In [1]:

```
import numpy as np
import pandas as pd
from collections import Counter
from sklearn.model_selection import train_test_split
from sklearn.neighbors import KNeighborsClassifier
from sklearn.metrics import accuracy_score
import matplotlib.pyplot as plt
from sklearn.model_selection import cross_val_score
```

In [2]:

```
#define the columns
names = ['x','y','class']

df = pd.read_csv('concertriccir2.csv',header=None,names =names)
print(df.head())
```

```
          x         y  class
0  0.700335 -0.247068    0.0
1 -3.950019  2.740080    1.0
2  0.150222 -2.157638    1.0
3 -1.672050 -0.941519    1.0
4  2.560483 -1.846577    1.0
```

Observation : We have defined the column name x,y and class

In [4]:

```
#create design matrix X and target y

x = np.array(df.iloc[:,0:2])
y = np.array(df['class'])

print(x)
print(y)
```

```
[[ 7.00334571e-01 -2.47067578e-01]
 [-3.95001869e+00  2.74007953e+00]
 [ 1.50221617e-01 -2.15763780e+00]
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 [ 1.89572778e-01  1.69996229e+00]
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 [ 3.09811727e+00 -2.68185934e+00]
 [-1.24066342e+00 -1.22723646e+00]
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 [ 2.92145879e+00 -2.08053008e+00]
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 [ 1.60339212e+00 -1.55548115e+00]
 [ 4.95746877e-01 -1.85584900e+00]
 [ 2.06773287e+00 -2.91347893e+00]
 [-1.02614929e+00 -1.22721023e+00]
 [-1.05664139e+00  2.39349225e+00]
 [-1.55651057e+00  1.61888380e+00]
 [-1.44516496e+00  1.12363261e+00]
 [ 8.59137508e-02  2.98575492e-01]
 [ 1.72281294e-01  1.59733146e+00]
 [ 3.51855148e-01 -4.19513941e-01]
 [ 4.24504938e-01 -4.98156510e-01]
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 [ 1.19665186e+00 -1.21553910e+00]
 [ 2.46753646e+00 -1.07650912e+00]
 [ 5.18071703e-01 -1.47727247e+00]
 [ 1.60036563e+00  2.14934555e+00]
```

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[ 6.09655394e+00  2.69548583e+00]
[ 3.22172627e+00  4.35600746e+00]
[ 2.31131931e+00  5.39422690e+00]
[ 2.31721120e+00  4.15024210e+00]
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[ 2.67395025e+00  3.03994450e+00]
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[ 3.80958121e+00  5.19493658e+00]
[ 3.75755263e+00  2.45722745e+00]
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[ 4.40745772e-02  8.22934698e-01]
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[ 4.59976918e+00  2.25951561e+00]
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[ 1.23132902e+00  2.38215802e+00]
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[ 7.24446240e-01  4.51398556e+00]
[ 4.27985154e+00  3.74527526e+00]
[ 1.08237023e+00  4.24167387e+00]
[ 1.62936916e+00  5.39569761e+00]
[ 2.04732139e+00  4.36662067e+00]
[ 1.28681117e+00  3.10014472e+00]
[ 3.73768745e+00  3.51473847e+00]
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 [ 1.77890512e+00  2.86920461e+00]
 [ 8.94180435e-01  3.06995865e+00]
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```

In [54]:

```
#split the data into train and test
x1,x_test,y1,y_test = train_test_split(x,y,test_size=0.3,random_state=0)
x_tr,x_cv,y_tr,y_cv = train_test_split(x1,y1,test_size=0.3)

for i in range(1,30,2):
    #instantiate learning model(k=30)
    knn = KNeighborsClassifier(n_neighbors=i)
    #fitting the model
    knn.fit(x_tr,y_tr)
    #predict the response
    pred = knn.predict(x_cv)
    #evaluate the cv accuracy
    acc = accuracy_score(y_cv,pred,normalize = True)*float(100)
    print("\ncv accuracy for k = %d is %d%%" %(i,acc))
```

```
cv accuracy for k = 1 is 85%

cv accuracy for k = 3 is 87%

cv accuracy for k = 5 is 88%

cv accuracy for k = 7 is 81%

cv accuracy for k = 9 is 83%

cv accuracy for k = 11 is 83%

cv accuracy for k = 13 is 82%

cv accuracy for k = 15 is 86%

cv accuracy for k = 17 is 85%

cv accuracy for k = 19 is 85%

cv accuracy for k = 21 is 82%

cv accuracy for k = 23 is 81%

cv accuracy for k = 25 is 79%

cv accuracy for k = 27 is 79%

cv accuracy for k = 29 is 77%
```

Observation: We did cross validation

1. First step, we have split the x,y into train and test then dataset
2. Again the train datase has been splited into cross validation

We found highest accuracy 88% for k = 5

In [55]:

```
knn = KNeighborsClassifier(5)
knn.fit(x_tr,y_tr)
pred = knn.predict(x_test)
acc = accuracy_score(y_test,pred,normalize=True)*float(100)
print("\nTest accuracy for k = 1 is %d%%" %(acc))
```

```
Test accuracy for k = 1 is 85%
```

10 fold cross validation

In [63]:

```
#creating add list of k for KNN
mylist = list(range(1,50))
neighbors = list(filter(lambda x: x%2 != 0,mylist))
print(neighbors)
```

```
[1, 3, 5, 7, 9, 11, 13, 15, 17, 19, 21, 23, 25, 27, 29, 31, 33, 35, 37, 39, 41, 43, 45, 47, 49]
```

In [64]:

```
#empty list that will hold cv scores
cv_score = []
# perform 10-fold cross validation
for k in neighbors:
    knn = KNeighborsClassifier(n_neighbors=k)
    scores = cross_val_score(knn, x1, y1, cv=10, scoring='accuracy')
    cv_score.append(scores.mean())
print(cv_score)
```

```
[0.8971428571428571, 0.8885714285714286, 0.9028571428571428, 0.8828571428571428,
0.8742857142857142, 0.8714285714285713, 0.8514285714285714, 0.8371428571428572,
0.8342857142857143, 0.8171428571428571, 0.8171428571428571, 0.8114285714285714,
0.8057142857142857, 0.7885714285714286, 0.78, 0.7571428571428571, 0.7314285714285715,
0.7171428571428572, 0.7028571428571428, 0.6885714285714286, 0.6828571428571429,
0.6714285714285715, 0.66, 0.6542857142857144, 0.6371428571428571]
```

In [65]:

```
#changing to misclassification error

MSE = [1-x for x in cv_score]
#print(MSE)
```

In [66]:

```
#determining best k

optimal_k = neighbors[MSE.index(min(MSE))]

print("Optimal K:",optimal_k)

# plot misclassification error vs k
plt.plot(neighbors, MSE)

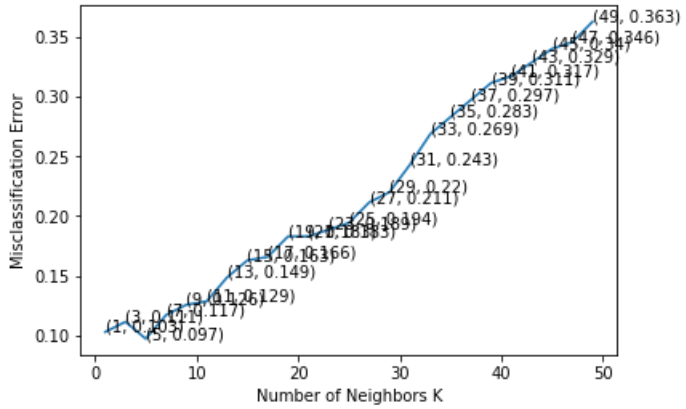
for xy in zip(neighbors, np.round(MSE,3)):
```

```
    plt.annotate('(%s, %s)' % xy, xy=xy, textcoords='data')

plt.xlabel('Number of Neighbors K')
plt.ylabel('Misclassification Error')
plt.show()

print("the misclassification error for each k value is : ", np.round(MSE,3))
```

```
Optimal K: 5
```




```
the misclassification error for each k value is :  [0.103 0.111 0.097 0.117 0.126 0.129 0.149 0.163
0.166 0.183 0.183 0.189
 0.194 0.211 0.22  0.243 0.269 0.283 0.297 0.311 0.317 0.329 0.34  0.346
 0.363]
```

In [67]:

```
knn_optimal = KNeighborsClassifier(n_neighbors=optimal_k)
```

In [68]:

```
knn_optimal.fit(x_tr,y_tr)
```

Out[68]:

```
KNeighborsClassifier()
```

In [69]:

```
pred = knn_optimal.predict(x_test)
#evaluate accuracy
acc = accuracy_score(y_test,pred)*100
print('\nThe accuracy of the knn classifier for k = %d is %f%%' % (optimal_k, acc))
```

```
The accuracy of the knn classifier for k = 5 is 85.333333%
```

In [ ]:

```

```