An important quality characteristic used by the manufacturers of ABC asphalt shingles is the amount of moisture the shingles contain when they are packaged. Customers may feel that they have purchased a product lacking in quality if they find moisture and wet shingles inside the packaging. In some cases, excessive moisture can cause the granules attached to the shingles for texture and coloring purposes to fall off the shingles resulting in appearance problems. To monitor the amount of moisture present, the company conducts moisture tests. A shingle is weighed and then dried. The shingle is then reweighed, and based on the amount of moisture taken out of the product, the pounds of moisture per 100 square feet are calculated. The company would like to show that the mean moisture content is less than 0.35 pounds per 100 square feet.

The file (A & B shingles.csv) includes 36 measurements (in pounds per 100 square feet) for A shingles and 31 for B shingles.

3.1 Do you think there is evidence that means moisture contents in both types of shingles are within the permissible limits? State your conclusions clearly showing all steps.

3.2 Do you think that the population mean for shingles A and B are equal? Form the hypothesis and conduct the test of the hypothesis. What assumption do you need to check before the test for equality of means is performed?

One-Sample t-test

```
#hypothsis for the above is as follows:

'''

Null Hypothesis(H0) = Moisture mean of Shingle A is greater than or equal to (0.35).
              (H0) = Ua <= 0.35
Alternate Hypothesis(H1) = Moisture mean of Shingle A is less than (0.35)
                   (H1) =  Ua > 0.35

'''
```

```
import scipy.stats as stats
```

```
t_statistic,p_value = stats.ttest_1samp(df['A'],0.35)
print('t_statistic is',t_statistic)

critical= print('crit_value is',stats.norm.ppf(0.05/2))

p_value = 1-(p_value/2)
if p_value >  0.05:
  print('p_value is',p_value,'- Fail to reject null hypothesis')
else:
  print('p_value is',p_value,'- Accept the null hypothesis')
```

```
t_statistic is -1.4735046253382782
crit_value is -1.9599639845400545
p_value is 0.9252236685509249 - Fail to reject null hypothesis
```

```
#Hypothesis for shingle B

'''

Null Hypothesis(H0) = Moisture mean of Shingle A is greater than or equal to (0.35).
              (H0) = Ub <= 0.35
Alternate Hypothesis(H1) = Moisture mean of Shingle A is less than (0.35)
                   (H1) =  Ub > 0.35

'''
```

```
t_statistic,p_value = stats.ttest_1samp(df['B'].dropna(),0.35)
print('t_statistic is',t_statistic)


critical= print('crit_value is',stats.norm.ppf(0.05/2))

p_value = 1-(p_value/2)
if p_value > 0.05:
  print('p_value is',p_value,'- Accept null hypothesis')
else:
  print('p_value is',p_value,'- Reject the null hypothesis')
```

```
t_statistic is -3.1003313069986995
crit_value is -1.9599639845400545
p_value is 0.9979095225996808 - Accept null hypothesis
```

Two- Sample t- test

3.2 Do you think that the population mean for shingles A and B are equal? Form the hypothesis and conduct the test of the hypothesis. What assumption do you need to check before the test for equality of means is performed?

```
#Hypothesis for the same is as follows:

'''

Null Hypothesis(H0) = The moisture mean in Shingle A is same as moisture mean in Shingle B
               (H0) = Ua = Ub

Alternate Hypothesis(H1) = The moisture mean in Shingle A is not same as moisture mean in Shingle B
               (H0) = Ua ≠ Ub

'''
```

```
[731] t_statistic, p_value = stats.ttest_ind(df['A'],df['B'],axis=0,equal_var=True,nan_policy = 'omit')
      print('t_statistic value is', t_statistic)
      print('p_value is',p_value)


      critical = stats.norm.ppf(0.05)
      print('critical value is',critical)

      if p_value < 0.05:
        print('Reject the null hypothesis as p_value is',p_value)
      else:
        print('Accept the null hypothesis as p_value is',p_value)
```

```
t_statistic value is 1.2896282719661123
p_value is 0.2017496571835306
critical value is -1.6448536269514729
Accept the null hypothesis as p_value is 0.2017496571835306
```