Assignment - 4 Vajjah Srinivasa Taaran

In [1]:

```
#Import the Libraries.
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
import seaborn as sns
```

In [2]:

```
#Importing the dataset.
df = pd.read_csv("Employee-Attrition.csv")
```

In [3]:

```
df.head()
```

Out[3]:

	Age	Attrition	BusinessTravel	DailyRate	Department	DistanceFromHome	Education	Educa
0	41	Yes	Travel_Rarely	1102	Sales	1	2	Life
1	49	No	Travel_Frequently	279	Research & Development	8	1	Life
2	37	Yes	Travel_Rarely	1373	Research & Development	2	2	
3	33	No	Travel_Frequently	1392	Research & Development	3	4	Life
4	27	No	Travel_Rarely	591	Research & Development	2	1	

5 rows × 35 columns

In [4]:

```
df.shape
```

Out[4]:

```
(1470, 35)
```

In [5]:

```
df.Age.value_counts()
```

Out[5]:

```
35    78
34    77
36    69
31    69
29    68
32    61
30    60
33    58
38    58
40    57
37    50
27    48
28    48
42    46
39    42
45    41
41    40
26    39
44    33
46    33
43    32
50    30
25    26
24    26
49    24
47    24
55    22
51    19
53    19
48    19
54    18
52    18
22    16
56    14
23    14
58    14
21    13
20    11
59    10
19     9
18     8
60     5
57     4
Name: Age, dtype: int64
```

In [6]:

```
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 1470 entries, 0 to 1469
Data columns (total 35 columns):
 #   Column                    Non-Null Count  Dtype 
---  ------                    --------------  ----- 
 0   Age                       1470 non-null   int64 
 1   Attrition                 1470 non-null   object
 2   BusinessTravel            1470 non-null   object
 3   DailyRate                 1470 non-null   int64 
 4   Department                1470 non-null   object
 5   DistanceFromHome          1470 non-null   int64 
 6   Education                 1470 non-null   int64 
 7   EducationField            1470 non-null   object
 8   EmployeeCount             1470 non-null   int64 
 9   EmployeeNumber            1470 non-null   int64 
 10  EnvironmentSatisfaction   1470 non-null   int64 
 11  Gender                    1470 non-null   object
 12  HourlyRate                1470 non-null   int64 
 13  JobInvolvement            1470 non-null   int64 
 14  JobLevel                  1470 non-null   int64 
 15  JobRole                   1470 non-null   object
 16  JobSatisfaction           1470 non-null   int64 
 17  MaritalStatus             1470 non-null   object
 18  MonthlyIncome             1470 non-null   int64 
 19  MonthlyRate               1470 non-null   int64 
 20  NumCompaniesWorked        1470 non-null   int64 
 21  Over18                    1470 non-null   object
 22  OverTime                  1470 non-null   object
 23  PercentSalaryHike         1470 non-null   int64 
 24  PerformanceRating         1470 non-null   int64 
 25  RelationshipSatisfaction  1470 non-null   int64 
 26  StandardHours             1470 non-null   int64 
 27  StockOptionLevel          1470 non-null   int64 
 28  TotalWorkingYears         1470 non-null   int64 
 29  TrainingTimesLastYear     1470 non-null   int64 
 30  WorkLifeBalance           1470 non-null   int64 
 31  YearsAtCompany            1470 non-null   int64 
 32  YearsInCurrentRole        1470 non-null   int64 
 33  YearsSinceLastPromotion   1470 non-null   int64 
 34  YearsWithCurrManager      1470 non-null   int64 
dtypes: int64(26), object(9)
memory usage: 402.1+ KB
```

In [7]:

```
df.describe()
```

Out[7]:

	Age	DailyRate	DistanceFromHome	Education	EmployeeCount	EmployeeNur
count	1470.000000	1470.000000	1470.000000	1470.000000	1470.0	1470.00
mean	36.923810	802.485714	9.192517	2.912925	1.0	1024.86
std	9.135373	403.509100	8.106864	1.024165	0.0	602.02
min	18.000000	102.000000	1.000000	1.000000	1.0	1.00
25%	30.000000	465.000000	2.000000	2.000000	1.0	491.25
50%	36.000000	802.000000	7.000000	3.000000	1.0	1020.50
75%	43.000000	1157.000000	14.000000	4.000000	1.0	1555.75
max	60.000000	1499.000000	29.000000	5.000000	1.0	2068.00

8 rows × 26 columns

In [8]:

```
#Checking for Null Values.
df.isnull().any()
```

Out[8]:

```
Age                         False
Attrition                   False
BusinessTravel              False
DailyRate                   False
Department                  False
DistanceFromHome            False
Education                   False
EducationField              False
EmployeeCount               False
EmployeeNumber              False
EnvironmentSatisfaction     False
Gender                      False
HourlyRate                  False
JobInvolvement              False
JobLevel                    False
JobRole                     False
JobSatisfaction             False
MaritalStatus               False
MonthlyIncome               False
MonthlyRate                 False
NumCompaniesWorked          False
Over18                      False
OverTime                    False
PercentSalaryHike           False
PerformanceRating           False
RelationshipSatisfaction    False
StandardHours               False
StockOptionLevel            False
TotalWorkingYears           False
TrainingTimesLastYear       False
WorkLifeBalance             False
YearsAtCompany              False
YearsInCurrentRole          False
YearsSinceLastPromotion     False
YearsWithCurrManager        False
dtype: bool
```

In [9]:

```
df.isnull().sum()
```

Out[9]:

```
Age                         0
Attrition                   0
BusinessTravel              0
DailyRate                   0
Department                  0
DistanceFromHome            0
Education                   0
EducationField              0
EmployeeCount               0
EmployeeNumber              0
EnvironmentSatisfaction     0
Gender                      0
HourlyRate                  0
JobInvolvement              0
JobLevel                    0
JobRole                     0
JobSatisfaction             0
MaritalStatus               0
MonthlyIncome               0
MonthlyRate                 0
NumCompaniesWorked          0
Over18                      0
OverTime                    0
PercentSalaryHike           0
PerformanceRating           0
RelationshipSatisfaction    0
StandardHours               0
StockOptionLevel            0
TotalWorkingYears           0
TrainingTimesLastYear       0
WorkLifeBalance             0
YearsAtCompany              0
YearsInCurrentRole          0
YearsSinceLastPromotion     0
YearsWithCurrManager        0
dtype: int64
```

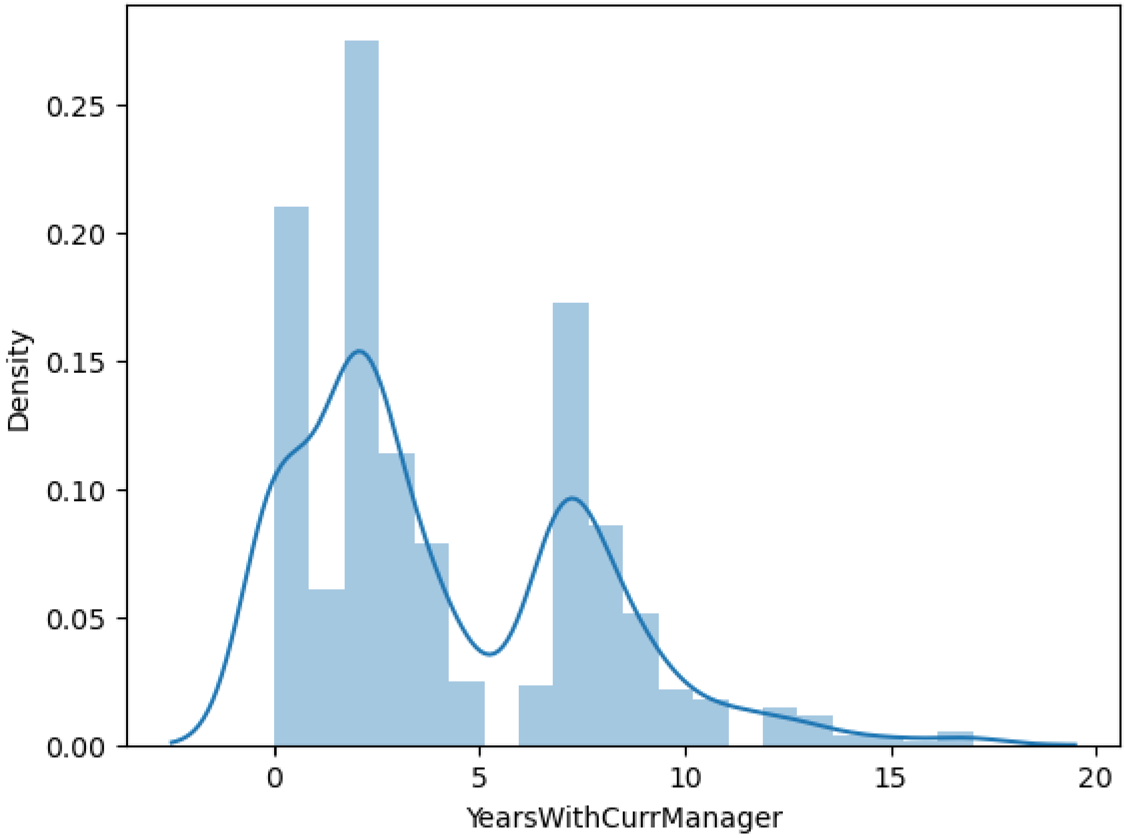
In [10]:

```
#Data Visualization.
sns.distplot(df["YearsWithCurrManager"])
```

```
/var/folders/0g/xqmh0yz92jx_s8ljsv3x08wr0000gn/T/ipykernel_82696/94493
4001.py:2: UserWarning:

`distplot` is a deprecated function and will be removed in seaborn v0.
14.0.

Please adapt your code to use either `displot` (a figure-level functio
n with
similar flexibility) or `histplot` (an axes-level function for histogr
ams).

For a guide to updating your code to use the new functions, please see
https://gist.github.com/mwaskom/de44147ed2974457ad6372750bbe5751 (http
s://gist.github.com/mwaskom/de44147ed2974457ad6372750bbe5751)

  sns.distplot(df["YearsWithCurrManager"])
```

Out[10]:

```
<Axes: xlabel='YearsWithCurrManager', ylabel='Density'>
```



In [11]:

```
df.corr()
```

```
/var/folders/0g/xqmh0yz92jx_s8ljsv3x08wr0000gn/T/ipykernel_82696/11347
22465.py:1: FutureWarning: The default value of numeric_only in DataFr
ame.corr is deprecated. In a future version, it will default to False.
Select only valid columns or specify the value of numeric_only to sile
nce this warning.
  df.corr()
```

Out[11]:

	Age	DailyRate	DistanceFromHome	Education	EmployeeCount
Age	1.000000	0.010661	-0.001686	0.208034	NaN
DailyRate	0.010661	1.000000	-0.004985	-0.016806	NaN
DistanceFromHome	-0.001686	-0.004985	1.000000	0.021042	NaN
Education	0.208034	-0.016806	0.021042	1.000000	NaN
EmployeeCount	NaN	NaN	NaN	NaN	NaN
EmployeeNumber	-0.010145	-0.050990	0.032916	0.042070	NaN
EnvironmentSatisfaction	0.010146	0.018355	-0.016075	-0.027128	NaN
HourlyRate	0.024287	0.023381	0.031131	0.016775	NaN
JobInvolvement	0.029820	0.046135	0.008783	0.042438	NaN
JobLevel	0.509604	0.002966	0.005303	0.101589	NaN
JobSatisfaction	-0.004892	0.030571	-0.003669	-0.011296	NaN
MonthlyIncome	0.497855	0.007707	-0.017014	0.094961	NaN
MonthlyRate	0.028051	-0.032182	0.027473	-0.026084	NaN
NumCompaniesWorked	0.299635	0.038153	-0.029251	0.126317	NaN
PercentSalaryHike	0.003634	0.022704	0.040235	-0.011111	NaN
PerformanceRating	0.001904	0.000473	0.027110	-0.024539	NaN
RelationshipSatisfaction	0.053535	0.007846	0.006557	-0.009118	NaN
StandardHours	NaN	NaN	NaN	NaN	NaN
StockOptionLevel	0.037510	0.042143	0.044872	0.018422	NaN
TotalWorkingYears	0.680381	0.014515	0.004628	0.148280	NaN
TrainingTimesLastYear	-0.019621	0.002453	-0.036942	-0.025100	NaN
WorkLifeBalance	-0.021490	-0.037848	-0.026556	0.009819	NaN
YearsAtCompany	0.311309	-0.034055	0.009508	0.069114	NaN
YearsInCurrentRole	0.212901	0.009932	0.018845	0.060236	NaN
YearsSinceLastPromotion	0.216513	-0.033229	0.010029	0.054254	NaN
YearsWithCurrManager	0.202089	-0.026363	0.014406	0.069065	NaN

26 rows × 26 columns

In [12]:

```
df.head()
```

Out[12]:

	Age	Attrition	BusinessTravel	DailyRate	Department	DistanceFromHome	Education	Educa
0	41	Yes	Travel_Rarely	1102	Sales	1	2	Life
1	49	No	Travel_Frequently	279	Research & Development	8	1	Life
2	37	Yes	Travel_Rarely	1373	Research & Development	2	2	
3	33	No	Travel_Frequently	1392	Research & Development	3	4	Life
4	27	No	Travel_Rarely	591	Research & Development	2	1	

5 rows × 35 columns

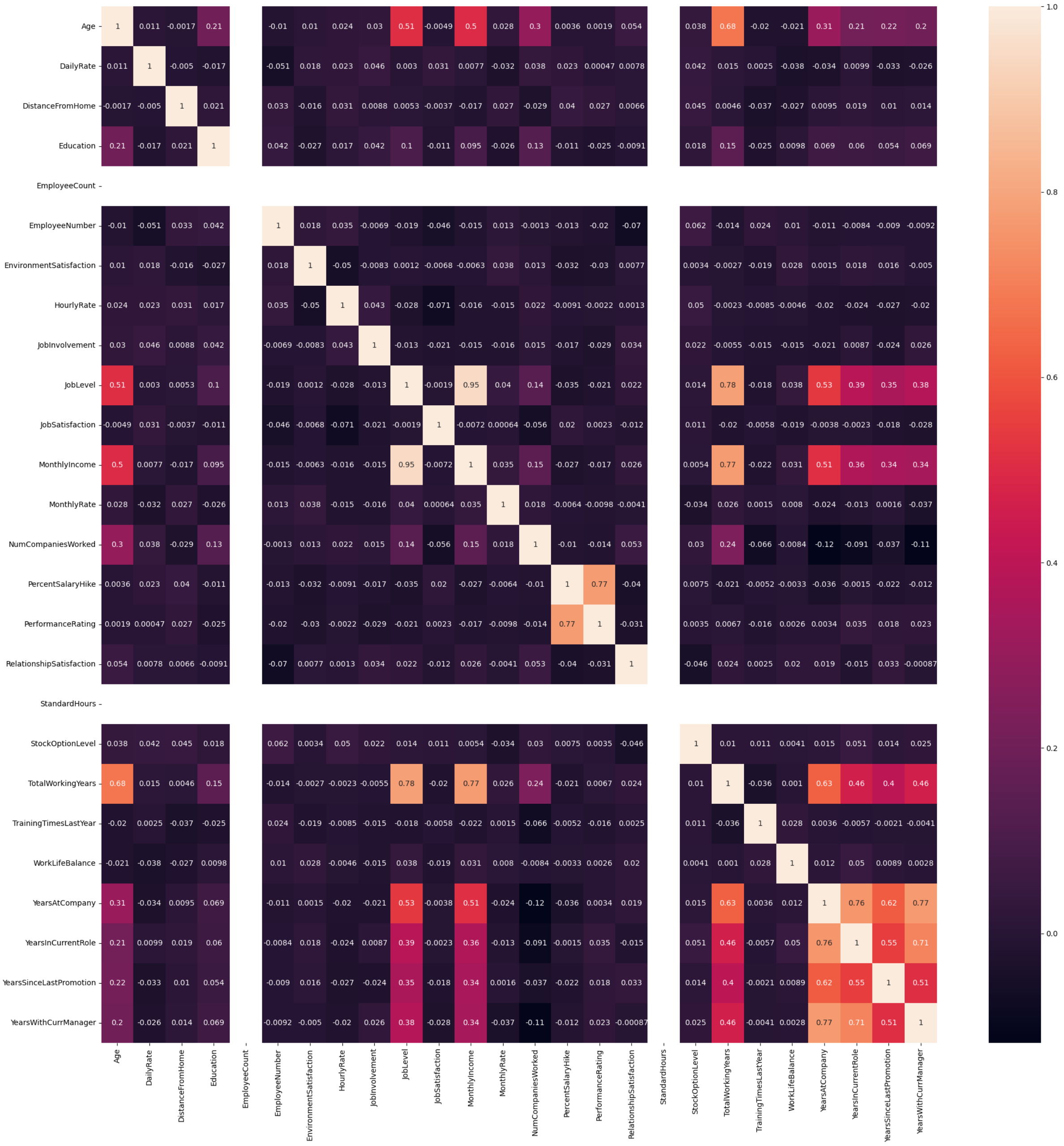
In [13]:

```
plt.subplots(figsize = (25,25))
sns.heatmap(df.corr(),annot=True)
```

```
/var/folders/0g/xqmh0yz92jx_s8ljsv3x08wr0000gn/T/ipykernel_82696/39174
69003.py:2: FutureWarning: The default value of numeric_only in DataFr
ame.corr is deprecated. In a future version, it will default to False.
Select only valid columns or specify the value of numeric_only to sile
nce this warning.
  sns.heatmap(df.corr(),annot=True)
```

Out[13]:

```
<Axes: >
```

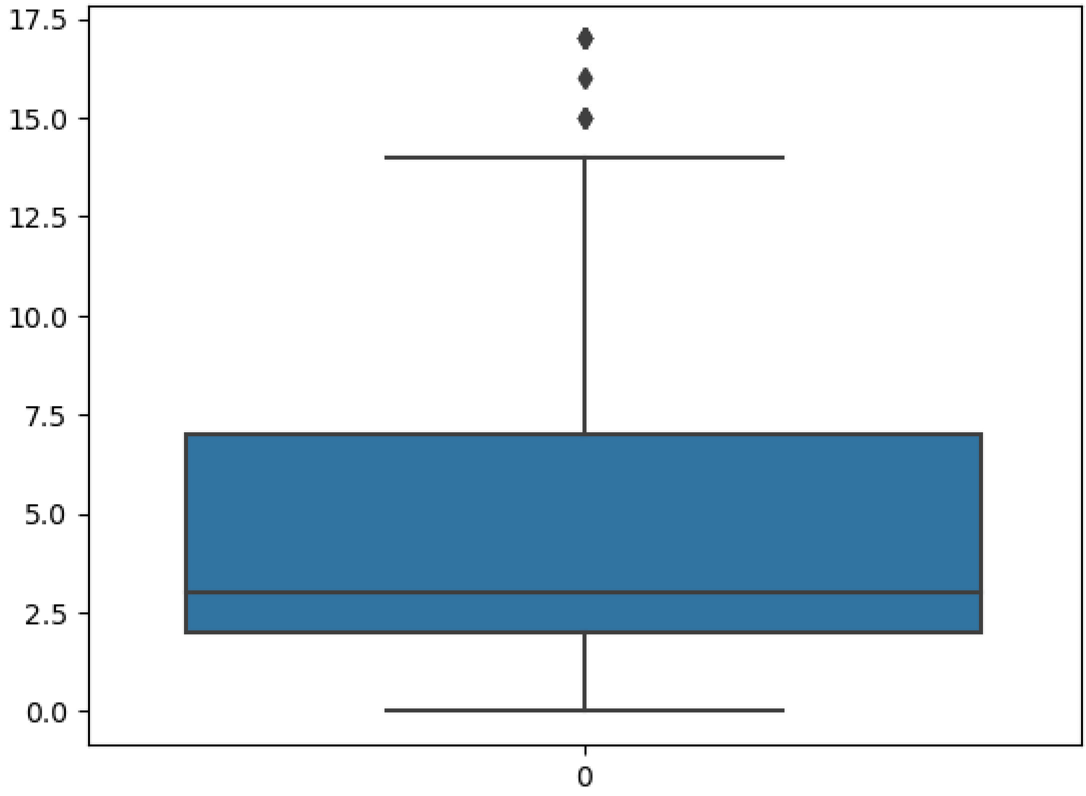


In [14]:

```
sns.boxplot(df.YearsWithCurrManager)
```

Out[14]:

```
<Axes: >
```



In [15]:

```
from scipy import stats
z_scores = np.abs(stats.zscore(df['YearsWithCurrManager']))
max_threshold=3
outliers = df['YearsWithCurrManager'][z_scores > max_threshold]

# Print and visualize the outliers
print("Outliers detected using Z-Score:")
print(outliers)
```

```
Outliers detected using Z-Score:
28      17
123     15
153     15
187     15
231     15
386     17
561     16
616     17
635     15
686     17
875     17
926     17
1078    17
1348    16
Name: YearsWithCurrManager, dtype: int64
```

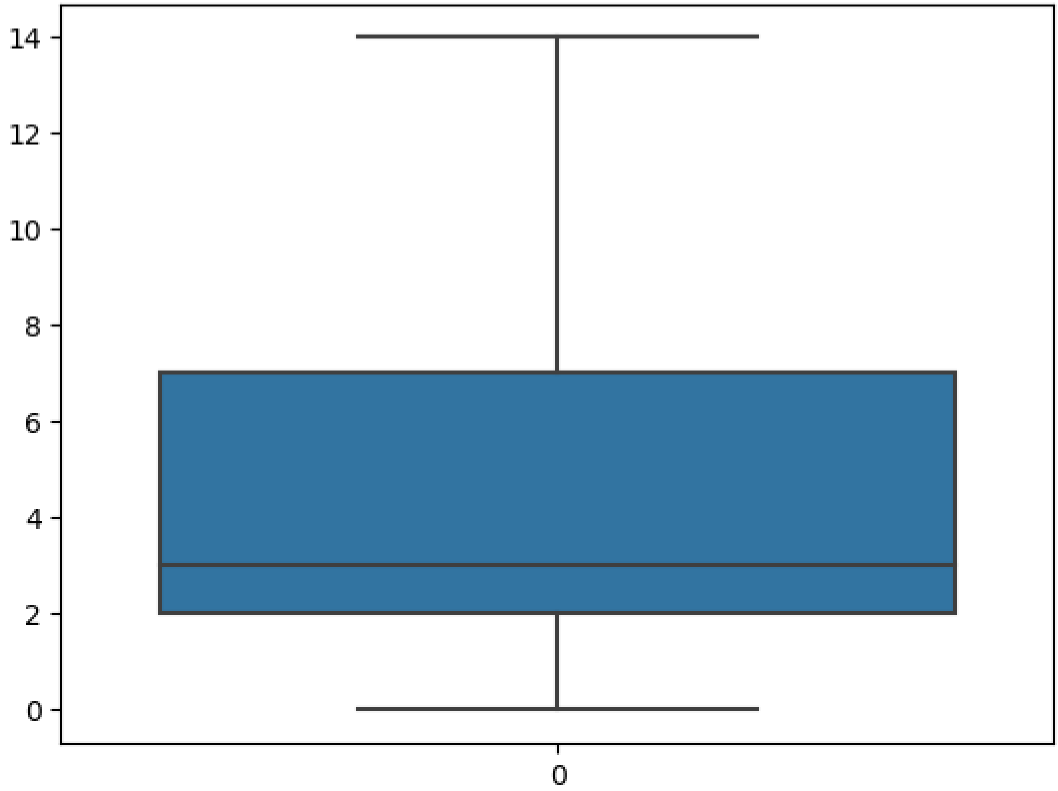
In [16]:

```
q1 = df.YearsWithCurrManager.quantile(0.25)
q3 = df.YearsWithCurrManager.quantile(0.75)
print(q1)
print(q3)
upperlimit = q3+1.5*(q3-q1)
upperlimit
lowerlimit = q1-1.5*(q3-q1)
lowerlimit
df.median()
df["YearsWithCurrManager"]=np.where(df["YearsWithCurrManager"]>upperlimit,14,df['Yea
sns.boxplot(df.YearsWithCurrManager)
```

```
2.0
7.0

/var/folders/0g/xqmh0yz92jx_s8ljsv3x08wr0000gn/T/ipykernel_82696/17509
64472.py:9: FutureWarning: The default value of numeric_only in DataFr
ame.median is deprecated. In a future version, it will default to Fals
e. In addition, specifying 'numeric_only=None' is deprecated. Select o
nly valid columns or specify the value of numeric_only to silence this
warning.
  df.median()
```

Out[16]:

```
<Axes: >
```



In [17]:

```
from scipy import stats
z_scores = np.abs(stats.zscore(df['YearsWithCurrManager']))
max_threshold=3
outliers = df['YearsWithCurrManager'][z_scores > max_threshold]

# Print and visualize the outliers
print("Outliers detected using Z-Score:")
print(outliers)
```

```
Outliers detected using Z-Score:
Series([], Name: YearsWithCurrManager, dtype: int64)
```

In [18]:

```
df.head()
```

Out[18]:

	Age	Attrition	BusinessTravel	DailyRate	Department	DistanceFromHome	Education	Educa
0	41	Yes	Travel_Rarely	1102	Sales	1	2	Life
1	49	No	Travel_Frequently	279	Research & Development	8	1	Life
2	37	Yes	Travel_Rarely	1373	Research & Development	2	2	
3	33	No	Travel_Frequently	1392	Research & Development	3	4	Life
4	27	No	Travel_Rarely	591	Research & Development	2	1	

5 rows × 35 columns

In [19]:

```
x=df.drop('Attrition',axis=1)
x.head()
```

Out[19]:

	Age	BusinessTravel	DailyRate	Department	DistanceFromHome	Education	EducationField
0	41	Travel_Rarely	1102	Sales	1	2	Life Sciences
1	49	Travel_Frequently	279	Research & Development	8	1	Life Sciences
2	37	Travel_Rarely	1373	Research & Development	2	2	Other
3	33	Travel_Frequently	1392	Research & Development	3	4	Life Sciences
4	27	Travel_Rarely	591	Research & Development	2	1	Medical

5 rows × 34 columns

In [20]:

```
y=df.Attrition
y.head()
```

Out[20]:

```
0     Yes
1      No
2     Yes
3      No
4      No
Name: Attrition, dtype: object
```

In [21]:

```
#label encoding
from sklearn.preprocessing import LabelEncoder
le=LabelEncoder()
x.BusinessTravel    =le.fit_transform(x.BusinessTravel  )
x.head()
x.Department    =le.fit_transform(x.Department  )
x.head()
x.EducationField    =le.fit_transform(x.EducationField  )
x.head()
x.Gender=le.fit_transform(x.Gender)
x.head()
x.JobRole   =le.fit_transform(x.JobRole )
x.head()
x.MaritalStatus =le.fit_transform(x.MaritalStatus   )
x.head()
x.Over18    =le.fit_transform(x.Over18  )
x.head()
x.OverTime  =le.fit_transform(x.OverTime    )
x.head()
```

Out[21]:

	Age	BusinessTravel	DailyRate	Department	DistanceFromHome	Education	EducationField	E
0	41	2	1102	2	1	2	1	
1	49	1	279	1	8	1	1	
2	37	2	1373	1	2	2	4	
3	33	1	1392	1	3	4	1	
4	27	2	591	1	2	1	3	

5 rows × 34 columns

In [22]:

```
df.columns
```

Out[22]:

```
Index(['Age', 'Attrition', 'BusinessTravel', 'DailyRate', 'Departmen
t',
       'DistanceFromHome', 'Education', 'EducationField', 'EmployeeCou
nt',
       'EmployeeNumber', 'EnvironmentSatisfaction', 'Gender', 'HourlyR
ate',
       'JobInvolvement', 'JobLevel', 'JobRole', 'JobSatisfaction',
       'MaritalStatus', 'MonthlyIncome', 'MonthlyRate', 'NumCompaniesW
orked',
       'Over18', 'OverTime', 'PercentSalaryHike', 'PerformanceRating',
       'RelationshipSatisfaction', 'StandardHours', 'StockOptionLeve
l',
       'TotalWorkingYears', 'TrainingTimesLastYear', 'WorkLifeBalanc
e',
       'YearsAtCompany', 'YearsInCurrentRole', 'YearsSinceLastPromotio
n',
       'YearsWithCurrManager'],
      dtype='object')
```

In [23]:

```
#feature scaling
from sklearn.preprocessing import MinMaxScaler
ms=MinMaxScaler()
x_scaled=pd.DataFrame(ms.fit_transform(x),columns=x.columns)
```

In [24]:

```
x_scaled
```

Out[24]:

	Age	BusinessTravel	DailyRate	Department	DistanceFromHome	Education	Educatior
0	0.547619	1.0	0.715820	1.0	0.000000	0.25	
1	0.738095	0.5	0.126700	0.5	0.250000	0.00	
2	0.452381	1.0	0.909807	0.5	0.035714	0.25	
3	0.357143	0.5	0.923407	0.5	0.071429	0.75	
4	0.214286	1.0	0.350036	0.5	0.035714	0.00	
...	...	...	...	...	...	...	
1465	0.428571	0.5	0.559771	0.5	0.785714	0.25	
1466	0.500000	1.0	0.365784	0.5	0.178571	0.00	
1467	0.214286	1.0	0.037938	0.5	0.107143	0.50	
1468	0.738095	0.5	0.659270	1.0	0.035714	0.50	
1469	0.380952	1.0	0.376521	0.5	0.250000	0.50	

1470 rows × 34 columns

In [25]:

```
#Splitting Data into Train and Test.
from sklearn.model_selection import train_test_split
x_train,x_test,y_train,y_test=train_test_split(x_scaled,y,test_size=0.2,random_state
```

In [26]:

```
x_train.shape,x_test.shape,y_train.shape,y_test.shape
```

Out[26]:

```
((1176, 34), (294, 34), (1176,), (294,))
```

In [27]:

```
x_train.head()
```

Out[27]:

	Age	BusinessTravel	DailyRate	Department	DistanceFromHome	Education	Educatior
1374	0.952381	1.0	0.360057	1.0	0.714286	0.50	
1092	0.642857	1.0	0.607015	0.5	0.964286	0.50	
768	0.523810	1.0	0.141732	1.0	0.892857	0.50	
569	0.428571	0.0	0.953472	1.0	0.250000	0.75	
911	0.166667	0.5	0.355762	1.0	0.821429	0.00	

5 rows × 34 columns

In [28]:

```
from sklearn.linear_model import LogisticRegression
model=LogisticRegression()
```

In [29]:

```
model.fit(x_train,y_train)
pred=model.predict(x_test)
pred
```

Out[29]:

```
array(['No', 'No', 'No', 'No', 'Yes', 'No', 'Yes', 'No', 'No', 'No',
'No',
       'No', 'No', 'Yes', 'No', 'No', 'No', 'No', 'No', 'No', 'No', 'N
o',
       'No', 'No', 'Yes', 'No', 'No', 'No', 'Yes', 'No', 'No', 'No',
'No',
       'No', 'No', 'No', 'No', 'No', 'No', 'No', 'No', 'No', 'No', 'N
o',
       'No', 'Yes', 'No', 'No', 'Yes', 'Yes', 'No', 'No', 'No', 'No',
       'Yes', 'No', 'No', 'No', 'No', 'No', 'No', 'No', 'No', 'No', 'N
o',
       'No', 'No', 'No', 'No', 'No', 'No', 'No', 'No', 'No', 'No', 'N
o',
       'No', 'No', 'No', 'No', 'No', 'No', 'No', 'No', 'No', 'No', 'N
o',
       'No', 'No', 'No', 'No', 'No', 'No', 'No', 'No', 'No', 'No', 'N
o',
       'No', 'No', 'No', 'Yes', 'No', 'No', 'No', 'No', 'No', 'No', 'N
o',
       'No', 'No', 'No', 'No', 'No', 'No', 'No', 'No', 'No', 'No', 'N
o',
       'No', 'No', 'No', 'Yes', 'No', 'No', 'No', 'No', 'No', 'No', 'N
o',
       'No', 'Yes', 'No', 'No', 'No', 'Yes', 'No', 'No', 'No', 'No',
'No',
       'No', 'No', 'No', 'No', 'No', 'No', 'No', 'No', 'No', 'No', 'N
o',
       'No', 'No', 'No', 'No', 'No', 'No', 'No', 'No', 'No', 'No', 'Ye
s',
       'No', 'No', 'No', 'No', 'No', 'No', 'No', 'No', 'No', 'No', 'N
o',
       'No', 'No', 'No', 'No', 'No', 'No', 'No', 'No', 'Yes', 'No', 'N
o',
       'No', 'No', 'Yes', 'No', 'No', 'No', 'No', 'No', 'No', 'No', 'N
o',
       'No', 'No', 'No', 'No', 'No', 'Yes', 'No', 'No', 'No', 'No', 'N
o',
       'No', 'No', 'No', 'No', 'No', 'No', 'No', 'No', 'No', 'No', 'N
o',
       'No', 'No', 'No', 'Yes', 'No', 'No', 'No', 'No', 'No', 'No', 'N
o',
       'No', 'No', 'No', 'No', 'No', 'No', 'No', 'No', 'No', 'No', 'N
o',
       'No', 'No', 'No', 'No', 'No', 'No', 'No', 'No', 'No', 'No', 'N
o',
       'Yes', 'No', 'No', 'No', 'No', 'Yes', 'No', 'No', 'No', 'No',
'No',
       'No', 'No', 'No', 'No', 'No', 'No', 'No', 'No', 'No', 'No', 'N
o',
       'No', 'No', 'No', 'No', 'No', 'No', 'No', 'No', 'No', 'No', 'N
o',
       'No', 'No', 'No', 'No', 'No', 'No', 'Yes', 'No', 'No'],
      dtype=object)
```

In [30]:

```
#label encoding
from sklearn.preprocessing import LabelEncoder
le=LabelEncoder()
y=le.fit_transform(y)
```

In [31]:

```
y_test
```

Out[31]:

```
442      No
1091     No
981     Yes
785      No
1332    Yes
       ... 
1439     No
481      No
124     Yes
198      No
1229     No
Name: Attrition, Length: 294, dtype: object
```

In [32]:

```
df
```

Out[32]:

	Age	Attrition	BusinessTravel	DailyRate	Department	DistanceFromHome	Education	Ec
0	41	Yes	Travel_Rarely	1102	Sales	1	2	
1	49	No	Travel_Frequently	279	Research & Development	8	1	
2	37	Yes	Travel_Rarely	1373	Research & Development	2	2	
3	33	No	Travel_Frequently	1392	Research & Development	3	4	
4	27	No	Travel_Rarely	591	Research & Development	2	1	
...	...	...	...	...	...	...	...	
1465	36	No	Travel_Frequently	884	Research & Development	23	2	
1466	39	No	Travel_Rarely	613	Research & Development	6	1	
1467	27	No	Travel_Rarely	155	Research & Development	4	3	
1468	49	No	Travel_Frequently	1023	Sales	2	3	
1469	34	No	Travel_Rarely	628	Research & Development	8	3	

1470 rows × 35 columns

Evaluation of classification model

In [33]:

```
#Accuracy score
from sklearn.metrics import accuracy_score,confusion_matrix,classification_report,rc
```

In [34]:

```
accuracy_score(y_test,pred)
```

Out[34]:

```
0.8843537414965986
```

In [35]:

```
confusion_matrix(y_test,pred)
```

Out[35]:

```
array([[242,   3],
       [ 31,  18]])
```

In [36]:

```
pd.crosstab(y_test,pred)
```

Out[36]:

col_0	No	Yes
Attrition		
No	242	3
Yes	31	18

Roc-AUC curve

In [37]:

```
probability=model.predict_proba(x_test)[:,1]
probability
```

Out[37]:

```
array([0.15843867, 0.20617997, 0.31691729, 0.09672152, 0.63876647,
       0.06205401, 0.61414184, 0.07466397, 0.00797252, 0.39157785,
       0.05281564, 0.33160211, 0.02022395, 0.6671328 , 0.19419683,
       0.0335299 , 0.10954936, 0.17130578, 0.043804  , 0.2241511 ,
       0.23531373, 0.01475346, 0.06562592, 0.05019163, 0.59115162,
       0.44667993, 0.07401303, 0.0449937 , 0.67637047, 0.05859033,
       0.01545736, 0.03386798, 0.07021403, 0.1707141 , 0.07767295,
       0.04154894, 0.08312937, 0.06997437, 0.03567429, 0.05269126,
       0.05742727, 0.02144976, 0.01779053, 0.01301572, 0.02825292,
       0.50162054, 0.41541766, 0.00299378, 0.74315718, 0.51799699,
       0.09708281, 0.48942319, 0.07941138, 0.25720931, 0.66861063,
       0.26482373, 0.01970983, 0.30281497, 0.02858501, 0.16213966,
       0.02040161, 0.2173984 , 0.13768821, 0.03568054, 0.37558052,
       0.03010741, 0.29718154, 0.15832399, 0.10264349, 0.08700774,
       0.0815183 , 0.30943969, 0.08708969, 0.07442596, 0.12300414,
       0.0618342 , 0.04633075, 0.07672219, 0.19834226, 0.03129952,
       0.00857215, 0.02394842, 0.13606932, 0.02587787, 0.03217004,
       0.0821409 , 0.00518749, 0.035308  , 0.03813342, 0.14270872,
       0.26418695, 0.16461435, 0.27401734, 0.24146954, 0.02119787,
       0.17774284, 0.34102562, 0.28338745, 0.06906981, 0.04948532,
       0.24465264, 0.74929682, 0.35691434, 0.01878265, 0.08772637,
       0.03239915, 0.05413857, 0.15215059, 0.07127406, 0.13828798,
       0.09342465, 0.04693869, 0.02494493, 0.15041914, 0.07133392,
       0.03025642, 0.05306455, 0.1165452 , 0.00872431, 0.01229042,
       0.17575238, 0.05005249, 0.09018395, 0.82857166, 0.03066995,
       0.0228189 , 0.00874605, 0.13496234, 0.16593413, 0.05060052,
       0.01520085, 0.29791945, 0.54919611, 0.33581407, 0.0469494 ,
       0.38773566, 0.61348127, 0.14171081, 0.07455884, 0.2409655 ,
       0.09528764, 0.06730943, 0.09797576, 0.20026612, 0.20053142,
       0.03046036, 0.14877431, 0.0036571 , 0.11146887, 0.15912883,
       0.06017571, 0.17964687, 0.06063618, 0.1199213 , 0.03284092,
       0.02688355, 0.06536903, 0.08335812, 0.01464284, 0.01536292,
       0.37701597, 0.01262506, 0.15004068, 0.80530948, 0.11655522,
       0.28461049, 0.17042029, 0.15392139, 0.02756879, 0.00599553,
       0.04142216, 0.09958411, 0.11567269, 0.10448555, 0.01830036,
       0.1444171 , 0.1048541 , 0.10079777, 0.05099176, 0.09183576,
       0.02893646, 0.09754427, 0.00516687, 0.75206394, 0.04227453,
       0.04018918, 0.37563319, 0.04457964, 0.72551665, 0.10583031,
       0.36656526, 0.38293703, 0.32923777, 0.05248015, 0.08216713,
       0.13748888, 0.04309097, 0.01429957, 0.2656631 , 0.06297408,
       0.16075744, 0.15388494, 0.67190498, 0.05834473, 0.28467369,
       0.04694404, 0.46237195, 0.00339026, 0.13927388, 0.02695884,
       0.12707414, 0.17395277, 0.0750947 , 0.10135673, 0.16496216,
       0.02583798, 0.01790826, 0.08850395, 0.02838351, 0.13795992,
       0.08655223, 0.22164621, 0.73379009, 0.17294814, 0.40907888,
       0.01503347, 0.11411826, 0.21412683, 0.32566668, 0.03366086,
       0.04472831, 0.32127248, 0.05442236, 0.0242917 , 0.16228044,
       0.32858438, 0.22879119, 0.00852736, 0.0798162 , 0.01140248,
       0.14102568, 0.29116266, 0.01282151, 0.17118076, 0.04051376,
       0.04165738, 0.42684273, 0.35009936, 0.0366853 , 0.11692325,
       0.37940034, 0.31562415, 0.79587005, 0.05488792, 0.21568794,
       0.06397987, 0.00569145, 0.66085682, 0.35796045, 0.37592133,
       0.3650533 , 0.03568965, 0.21192376, 0.05892118, 0.06428028,
       0.10143977, 0.00796354, 0.2678938 , 0.4288445 , 0.0652538 ,
       0.09309022, 0.01226927, 0.14314823, 0.04989664, 0.02304292,
       0.02508766, 0.06618985, 0.24272596, 0.26663754, 0.1979951 ,
       0.26504226, 0.01648205, 0.15826843, 0.08519882, 0.02669729,
       0.18757572, 0.00768502, 0.27928747, 0.0027473 , 0.02506718,
       0.22608608, 0.72428674, 0.07739605, 0.26575953])
```

In [38]:

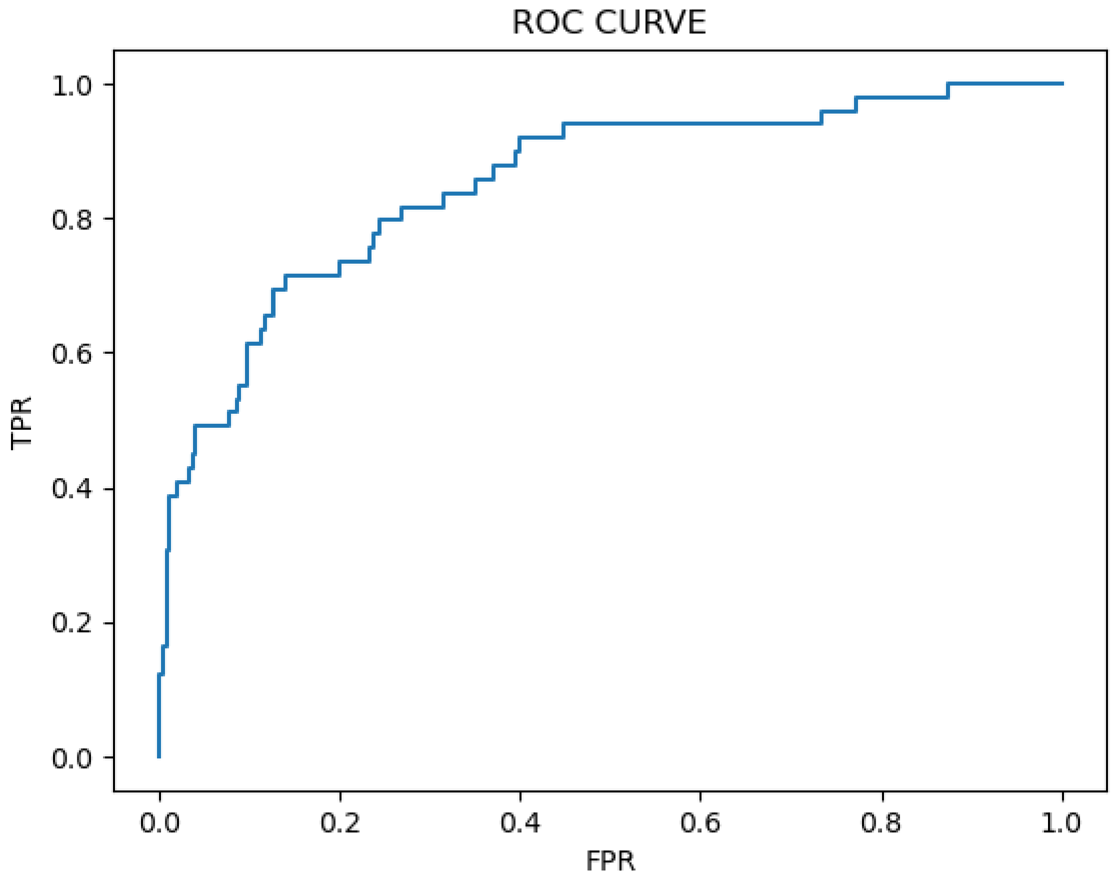
```
#label encoding
from sklearn.preprocessing import LabelEncoder
le=LabelEncoder()
y_test=le.fit_transform(y_test)
```

In [39]:

```
 # roc_curve
fpr,tpr,threshsholds = roc_curve(y_test,probability)
```

In [40]:

```
plt.plot(fpr,tpr)
plt.xlabel('FPR')
plt.ylabel('TPR')
plt.title('ROC CURVE')
plt.show()
```



DecisionTreeClassifier

In [41]:

```
from sklearn.tree import DecisionTreeClassifier
dtc=DecisionTreeClassifier()
```

In [42]:

```
dtc.fit(x_train,y_train)
```

Out[42]:

```
▼ DecisionTreeClassifier
DecisionTreeClassifier()
```

In [43]:

```
pred=dtc.predict(x_test)
```

In [44]:

```
pred
```

Out[44]:

```
array(['No', 'No', 'No', 'No', 'Yes', 'No', 'Yes', 'No', 'No', 'No',
'No',
       'No', 'No', 'Yes', 'No', 'No', 'No', 'No', 'No', 'No', 'Yes',
'No',
       'No', 'No', 'Yes', 'No', 'No', 'No', 'No', 'No', 'No', 'No', 'N
o',
       'No', 'No', 'No', 'No', 'No', 'No', 'No', 'No', 'No', 'No', 'N
o',
       'No', 'No', 'No', 'No', 'Yes', 'No', 'Yes', 'Yes', 'No', 'No',
       'No', 'No', 'No', 'No', 'No', 'No', 'No', 'No', 'Yes', 'No', 'Y
es',
       'No', 'No', 'No', 'No', 'No', 'No', 'Yes', 'No', 'No', 'No', 'Y
es',
       'Yes', 'No', 'No', 'No', 'Yes', 'No', 'No', 'No', 'No', 'No',
       'Yes', 'No', 'No', 'No', 'No', 'No', 'No', 'Yes', 'No', 'No',
'No',
       'No', 'No', 'No', 'No', 'No', 'Yes', 'No', 'No', 'No', 'No', 'N
o',
       'No', 'No', 'No', 'Yes', 'No', 'No', 'No', 'No', 'No', 'No', 'N
o',
       'No', 'No', 'No', 'No', 'Yes', 'Yes', 'No', 'No', 'No', 'No',
'No',
       'No', 'Yes', 'Yes', 'Yes', 'No', 'No', 'No', 'No', 'Yes', 'No',
       'No', 'No', 'Yes', 'No', 'No', 'No', 'No', 'Yes', 'No', 'No',
'No',
       'No', 'No', 'No', 'No', 'No', 'No', 'No', 'No', 'No', 'Yes', 'N
o',
       'No', 'No', 'No', 'No', 'No', 'No', 'No', 'No', 'No', 'No', 'N
o',
       'No', 'No', 'Yes', 'No', 'Yes', 'Yes', 'No', 'No', 'No', 'No',
       'Yes', 'No', 'No', 'Yes', 'No', 'No', 'Yes', 'No', 'Yes', 'No',
       'No', 'No', 'No', 'No', 'No', 'No', 'No', 'No', 'No', 'Yes', 'N
o',
       'Yes', 'No', 'No', 'Yes', 'No', 'No', 'No', 'No', 'No', 'No',
'No',
       'No', 'No', 'No', 'No', 'No', 'No', 'No', 'Yes', 'No', 'No', 'N
o',
       'No', 'Yes', 'Yes', 'No', 'No', 'Yes', 'No', 'No', 'No', 'No',
       'No', 'No', 'No', 'Yes', 'Yes', 'No', 'No', 'No', 'No', 'No',
'No',
       'No', 'No', 'No', 'No', 'No', 'No', 'No', 'No', 'No', 'No', 'Ye
s',
       'No', 'No', 'No', 'No', 'No', 'No', 'No', 'Yes', 'No', 'Yes',
'No',
       'No', 'No', 'No', 'No', 'No', 'No', 'No', 'No', 'Yes', 'No', 'Y
es',
       'No', 'No', 'Yes', 'No', 'No', 'Yes', 'No', 'No', 'No', 'No',
'No',
       'No', 'No', 'No'], dtype=object)
```

In [45]:

```
y_test
```

Out[45]:

```
array([0, 0, 1, 0, 1, 0, 1, 0, 0, 1, 0, 1, 0, 1, 0, 0, 0, 1, 0, 0, 0,
0,
       0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 1, 0, 0, 0, 0,
0,
       0, 1, 0, 0, 1, 1, 0, 1, 0, 0, 1, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0,
0,
       1, 1, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0,
0,
       0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 1, 0, 0, 0, 0, 0, 0, 0,
0,
       0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0,
1,
       1, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 1, 0, 0, 0, 0,
1,
       0, 0, 0, 0, 0, 0, 1, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 1,
0,
       0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 1, 0, 0, 1, 0, 0, 0, 0, 0,
0,
       1, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 1, 0, 0, 0, 0,
0,
       0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1,
0,
       0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 1, 0, 1, 0, 0, 0,
0,
       0, 0, 0, 1, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0,
0,
       0, 1, 0, 0, 0, 1, 0, 0])
```

In [46]:

```
df
```

Out[46]:

	Age	Attrition	BusinessTravel	DailyRate	Department	DistanceFromHome	Education	Ec
0	41	Yes	Travel_Rarely	1102	Sales	1	2	
1	49	No	Travel_Frequently	279	Research & Development	8	1	
2	37	Yes	Travel_Rarely	1373	Research & Development	2	2	
3	33	No	Travel_Frequently	1392	Research & Development	3	4	
4	27	No	Travel_Rarely	591	Research & Development	2	1	
...	...	...	...	...	...	...	...	
1465	36	No	Travel_Frequently	884	Research & Development	23	2	
1466	39	No	Travel_Rarely	613	Research & Development	6	1	
1467	27	No	Travel_Rarely	155	Research & Development	4	3	
1468	49	No	Travel_Frequently	1023	Sales	2	3	
1469	34	No	Travel_Rarely	628	Research & Development	8	3	

1470 rows × 35 columns

Evaluation of classification model

In [47]:

```
#Accuracy score
from sklearn.metrics import accuracy_score,confusion_matrix,classification_report,rc
```

In [48]:

```
#label encoding
from sklearn.preprocessing import LabelEncoder
le=LabelEncoder()
y=le.fit_transform(y)
#label encoding
from sklearn.preprocessing import LabelEncoder
le=LabelEncoder()
pred=le.fit_transform(pred)
```

In [49]:

```
accuracy_score(y_test,pred)
```

Out[49]:

```
0.7721088435374149
```

In [50]:

```
confusion_matrix(y_test,pred)
```

Out[50]:

```
array([[211,  34],
       [ 33,  16]])
```

In [51]:

```
pd.crosstab(y_test,pred)
```

Out[51]:

col_0	0	1
row_0		
0	211	34
1	33	16

In [52]:

```
print(classification_report(y_test,pred))
```

```
              precision    recall  f1-score   support

           0       0.86      0.86      0.86       245
           1       0.32      0.33      0.32        49

    accuracy                           0.77       294
   macro avg       0.59      0.59      0.59       294
weighted avg       0.77      0.77      0.77       294
```

Roc-AUC curve

In [53]:

```
probability=dtc.predict_proba(x_test)[:,1]
```

In [54]:

```
probability
```

Out[54]:

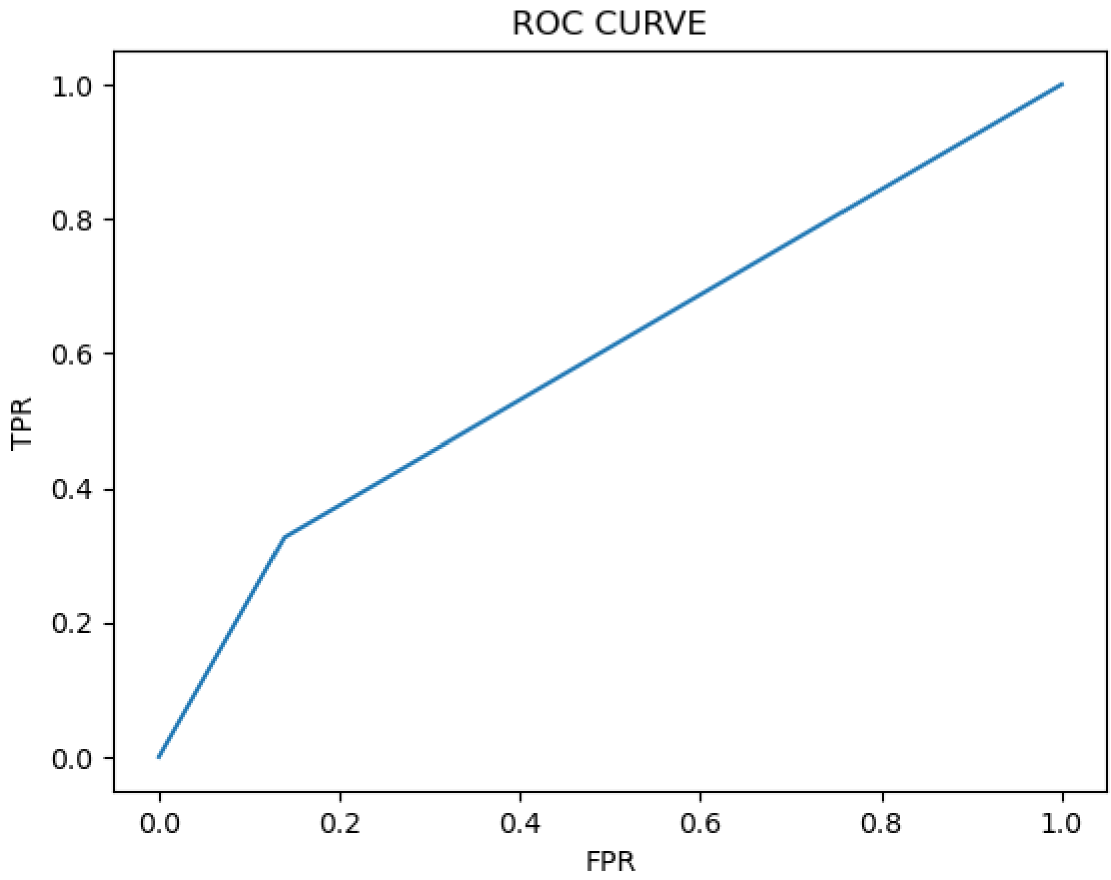
```
array([0., 0., 0., 0., 1., 0., 1., 0., 0., 0., 0., 0., 0., 1., 0., 0.,
0.,
       0., 0., 0., 1., 0., 0., 0., 1., 0., 0., 0., 0., 0., 0., 0., 0.,
0.,
       0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 1., 0.,
1.,
       1., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 1., 0., 1., 0., 0.,
0.,
       0., 0., 0., 1., 0., 0., 0., 1., 1., 0., 0., 0., 1., 0., 0., 0.,
0.,
       0., 1., 0., 0., 0., 0., 0., 0., 1., 0., 0., 0., 0., 0., 0., 0.,
0.,
       1., 0., 0., 0., 0., 0., 0., 0., 0., 1., 0., 0., 0., 0., 0., 0.,
0.,
       0., 0., 0., 0., 1., 1., 0., 0., 0., 0., 0., 0., 1., 1., 1., 0.,
0.,
       0., 0., 1., 0., 0., 0., 1., 0., 0., 0., 0., 1., 0., 0., 0., 0.,
0.,
       0., 0., 0., 0., 0., 0., 0., 1., 0., 0., 0., 0., 0., 0., 0., 0.,
0.,
       0., 0., 0., 0., 0., 1., 0., 1., 1., 0., 0., 0., 0., 1., 0., 0.,
1.,
       0., 0., 1., 0., 1., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 1.,
0.,
       1., 0., 0., 1., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0.,
0.,
       0., 1., 0., 0., 0., 0., 1., 1., 0., 0., 1., 0., 0., 0., 0., 0.,
0.,
       0., 1., 1., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0.,
0.,
       0., 0., 1., 0., 0., 0., 0., 0., 0., 0., 1., 0., 1., 0., 0., 0.,
0.,
       0., 0., 0., 0., 0., 1., 0., 1., 0., 0., 1., 0., 0., 1., 0., 0.,
0.,
       0., 0., 0., 0., 0.])
```

In [55]:

```
fpr,tpr,thresholds =  roc_curve(y_test,probability)
```

In [56]:

```
plt.plot(fpr,tpr)
plt.xlabel('FPR')
plt.ylabel('TPR')
plt.title('ROC CURVE')
plt.show()
```



In [57]:

```
from sklearn import tree
plt.figure(figsize=(25,15))
tree.plot_tree(dtc,filled=True)
```

Out[57]:

```
[Text(0.33072029386712093, 0.9722222222222222, 'x[27] <= 0.038\ngini =
0.269\nsamples = 1176\nvalue = [988, 188]'),
 Text(0.0817717206132879, 0.9166666666666666, 'x[16] <= 0.75\ngini =
0.5\nsamples = 78\nvalue = [39, 39]'),
 Text(0.05110732538330494, 0.8611111111111112, 'x[4] <= 0.554\ngini =
0.426\nsamples = 39\nvalue = [27, 12]'),
 Text(0.034071550255536626, 0.8055555555555556, 'x[15] <= 0.167\ngini
= 0.312\nsamples = 31\nvalue = [25, 6]'),
 Text(0.020442930153321975, 0.75, 'x[21] <= 0.5\ngini = 0.49\nsamples
= 7\nvalue = [3, 4]'),
 Text(0.013628620102214651, 0.6944444444444444, 'x[16] <= 0.25\ngini =
0.375\nsamples = 4\nvalue = [3, 1]'),
 Text(0.0068143100511073255, 0.6388888888888888, 'gini = 0.0\nsamples
= 3\nvalue = [3, 0]'),
 Text(0.020442930153321975, 0.6388888888888888, 'gini = 0.0\nsamples =
1\nvalue = [0, 1]'),
 Text(0.027257240204429302, 0.6944444444444444, 'gini = 0.0\nsamples =
3\nvalue = [0, 3]'),
```

In [58]:

```
from sklearn.model_selection import GridSearchCV
parameter={
 'criterion':['gini','entropy'],
  'splitter':['best','random'],
  'max_depth':[1,2,3,4,5],
  'max_features':['auto', 'sqrt', 'log2']

}
```

In [59]:

```
grid_search=GridSearchCV(estimator=dtc,param_grid=parameter,cv=5,scoring="accuracy")
```

In [60]:

```
grid_search.fit(x_train,y_train)
```

```
/Users/taaran/anaconda3/lib/python3.11/site-packages/sklearn/model_sel
ection/_validation.py:425: FitFailedWarning:
100 fits failed out of a total of 300.
The score on these train-test partitions for these parameters will be
set to nan.
If these failures are not expected, you can try to debug them by setti
ng error_score='raise'.

Below are more details about the failures:
-----------------------------------------------------------------------
----------
100 fits failed with the following error:
Traceback (most recent call last):
  File "/Users/taaran/anaconda3/lib/python3.11/site-packages/sklearn/m
odel_selection/_validation.py", line 732, in _fit_and_score
    estimator.fit(X_train, y_train, **fit_params)
  File "/Users/taaran/anaconda3/lib/python3.11/site-packages/sklearn/b
ase.py", line 1144, in wrapper
    estimator._validate_params()
  File "/Users/taaran/anaconda3/lib/python3.11/site-packages/sklearn/b
ase.py", line 637, in _validate_params
    validate_parameter_constraints(
  File "/Users/taaran/anaconda3/lib/python3.11/site-packages/sklearn/u
tils/_param_validation.py", line 95, in validate_parameter_constraints
    raise InvalidParameterError(
sklearn.utils._param_validation.InvalidParameterError: The 'max_featur
es' parameter of DecisionTreeClassifier must be an int in the range
[1, inf), a float in the range (0.0, 1.0], a str among {'log2', 'sqr
t'} or None. Got 'auto' instead.

  warnings.warn(some_fits_failed_message, FitFailedWarning)
/Users/taaran/anaconda3/lib/python3.11/site-packages/sklearn/model_sel
ection/_search.py:976: UserWarning: One or more of the test scores are
non-finite: [       nan        nan 0.84013704 0.84013704 0.84013704 0.
84013704
        nan        nan 0.8384313  0.83843491 0.82311576 0.84013704
        nan        nan 0.84437793 0.83928597 0.8452326  0.83758745
        nan        nan 0.83759106 0.84183916 0.83161558 0.83928237
        nan        nan 0.84608006 0.83673278 0.83163    0.84354129
        nan        nan 0.84013704 0.84013704 0.84013704 0.84013704
        nan        nan 0.83759466 0.84013704 0.83674721 0.84013704
        nan        nan 0.84267941 0.84013704 0.83841688 0.83928597
        nan        nan 0.83588532 0.84183916 0.84012261 0.83589975
        nan        nan 0.82824739 0.83589254 0.82483231 0.83843491]
  warnings.warn(
```

Out[60]:

```
▸           GridSearchCV
▸ estimator: DecisionTreeClassifier
      ▸ DecisionTreeClassifier
```

In [61]:

```
grid_search.best_params_
```

Out[61]:

```
{'criterion': 'gini',
 'max_depth': 5,
 'max_features': 'sqrt',
 'splitter': 'best'}
```

In [62]:

```
dtc_cv=DecisionTreeClassifier(criterion= 'entropy',
 max_depth=3,
 max_features='sqrt',
 splitter='best')
dtc_cv.fit(x_train,y_train)
```

Out[62]:

```
▾                        DecisionTreeClassifier
DecisionTreeClassifier(criterion='entropy', max_depth=3, max_features
='sqrt')
```

In [63]:

```
pred=dtc_cv.predict(x_test)
```

In [64]:

```
#label encoding
from sklearn.preprocessing import LabelEncoder
le=LabelEncoder()
y=le.fit_transform(y)
#label encoding
from sklearn.preprocessing import LabelEncoder
le=LabelEncoder()
pred=le.fit_transform(pred)
```

In [65]:

```
print(classification_report(y_test,pred))
```

```
              precision    recall  f1-score   support

           0       0.84      1.00      0.91       245
           1       1.00      0.04      0.08        49

    accuracy                           0.84       294
   macro avg       0.92      0.52      0.50       294
weighted avg       0.87      0.84      0.77       294
```

RandomForestClassifier

In [66]:

```
from sklearn.ensemble import RandomForestClassifier
rfc=RandomForestClassifier()
```

In [67]:

```
forest_params = [{'max_depth': list(range(10, 15)), 'max_features': list(range(0,14)
```

In [68]:

```
rfc_cv= GridSearchCV(rfc,param_grid=forest_params,cv=10,scoring="accuracy")
```

In [ ]:

```
rfc_cv.fit(x_train,y_train)
```

In [ ]:

```
pred=rfc_cv.predict(x_test)
```

In [ ]:

```
#label encoding
from sklearn.preprocessing import LabelEncoder
le=LabelEncoder()
y=le.fit_transform(y)
#label encoding
from sklearn.preprocessing import LabelEncoder
le=LabelEncoder()
pred=le.fit_transform(pred)
```

In [ ]:

```
print(classification_report(y_test,pred))
```

In [ ]:

```
rfc_cv.best_params_
```