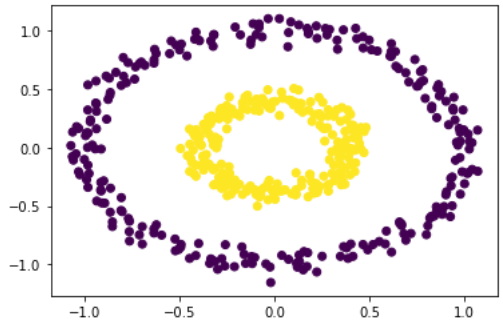
In [26]:
```
plt.scatter(X[:, 0], X[:, 1], c = y);
```



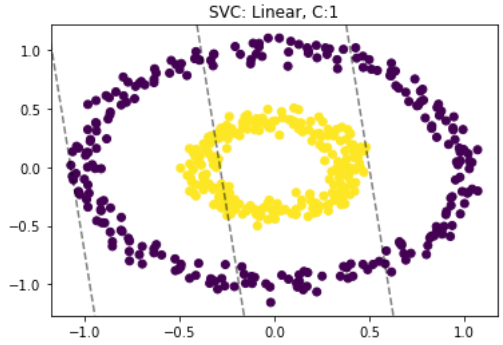
In [28]:
```
X, y = make_circles(n_samples = 500, random_state = 30, noise = 0.05)
plt.scatter(X[:, 0], X[:, 1], c = y);
```



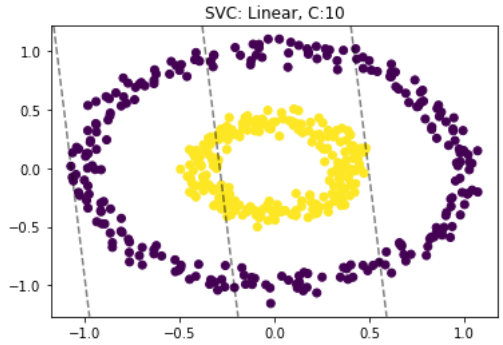
In [43]:
```
X, y = make_circles(n_samples = 500, random_state = 30, noise = 0.05, factor = 0.4) #factor closer to 0 -> separated, factor clos
plt.scatter(X[:, 0], X[:, 1], c = y);
```



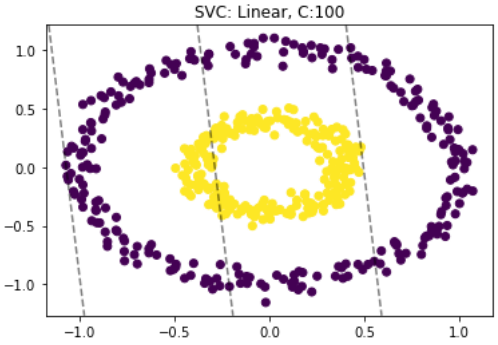
In [46]:
```
svc_lin = SVC(kernel = 'linear', C=1) # changing C to 100
svc_lin = svc_lin.fit(X, y)
plt.scatter(X[:, 0], X[:, 1], c = y)
plt.title('SVC: Linear, C:1')
plot_SVC_surface(svc_lin)
```



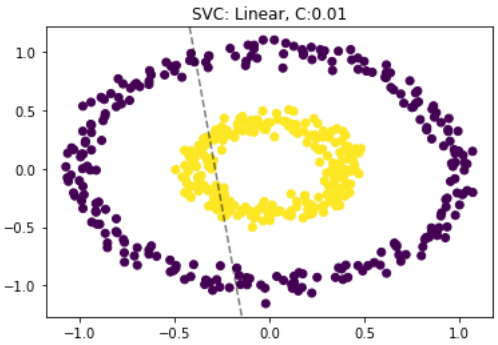
In [47]:
```
svc_lin = SVC(kernel = 'linear', C=10) # changing C to 100
svc_lin = svc_lin.fit(X, y)
plt.scatter(X[:, 0], X[:, 1], c = y)
plt.title('SVC: Linear, C:10')
plot_SVC_surface(svc_lin)
```



In [48]:
```
svc_lin = SVC(kernel = 'linear', C=100) # changing C to 100
svc_lin = svc_lin.fit(X, y)
plt.scatter(X[:, 0], X[:, 1], c = y)
plt.title('SVC: Linear, C:100')
plot_SVC_surface(svc_lin)
```



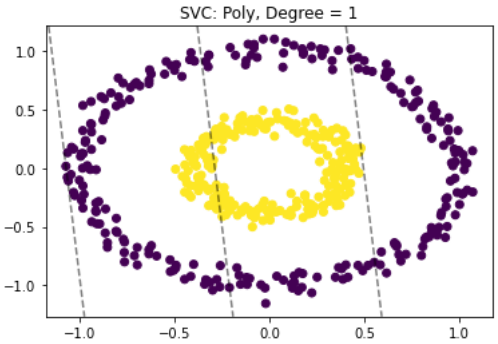
In [49]:
```
svc_lin = SVC(kernel = 'linear', C=0.01) # changing C to 100
svc_lin = svc_lin.fit(X, y)
plt.scatter(X[:, 0], X[:, 1], c = y)
plt.title('SVC: Linear, C:0.01')
plot_SVC_surface(svc_lin)
```



Non-linear kernels

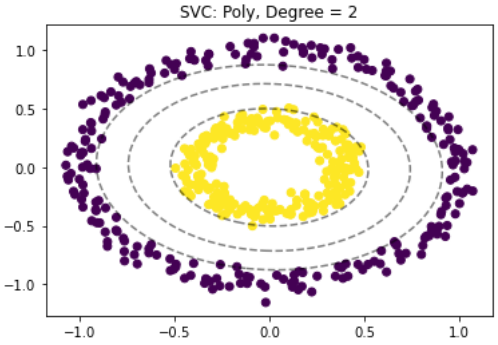
kernel = poly

In [53]:
```
svc_poly = SVC(kernel = 'poly', degree = 1)
svc_poly = svc_poly.fit(X, y)
plt.scatter(X[:, 0], X[:, 1], c = y)
plt.title('SVC: Poly, Degree = 1')
plot_SVC_surface(svc_poly)
```

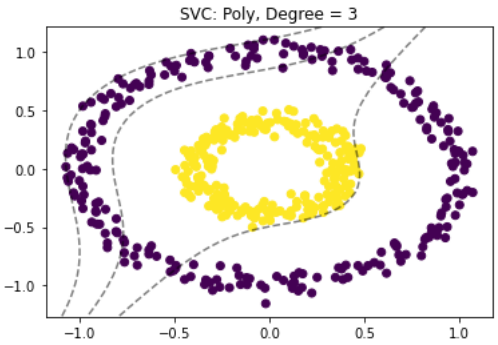


polynomial of degree = 1 --> Straight Line --> Linear

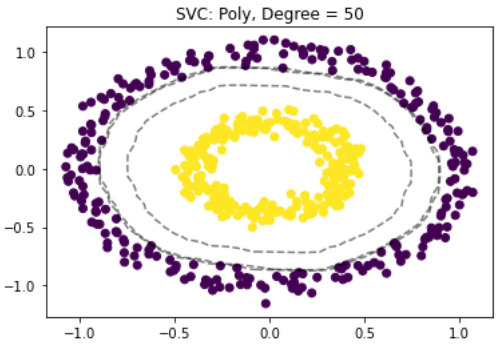
In [54]:
```
svc_poly = SVC(kernel = 'poly', degree = 2)
svc_poly = svc_poly.fit(X, y)
plt.scatter(X[:, 0], X[:, 1], c = y)
plt.title('SVC: Poly, Degree = 2')
plot_SVC_surface(svc_poly)
```



In [55]:
```
svc_poly = SVC(kernel = 'poly', degree = 3)
svc_poly = svc_poly.fit(X, y)
plt.scatter(X[:, 0], X[:, 1], c = y)
plt.title('SVC: Poly, Degree = 3')
plot_SVC_surface(svc_poly)
```

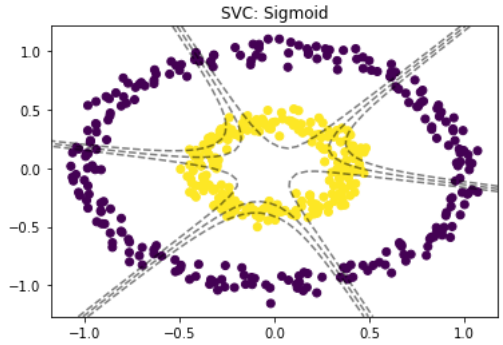


In [56]:
```
svc_poly = SVC(kernel = 'poly', degree = 50)
svc_poly = svc_poly.fit(X, y)
plt.scatter(X[:, 0], X[:, 1], c = y)
plt.title('SVC: Poly, Degree = 50')
plot_SVC_surface(svc_poly)
```



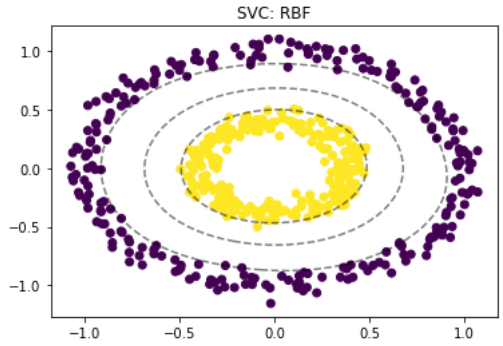
kernel = sigmoid

In [57]:
```
svc_sig = SVC(kernel = 'sigmoid')  #no other paramter needed for sigmoid
svc_sig = svc_sig.fit(X, y)
plt.scatter(X[:, 0], X[:, 1], c = y)
plt.title('SVC: Sigmoid')
plot_SVC_surface(svc_sig)
```

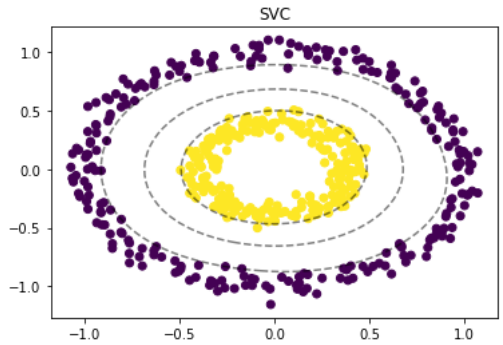


kernel = rbf

In [58]:
```
svc_rbf = SVC(kernel = 'rbf')  #no other paramter needed for rbf
svc_rbf = svc_rbf.fit(X, y)
plt.scatter(X[:, 0], X[:, 1], c = y)
plt.title('SVC: RBF')
plot_SVC_surface(svc_rbf)
```



In [60]:
```
# keeping everything default (default = rbf)
svc = SVC()
svc = svc.fit(X, y)
plt.scatter(X[:, 0], X[:, 1], c = y)
plt.title('SVC')
plot_SVC_surface(svc);
```



In [ ]: