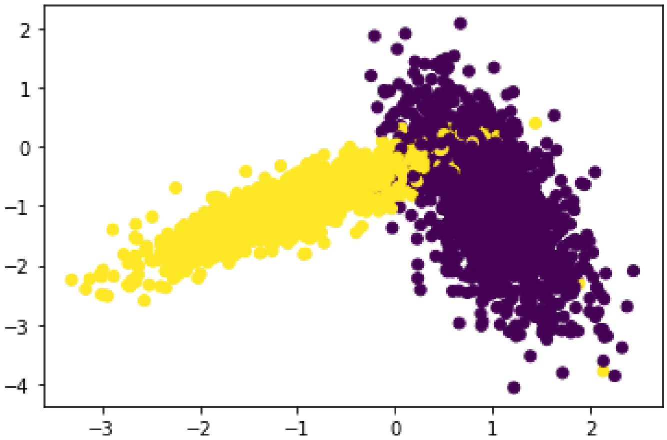
In [102]:

```
from sklearn.datasets import make_classification
from sklearn.model_selection import train_test_split
from sklearn.preprocessing import StandardScaler
import numpy
from tqdm import tqdm
import numpy as np
from sklearn.metrics.pairwise import euclidean_distances


x,y = make_classification(n_samples=10000, n_features=2, n_informative=2, n_redundant= 0
, n_clusters_per_class=1, random_state=60)
X_train, X_test, y_train, y_test = train_test_split(x,y,stratify=y,random_state=42)

# del X_train,X_test
```

In [103]:

```
%matplotlib inline
import matplotlib.pyplot as plt
colors = {0:'red', 1:'blue'}
plt.scatter(X_test[:,0], X_test[:,1],c=y_test)
plt.show()
```



Implementing Custom RandomSearchCV

```
def RandomSearchCV(x_train,y_train,classifier, param_range, folds):
    # x_train: its numpy array of shape, (n,d)
    # y_train: its numpy array of shape, (n,) or (n,1)
    # classifier: its typically KNeighborsClassifier()
    # param_range: its a tuple like (a,b) a < b
    # folds: an integer, represents number of folds we need to devide the data and
test our model


    #1.generate 10 unique values(uniform random distribution) in the given range "
param_range" and store them as "params"
    # ex: if param_range = (1, 50), we need to generate 10 random numbers in range
1 to 50
    #2.devide numbers ranging from  0 to len(X_train) into groups= folds
    # ex: folds=3, and len(x_train)=100, we can devide numbers from 0 to 100 into 3
groups
      group 1: 0-33, group 2:34-66, group 3: 67-100
    #3.for each hyperparameter that we generated in step 1:
        # and using the above groups we have created in step 2 you will do cross-v
```

```
alidation as follows

        # first we will keep group 1+group 2 i.e. 0-66 as train data and group 3:
67-100 as test data, and find train and
          test accuracies

        # second we will keep group 1+group 3 i.e. 0-33, 67-100 as train data and
group 2: 34-66 as test data, and find
          train and test accuracies

        # third we will keep group 2+group 3 i.e. 34-100 as train data and group 1
: 0-33 as test data, and find train and
          test accuracies
        # based on the 'folds' value we will do the same procedure

        # find the mean of train accuracies of above 3 steps and store in a list "
train_scores"
        # find the mean of test accuracies of above 3 steps and store in a list "t
est_scores"
    #4. return both "train_scores" and "test_scores"

#5. call function RandomSearchCV(x_train,y_train,classifier, param_range, folds) an
d store the returned values into "train_score", and "cv_scores"
#6. plot hyper-parameter vs accuracy plot as shown in reference notebook and choose
the best hyperparameter
#7. plot the decision boundaries for the model initialized with the best hyperparam
eter, as shown in the last cell of reference notebook
```

In [104]:

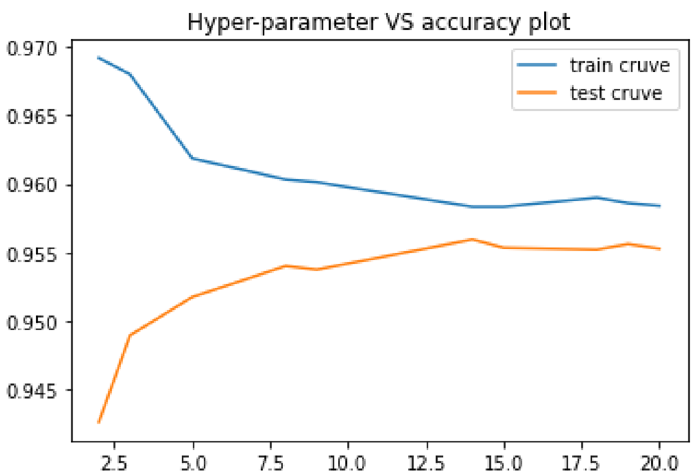
```
# it will take classifier and set of values for hyper prameter in dict type dict({hyper p
armeter: [list of values]})
# we are implementing this only for KNN, the hyper parameter should n_neighbors
from sklearn.metrics import accuracy_score
import math
#2.devide numbers ranging from  0 to len(X_train) into groups= folds
def data_groups_calculation(numoftrainrecords,folds):
  groups = []
  num = 0
  memory = 0
  for i in range(0,folds):
    num+=math.floor(numoftrainrecords/folds)
    if numoftrainrecords - num < math.floor(numoftrainrecords/folds):
      groups.append((memory,numoftrainrecords-1))
    else:
      groups.append((memory,num))
    memory = num +1
    num = num+1
  return groups


def RandomSearchCV(x_train,y_train,classifier, param_range, folds):
    trainscores = []
    testscores  = []
    #1.generate 10 unique values(uniform random distribution) in the given range "param_r
ange" and store them as "params"
    final_params = []
    while True:
      param = np.random.randint(param_range[0],param_range[1]+1)
      if param not in final_params:
        final_params.append(param)
      if len(final_params) == 10 or len(final_params) == (param_range[1] + 1 - param_ran
ge[0]):
        break
```

```python
    params =  sorted(final_params)
    for k in tqdm(params):
        trainscores_folds = []
        testscores_folds  = []
         #2.devide numbers ranging from  0 to len(X_train) into groups= folds
        data_groups = data_groups_calculation(len(x_train),folds)
        for j in range(0, folds):
            # check this out: https://stackoverflow.com/a/9755548/4084039
            train_indices = list(range(data_groups[j][0],data_groups[j][1]+1))
            test_indices  = list(set(list(range(0,len(x_train)))) - set(train_indices))
            # selecting the data points based on the train_indices and test_indices
            X_train = x_train[train_indices]
            Y_train = y_train[train_indices]
            X_test  = x_train[test_indices]
            Y_test  = y_train[test_indices]

            classifier.n_neighbors = k
            classifier.fit(X_train,Y_train)

            Y_predicted = classifier.predict(X_test)
            testscores_folds.append(accuracy_score(Y_test, Y_predicted))

            Y_predicted = classifier.predict(X_train)
            trainscores_folds.append(accuracy_score(Y_train, Y_predicted))
        trainscores.append(np.mean(np.array(trainscores_folds)))
        testscores.append(np.mean(np.array(testscores_folds)))
    return trainscores,testscores,params
```

In [122]:

```python
from sklearn.metrics import accuracy_score
from sklearn.neighbors import KNeighborsClassifier
import matplotlib.pyplot as plt
import random
import warnings
warnings.filterwarnings("ignore")
neigh = KNeighborsClassifier()
neighbours_params_range = (1,20)
folds = 3
trainscores,testscores,params_list = RandomSearchCV(X_train, y_train, neigh, neighbours_
params_range, folds)
plt.plot(params_list,trainscores, label='train cruve')
plt.plot(params_list,testscores, label='test cruve')
plt.title('Hyper-parameter VS accuracy plot')
plt.legend()
plt.show()
```

```
100%|██████████| 10/10 [00:08<00:00,  1.17it/s]
```



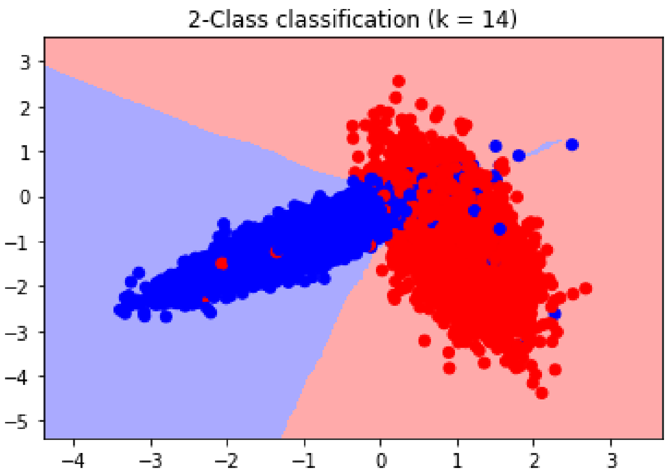
From above plot we can say that the best hyperparameter is 14 as at 14 we have train and validation accuracy is close.

In [123]:

```
# understanding this code line by line is not that importent
def plot_decision_boundary(X1, X2, y, clf):
        # Create color maps
    cmap_light = ListedColormap(['#FFAAAA', '#AAFFAA', '#AAAAFF'])
    cmap_bold = ListedColormap(['#FF0000', '#00FF00', '#0000FF'])

    x_min, x_max = X1.min() - 1, X1.max() + 1
    y_min, y_max = X2.min() - 1, X2.max() + 1

    xx, yy = np.meshgrid(np.arange(x_min, x_max, 0.02), np.arange(y_min, y_max, 0.02))
    Z = clf.predict(np.c_[xx.ravel(), yy.ravel()])
    Z = Z.reshape(xx.shape)

    plt.figure()
    plt.pcolormesh(xx, yy, Z, cmap=cmap_light)
    # Plot also the training points
    plt.scatter(X1, X2, c=y, cmap=cmap_bold)

    plt.xlim(xx.min(), xx.max())
    plt.ylim(yy.min(), yy.max())
    plt.title("2-Class classification (k = %i)" % (clf.n_neighbors))
    plt.show()
```

In [124]:

```
from matplotlib.colors import ListedColormap
neigh = KNeighborsClassifier(n_neighbors = 14)
neigh.fit(X_train, y_train)
plot_decision_boundary(X_train[:, 0], X_train[:, 1], y_train, neigh)
```



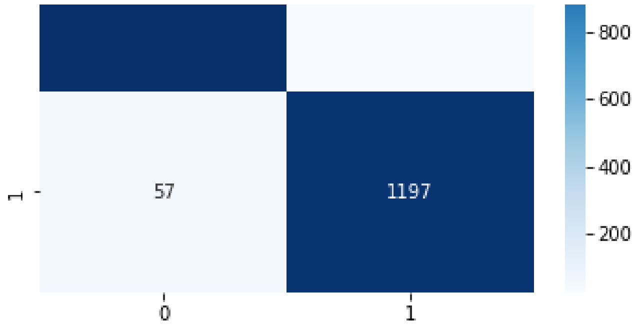
In [125]:

```
from sklearn.metrics import accuracy_score,f1_score,roc_auc_score,log_loss,confusion_matr
ix
import seaborn as sns
y_pred = neigh.predict(X_test)
y_prob = neigh.predict_proba(X_test)[:,[1]]
print('Accuracy Score with 14 neighbours :',accuracy_score(y_test,y_pred))
print('f1 Score Score with 14 neighbours :',f1_score(y_test,y_pred))
print('roc_auc_score with 14 neighbours :',roc_auc_score(y_test,y_prob))
print('log loss with 14 neighbours :', log_loss(y_test,y_prob))
sns.heatmap(confusion_matrix(y_test,y_pred),annot=True,cmap='Blues', fmt='g')
```

```
Accuracy Score with 14 neighbours : 0.9668
f1 Score Score with 14 neighbours : 0.9664917238595074
roc_auc_score with 14 neighbours : 0.9905477432088905
log loss with 14 neighbours : 0.24056510475252907
```

Out[125]:

```
<matplotlib.axes._subplots.AxesSubplot at 0x7f2a5ee27fd0>
```



In [125]: