In [1]:

```
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt,seaborn as sns
```

In [2]:

```
train_df=pd.read_csv(r"C:\Users\yasoda\Documents\202U1A05C1\Mobile_Price_Classification_test.csv")
train_df
```

Out[2]:

	id	battery_power	blue	clock_speed	dual_sim	fc	four_g	int_memory	m_dep	mobile_wt	...	pc	px_height	px_width	ram	sc_h	sc
0	1	1043	1	1.8	1	14	0	5	0.1	193	...	16	226	1412	3476	12	
1	2	841	1	0.5	1	4	1	61	0.8	191	...	12	746	857	3895	6	
2	3	1807	1	2.8	0	1	0	27	0.9	186	...	4	1270	1366	2396	17	
3	4	1546	0	0.5	1	18	1	25	0.5	96	...	20	295	1752	3893	10	
4	5	1434	0	1.4	0	11	1	49	0.5	108	...	18	749	810	1773	15	
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
995	996	1700	1	1.9	0	0	1	54	0.5	170	...	17	644	913	2121	14	
996	997	609	0	1.8	1	0	0	13	0.9	186	...	2	1152	1632	1933	8	
997	998	1185	0	1.4	0	1	1	8	0.5	80	...	12	477	825	1223	5	
998	999	1533	1	0.5	1	0	0	50	0.4	171	...	12	38	832	2509	15	
999	1000	1270	1	0.5	0	4	1	35	0.1	140	...	19	457	608	2828	9	

1000 rows × 21 columns

In [3]:
```
test_df=pd.read_csv(r"C:\Users\yasoda\Documents\202U1A05C1\Mobile_Price_Classification_train.csv")
test_df
```

Out[3]:
```
      battery_power  blue  clock_speed  dual_sim  fc  four_g  int_memory  m_dep  mobile_wt  n_cores  ...  px_height  px_width   ram  sc_h  sc_
   0            842     0          2.2         0   1       0           7    0.6        188        2  ...         20       756  2549     9
   1           1021     1          0.5         1   0       1          53    0.7        136        3  ...        905      1988  2631    17
   2            563     1          0.5         1   2       1          41    0.9        145        5  ...       1263      1716  2603    11
   3            615     1          2.5         0   0       0          10    0.8        131        6  ...       1216      1786  2769    16
   4           1821     1          1.2         0  13       1          44    0.6        141        2  ...       1208      1212  1411     8
 ...            ...   ...          ...       ...  ...    ...         ...    ...        ...      ...  ...        ...       ...   ...   ...
1995            794     1          0.5         1   0       1           2    0.8        106        6  ...       1222      1890   668    13
1996           1965     1          2.6         1   0       0          39    0.2        187        4  ...        915      1965  2032    11
1997           1911     0          0.9         1   1       1          36    0.7        108        8  ...        868      1632  3057     9
1998           1512     0          0.9         0   4       1          46    0.1        145        5  ...        336       670   869    18
1999            510     1          2.0         1   5       1          45    0.9        168        6  ...        483       754  3919    19

2000 rows × 21 columns
```

In [4]:

```
train_df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 1000 entries, 0 to 999
Data columns (total 21 columns):
 #   Column         Non-Null Count  Dtype  
---  ------         --------------  -----  
 0   id             1000 non-null   int64  
 1   battery_power  1000 non-null   int64  
 2   blue           1000 non-null   int64  
 3   clock_speed    1000 non-null   float64
 4   dual_sim       1000 non-null   int64  
 5   fc             1000 non-null   int64  
 6   four_g         1000 non-null   int64  
 7   int_memory     1000 non-null   int64  
 8   m_dep          1000 non-null   float64
 9   mobile_wt      1000 non-null   int64  
 10  n_cores        1000 non-null   int64  
 11  pc             1000 non-null   int64  
 12  px_height      1000 non-null   int64  
 13  px_width       1000 non-null   int64  
 14  ram            1000 non-null   int64  
 15  sc_h           1000 non-null   int64  
 16  sc_w           1000 non-null   int64  
 17  talk_time      1000 non-null   int64  
 18  three_g        1000 non-null   int64  
 19  touch_screen   1000 non-null   int64  
 20  wifi           1000 non-null   int64  
dtypes: float64(2), int64(19)
memory usage: 164.2 KB
```

In [5]:

```
test_df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 2000 entries, 0 to 1999
Data columns (total 21 columns):
 #   Column         Non-Null Count  Dtype  
---  ------         --------------  -----  
 0   battery_power  2000 non-null   int64  
 1   blue           2000 non-null   int64  
 2   clock_speed    2000 non-null   float64
 3   dual_sim       2000 non-null   int64  
 4   fc             2000 non-null   int64  
 5   four_g         2000 non-null   int64  
 6   int_memory     2000 non-null   int64  
 7   m_dep          2000 non-null   float64
 8   mobile_wt      2000 non-null   int64  
 9   n_cores        2000 non-null   int64  
 10  pc             2000 non-null   int64  
 11  px_height      2000 non-null   int64  
 12  px_width       2000 non-null   int64  
 13  ram            2000 non-null   int64  
 14  sc_h           2000 non-null   int64  
 15  sc_w           2000 non-null   int64  
 16  talk_time      2000 non-null   int64  
 17  three_g        2000 non-null   int64  
 18  touch_screen   2000 non-null   int64  
 19  wifi           2000 non-null   int64  
 20  price_range    2000 non-null   int64  
dtypes: float64(2), int64(19)
memory usage: 328.2 KB
```

In [6]:

```
x=train_df.drop('wifi',axis=1)
y=train_df['wifi']
```

In [7]:

```
x=test_df.drop('wifi',axis=1)
y=test_df['wifi']
```

In [8]:

```
train_df['dual_sim'].value_counts()
```

Out[8]:

```
dual_sim
1    517
0    483
Name: count, dtype: int64
```

In [9]:

```
test_df['blue'].value_counts()
```

Out[9]:

```
blue
0    1010
1     990
Name: count, dtype: int64
```

In [10]:

```
T={"Home Owner":{"Yes":1,"No":0}}
train_df=train_df.replace(T)
print(train_df)
```

```
       id  battery_power  blue  clock_speed  dual_sim  fc  four_g  int_memory  \
0       1           1043     1          1.8         1  14       0           5   
1       2            841     1          0.5         1   4       1          61   
2       3           1807     1          2.8         0   1       0          27   
3       4           1546     0          0.5         1  18       1          25   
4       5           1434     0          1.4         0  11       1          49   
..    ...            ...   ...          ...       ...  ..     ...         ...   
995   996           1700     1          1.9         0   0       1          54   
996   997            609     0          1.8         1   0       0          13   
997   998           1185     0          1.4         0   1       1           8   
998   999           1533     1          0.5         1   0       0          50   
999  1000           1270     1          0.5         0   4       1          35   

     m_dep  mobile_wt  ...  pc  px_height  px_width   ram  sc_h  sc_w  \
0      0.1        193  ...  16        226      1412  3476    12     7   
1      0.8        191  ...  12        746       857  3895     6     0   
2      0.9        186  ...   4       1270      1366  2396    17    10   
3      0.5         96  ...  20        295      1752  3893    10     0   
4      0.5        108  ...  18        749       810  1773    15     8   
..     ...        ...  ...  ..        ...       ...   ...   ...   ...   
995    0.5        170  ...  17        644       913  2121    14     8   
996    0.9        186  ...   2       1152      1632  1933     8     1   
997    0.5         80  ...  12        477       825  1223     5     0   
998    0.4        171  ...  12         38       832  2509    15    11   
999    0.1        140  ...  19        457       608  2828     9     2   

     talk_time  three_g  touch_screen  wifi  
0            2        0             1     0  
1            7        1             0     0  
2           10        0             1     1  
3            7        1             1     0  
4            7        1             0     1  
..         ...      ...           ...   ...  
995         15        1             1     0  
996         19        0             1     1  
997         14        1             0     0  
998          6        0             1     0  
999          3        1             0     1  

[1000 rows x 21 columns]
```

In [11]:

```
T={"Home Owner":{"Yes":1,"No":0}}
train_df=train_df.replace(T)
print(train_df)
```

```
       id  battery_power  blue  clock_speed  dual_sim  fc  four_g  int_memory  
0       1           1043     1          1.8         1  14       0           5  \
1       2            841     1          0.5         1   4       1          61   
2       3           1807     1          2.8         0   1       0          27   
3       4           1546     0          0.5         1  18       1          25   
4       5           1434     0          1.4         0  11       1          49   
..    ...            ...   ...          ...       ...  ..     ...         ...   
995   996           1700     1          1.9         0   0       1          54   
996   997            609     0          1.8         1   0       0          13   
997   998           1185     0          1.4         0   1       1           8   
998   999           1533     1          0.5         1   0       0          50   
999  1000           1270     1          0.5         0   4       1          35   

     m_dep  mobile_wt  ...  pc  px_height  px_width   ram  sc_h  sc_w  
0      0.1        193  ...  16        226      1412  3476    12     7  \
1      0.8        191  ...  12        746       857  3895     6     0   
2      0.9        186  ...   4       1270      1366  2396    17    10   
3      0.5         96  ...  20        295      1752  3893    10     0   
4      0.5        108  ...  18        749       810  1773    15     8   
..     ...        ...  ...  ..        ...       ...   ...   ...   ...   
995    0.5        170  ...  17        644       913  2121    14     8   
996    0.9        186  ...   2       1152      1632  1933     8     1   
997    0.5         80  ...  12        477       825  1223     5     0   
998    0.4        171  ...  12         38       832  2509    15    11   
999    0.1        140  ...  19        457       608  2828     9     2   

     talk_time  three_g  touch_screen  wifi  
0            2        0             1     0  
1            7        1             0     0  
2           10        0             1     1  
3            7        1             1     0  
4            7        1             0     1  
..         ...      ...           ...   ...  
995         15        1             1     0  
996         19        0             1     1  
997         14        1             0     0  
998          6        0             1     0  
999          3        1             0     1  

[1000 rows x 21 columns]
```

In [12]:

```
T={"Home Owner":{"Yes":1,"No":0}}
test_df=test_df.replace(T)
print(test_df)
```

```
      battery_power  blue  clock_speed  dual_sim  fc  four_g  int_memory  
0               842     0          2.2         0   1       0           7  \
1              1021     1          0.5         1   0       1          53   
2               563     1          0.5         1   2       1          41   
3               615     1          2.5         0   0       0          10   
4              1821     1          1.2         0  13       1          44   
...             ...   ...          ...       ...  ..     ...         ...   
1995            794     1          0.5         1   0       1           2   
1996           1965     1          2.6         1   0       0          39   
1997           1911     0          0.9         1   1       1          36   
1998           1512     0          0.9         0   4       1          46   
1999            510     1          2.0         1   5       1          45   

      m_dep  mobile_wt  n_cores  ...  px_height  px_width   ram  sc_h  sc_w  
0       0.6        188        2  ...         20       756  2549     9     7  \
1       0.7        136        3  ...        905      1988  2631    17     3   
2       0.9        145        5  ...       1263      1716  2603    11     2   
3       0.8        131        6  ...       1216      1786  2769    16     8   
4       0.6        141        2  ...       1208      1212  1411     8     2   
...     ...        ...      ...  ...        ...       ...   ...   ...   ...   
1995    0.8        106        6  ...       1222      1890   668    13     4   
1996    0.2        187        4  ...        915      1965  2032    11    10   
1997    0.7        108        8  ...        868      1632  3057     9     1   
1998    0.1        145        5  ...        336       670   869    18    10   
1999    0.9        168        6  ...        483       754  3919    19     4   

      talk_time  three_g  touch_screen  wifi  price_range  
0            19        0             0     1            1  
1             7        1             1     0            2  
2             9        1             1     0            2  
3            11        1             0     0            2  
4            15        1             1     0            1  
...         ...      ...           ...   ...          ...  
1995         19        1             1     0            0  
1996         16        1             1     1            2  
1997          5        1             1     0            3  
1998         19        1             1     1            0  
1999          2        1             1     1            3  

[2000 rows x 21 columns]
```

```
In [13]: x=train_df.drop('wifi',axis=1)
         y=train_df['wifi']
```

```
In [14]: x=test_df.drop('wifi',axis=1)
         y=test_df['wifi']
```

```
In [15]: from sklearn.model_selection import train_test_split
         x_train,x_test,y_train,y_test = train_test_split(x,y,train_size=0.7,random_state=42)
         x_train.shape,x_test.shape

Out[15]: ((1400, 20), (600, 20))
```

```
In [16]: from sklearn.ensemble import RandomForestClassifier
         rfc = RandomForestClassifier()
         rfc.fit(x_train,y_train)

Out[16]: ▾ RandomForestClassifier

         RandomForestClassifier()
```

In a Jupyter Environment ,please rerun this cell to show the HTML representation

```
In [17]: rf = RandomForestClassifier()
```

```
In [18]: params = {'max_depth': [2,3,5,10,20],
         'min_samples_leaf': [5,10,20,50,100,200],
         'n_estimators': [10,25,30,50,100,200]}
```

In [19]:

```
from sklearn.model_selection import GridSearchCV
grid_search = GridSearchCV(estimator=rf,param_grid=params,cv = 2, scoring='accuracy')
grid_search.fit(x_train,y_train)
```

Out[19]:

```
▸ GridSearchCV
▸ estimator: RandomForestClassifier
    ▸ RandomForestClassifier
```

In a Jupyter Environment,please rerun this cell to show the HTML representation

In [20]:

```
grid_search.best_score_
```

Out[20]:

```
0.5228571428571429
```

In [21]:

```
rf_best = grid_search.best_estimator_
print(rf_best)
```

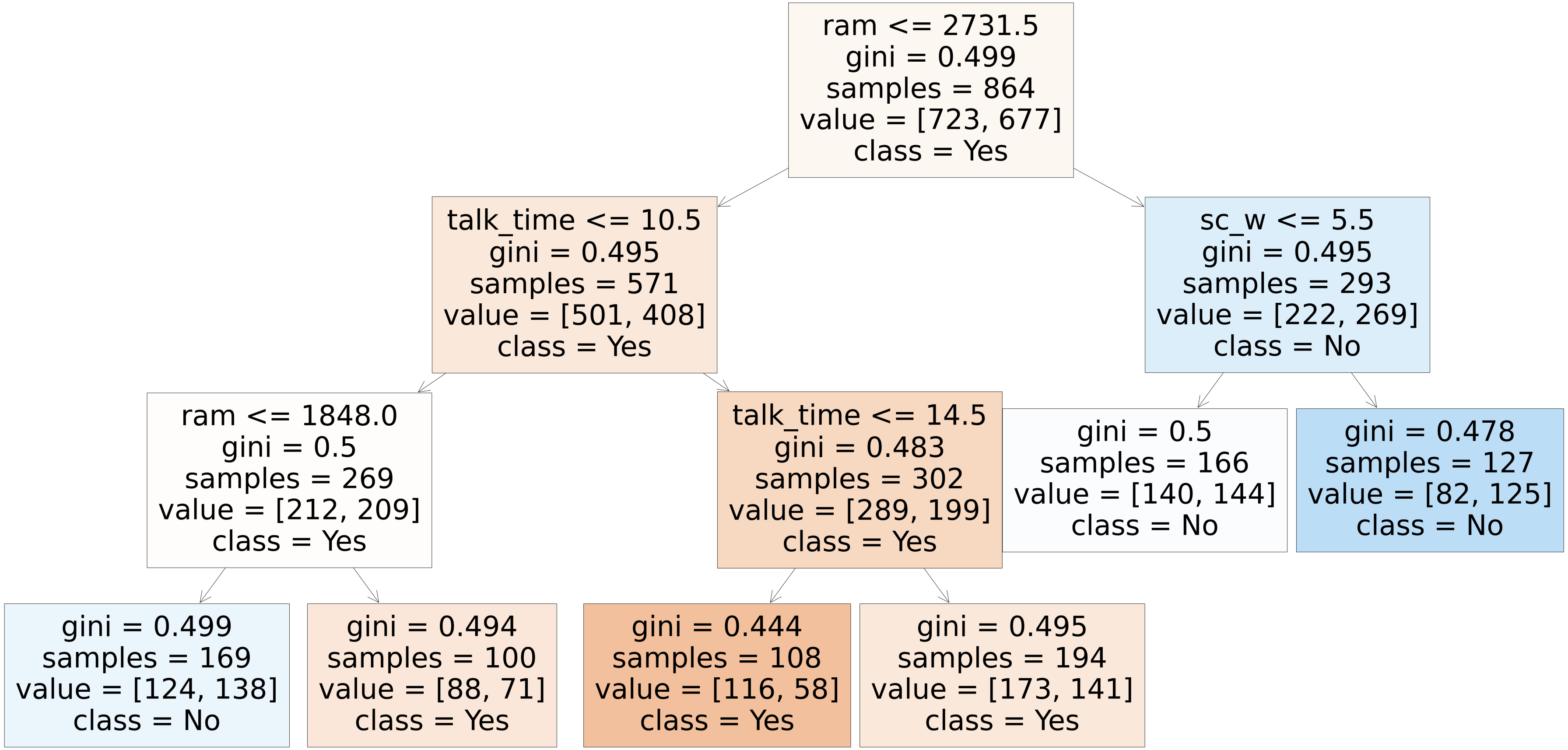
```
RandomForestClassifier(max_depth=5, min_samples_leaf=100, n_estimators=50)
```

In [22]:

```
from sklearn.tree import plot_tree
plt.figure(figsize=(80,40))
plot_tree(rf_best.estimators_[5], feature_names = x.columns,class_names=['Yes',"No"],filled=True)
```

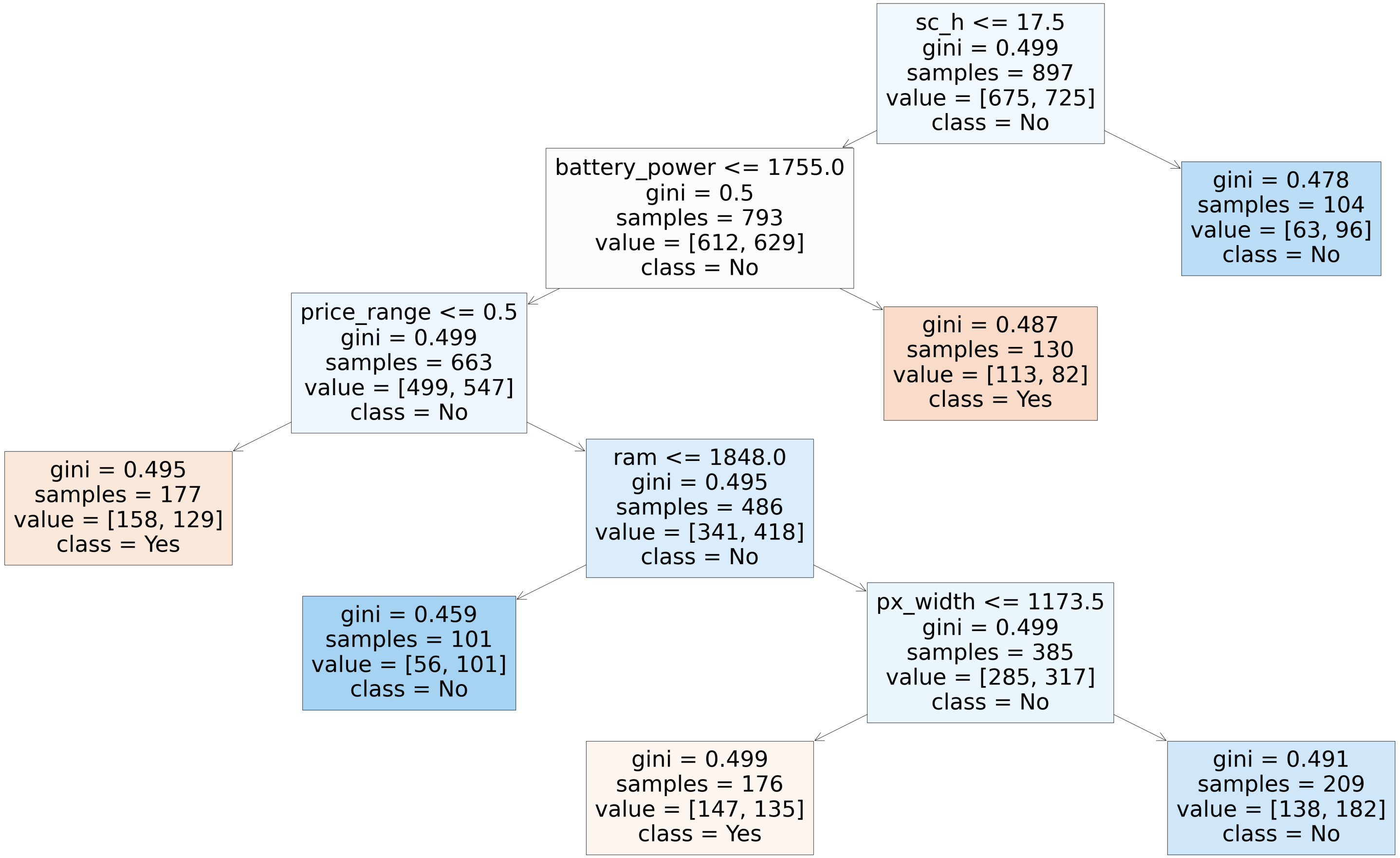
Out[22]:

```
[Text(0.5909090909090909, 0.875, 'ram <= 2731.5\ngini = 0.499\nsamples = 864\nvalue = [723, 677]\nclass = Yes'),
 Text(0.36363636363636365, 0.625, 'talk_time <= 10.5\ngini = 0.495\nsamples = 571\nvalue = [501, 408]\nclass = Ye
s'),
 Text(0.18181818181818182, 0.375, 'ram <= 1848.0\ngini = 0.5\nsamples = 269\nvalue = [212, 209]\nclass = Yes'),
 Text(0.09090909090909091, 0.125, 'gini = 0.499\nsamples = 169\nvalue = [124, 138]\nclass = No'),
 Text(0.2727272727272727, 0.125, 'gini = 0.494\nsamples = 100\nvalue = [88, 71]\nclass = Yes'),
 Text(0.5454545454545454, 0.375, 'talk_time <= 14.5\ngini = 0.483\nsamples = 302\nvalue = [289, 199]\nclass = Yes'),
 Text(0.45454545454545453, 0.125, 'gini = 0.444\nsamples = 108\nvalue = [116, 58]\nclass = Yes'),
 Text(0.6363636363636364, 0.125, 'gini = 0.495\nsamples = 194\nvalue = [173, 141]\nclass = Yes'),
 Text(0.8181818181818182, 0.625, 'sc_w <= 5.5\ngini = 0.495\nsamples = 293\nvalue = [222, 269]\nclass = No'),
 Text(0.7272727272727273, 0.375, 'gini = 0.5\nsamples = 166\nvalue = [140, 144]\nclass = No'),
 Text(0.9090909090909091, 0.375, 'gini = 0.478\nsamples = 127\nvalue = [82, 125]\nclass = No')]
```


ram <= 2731.5
gini = 0.499
samples = 864
value = [723, 677]
class = Yes
talk_time <= 10.5
gini = 0.495
samples = 571
value = [501, 408]
class = Yes
sc_w <= 5.5
gini = 0.495
samples = 293
value = [222, 269]
class = No
ram <= 1848.0
gini = 0.5
samples = 269
value = [212, 209]
class = Yes
talk_time <= 14.5
gini = 0.483
samples = 302
value = [289, 199]
class = Yes
gini = 0.5
samples = 166
value = [140, 144]
class = No
gini = 0.478
samples = 127
value = [82, 125]
class = No
gini = 0.499
samples = 169
value = [124, 138]
class = No
gini = 0.494
samples = 100
value = [88, 71]
class = Yes
gini = 0.444
samples = 108
value = [116, 58]
class = Yes
gini = 0.495
samples = 194
value = [173, 141]
class = Yes

In [23]:
```
from sklearn.tree import plot_tree
plt.figure(figsize=(80,40))
plot_tree(rf_best.estimators_[7],feature_names=x.columns,class_names=["Yes","No"],filled=True)
```

Out[23]:
```
[Text(0.6666666666666666, 0.9166666666666666, 'sc_h <= 17.5\ngini = 0.499\nsamples = 897\nvalue = [675, 725]\nclass
= No'),
 Text(0.5, 0.75, 'battery_power <= 1755.0\ngini = 0.5\nsamples = 793\nvalue = [612, 629]\nclass = No'),
 Text(0.3333333333333333, 0.5833333333333334, 'price_range <= 0.5\ngini = 0.499\nsamples = 663\nvalue = [499, 547]\n
class = No'),
 Text(0.16666666666666666, 0.4166666666666667, 'gini = 0.495\nsamples = 177\nvalue = [158, 129]\nclass = Yes'),
 Text(0.5, 0.4166666666666667, 'ram <= 1848.0\ngini = 0.495\nsamples = 486\nvalue = [341, 418]\nclass = No'),
 Text(0.3333333333333333, 0.25, 'gini = 0.459\nsamples = 101\nvalue = [56, 101]\nclass = No'),
 Text(0.6666666666666666, 0.25, 'px_width <= 1173.5\ngini = 0.499\nsamples = 385\nvalue = [285, 317]\nclass = No'),
 Text(0.5, 0.08333333333333333, 'gini = 0.499\nsamples = 176\nvalue = [147, 135]\nclass = Yes'),
 Text(0.8333333333333334, 0.08333333333333333, 'gini = 0.491\nsamples = 209\nvalue = [138, 182]\nclass = No'),
 Text(0.6666666666666666, 0.5833333333333334, 'gini = 0.487\nsamples = 130\nvalue = [113, 82]\nclass = Yes'),
 Text(0.8333333333333334, 0.75, 'gini = 0.478\nsamples = 104\nvalue = [63, 96]\nclass = No')]
```



In [24]:

```
rf_best.feature_importances_
```

Out[24]:

```
array([0.07717307, 0.00879   , 0.04434522, 0.01953574, 0.03032118,
       0.01928442, 0.08756478, 0.03099338, 0.05000981, 0.02300338,
       0.06283458, 0.16018601, 0.07803434, 0.06519901, 0.05008368,
       0.04774743, 0.10287966, 0.00509412, 0.00930888, 0.02761129])
```

In [25]:
```
imp_df = pd.DataFrame({"Vername": x_train.columns,"Imp": rf_best.feature_importances_})
imp_df.sort_values(by="Imp", ascending=False)
```

Out[25]:
```
          Vername       Imp
11      px_height  0.160186
16      talk_time  0.102880
 6     int_memory  0.087565
12       px_width  0.078034
 0  battery_power  0.077173
13            ram  0.065199
10             pc  0.062835
14           sc_h  0.050084
 8      mobile_wt  0.050010
15           sc_w  0.047747
 2    clock_speed  0.044345
 7          m_dep  0.030993
 4             fc  0.030321
19    price_range  0.027611
 9        n_cores  0.023003
 3       dual_sim  0.019536
 5         four_g  0.019284
18   touch_screen  0.009309
 1           blue  0.008790
17        three_g  0.005094
```