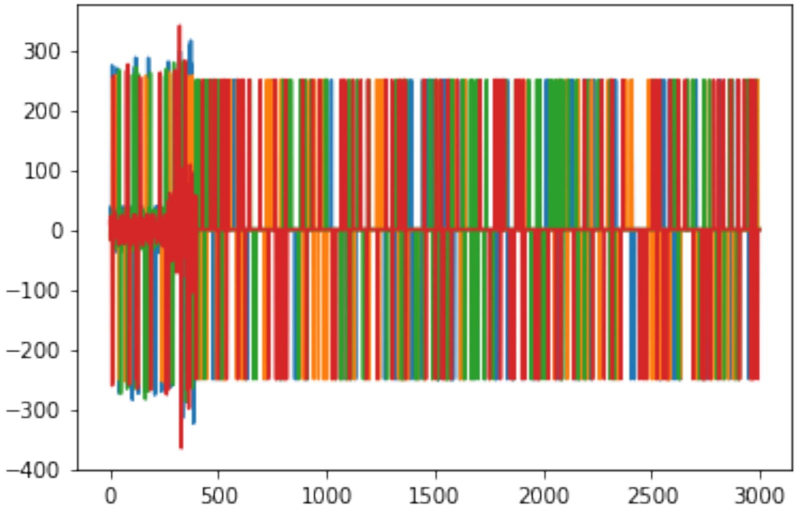
Data Preparation

In [1]:

```
# To help you get started...
from IPython.display import display
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
import datetime as dt
from scipy import stats
import math
%matplotlib inline
```

In [2]:

```
df = pd.read_csv(r'C:\Users\srika\OneDrive\Desktop\Spring20\Tagup\exam
plt.plot(range(len(df)), df)
plt.show()
```



Reframing Dataframe in understandable way

In [3]:

```
df['Date_created']=df.index
```

In [4]:

```
df=df.reset_index(drop=True)
```

In [5]:

```
df.rename(columns={'0':'sensor1',
                         '1':'sensor2',
                         '2':'sensor3','3':'sensor4'},inplace=True)
```

In [6]:

```
df.head()
```

Out[6]:

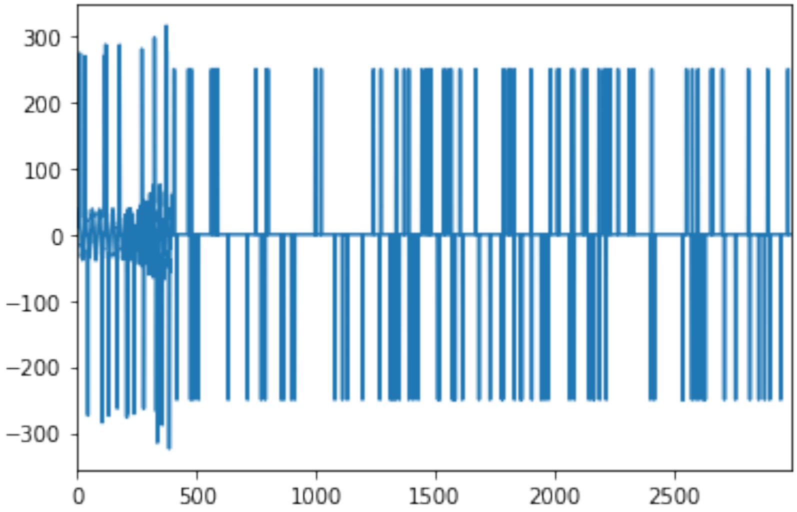
	sensor1	sensor2	sensor3	sensor4	Date_created
0	12.626096	8.803120	-11.809200	10.083961	2019-01-01 00:00:00.000000000
1	10.831994	2.816327	11.554778	21.892853	2019-01-01 08:00:09.603201067
2	21.083510	-0.672645	-17.839178	-1.349024	2019-01-01 16:00:19.206402134
3	32.294495	6.525132	-13.498586	-4.250752	2019-01-02 00:00:28.809603201
4	28.057100	3.691359	21.984744	13.670561	2019-01-02 08:00:38.412804268

In [7]:

```
df['sensor1'].plot()
```

Out[7]:

```
<matplotlib.axes._subplots.AxesSubplot at 0x1bac4d5f7b8>
```



In [8]:

```
cols = list(df.columns)
cols = [cols[-1]] + cols[:-1]
df = df[cols]
```

In [9]:

```
df.head()
```

Out[9]:

	Date_created	sensor1	sensor2	sensor3	sensor4
0	2019-01-01 00:00:00.000000000	12.626096	8.803120	-11.809200	10.083961
1	2019-01-01 08:00:09.603201067	10.831994	2.816327	11.554778	21.892853
2	2019-01-01 16:00:19.206402134	21.083510	-0.672645	-17.839178	-1.349024
3	2019-01-02 00:00:28.809603201	32.294495	6.525132	-13.498586	-4.250752
4	2019-01-02 08:00:38.412804268	28.057100	3.691359	21.984744	13.670561

Creating new features dependent on Date_created

In [10]:

```
df.head()
```

Out[10]:

	Date_created	sensor1	sensor2	sensor3	sensor4
0	2019-01-01 00:00:00.000000000	12.626096	8.803120	-11.809200	10.083961
1	2019-01-01 08:00:09.603201067	10.831994	2.816327	11.554778	21.892853
2	2019-01-01 16:00:19.206402134	21.083510	-0.672645	-17.839178	-1.349024
3	2019-01-02 00:00:28.809603201	32.294495	6.525132	-13.498586	-4.250752
4	2019-01-02 08:00:38.412804268	28.057100	3.691359	21.984744	13.670561

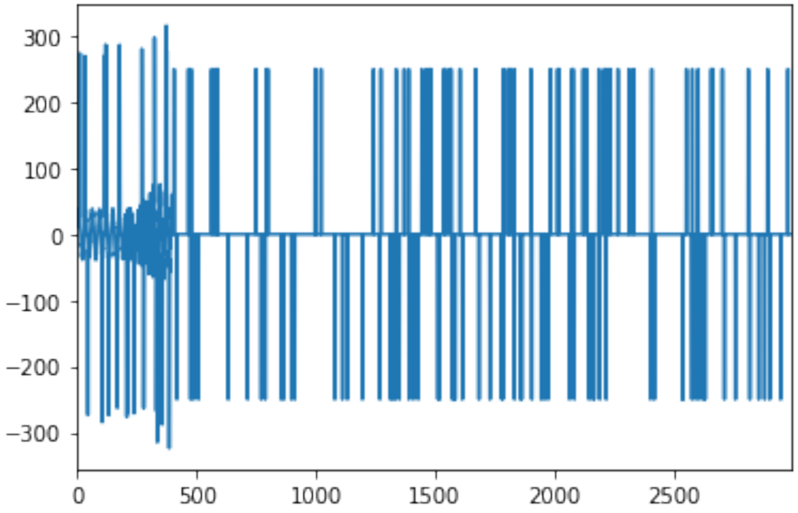
Correlation between sensors

In [11]:

```
df['sensor1'].plot()
```

Out[11]:

```
<matplotlib.axes._subplots.AxesSubplot at 0x1bac7e339b0>
```



keep only the ones that are within +3 to -3 standard deviations in the column 'Data' (Removing noise)

In [12]:

```
df=df[abs(df.sensor1-df.sensor1.mean()) <= (3*df.sensor1.std())]
df=df[abs(df.sensor2-df.sensor2.mean()) <= (3*df.sensor2.std())]
df=df[abs(df.sensor3-df.sensor3.mean()) <= (3*df.sensor3.std())]
df=df[abs(df.sensor4-df.sensor4.mean()) <= (3*df.sensor4.std())]
```

In [13]:

```
df=df.reset_index(drop=True)
```

In [14]:

```
df.head()
```

Out[14]:

	Date_created	sensor1	sensor2	sensor3	sensor4
0	2019-01-01 00:00:00.000000000	12.626096	8.803120	-11.809200	10.083961
1	2019-01-01 08:00:09.603201067	10.831994	2.816327	11.554778	21.892853
2	2019-01-01 16:00:19.206402134	21.083510	-0.672645	-17.839178	-1.349024
3	2019-01-02 00:00:28.809603201	32.294495	6.525132	-13.498586	-4.250752
4	2019-01-02 08:00:38.412804268	28.057100	3.691359	21.984744	13.670561

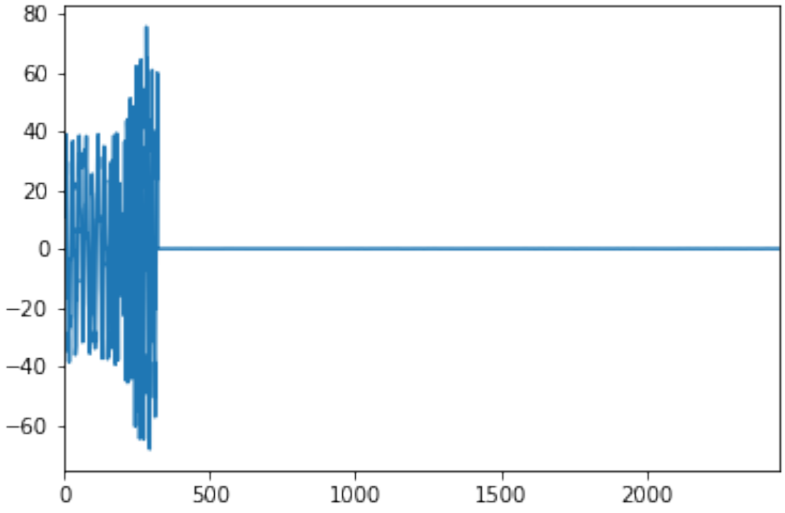
The below plot clearly tells us that machine is dead after 350 values

In [15]:

```
df['sensor1'].plot()
```

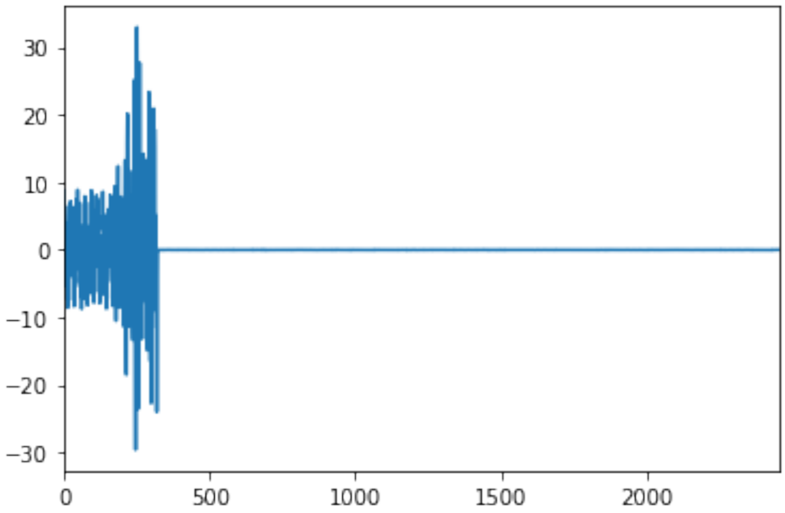
Out[15]:

```
<matplotlib.axes._subplots.AxesSubplot at 0x1bac7ea1dd8>
```



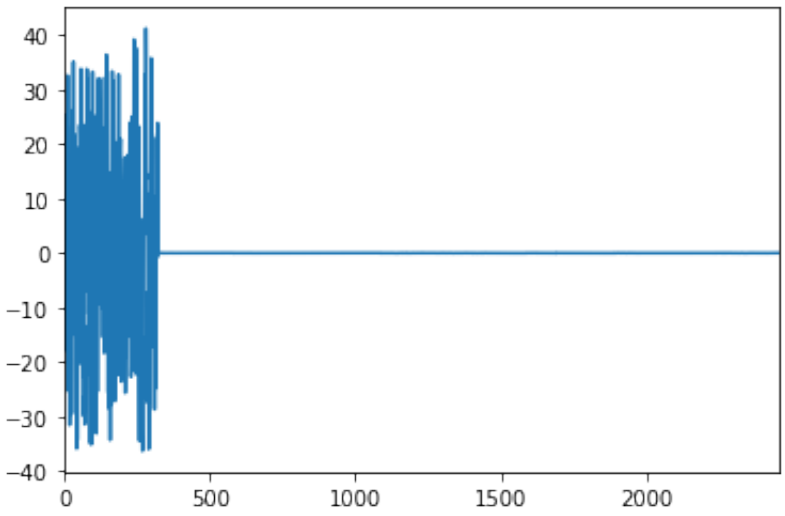
In [16]:
```
df['sensor2'].plot()
```

Out[16]:
```
<matplotlib.axes._subplots.AxesSubplot at 0x1bac7eed7b8>
```

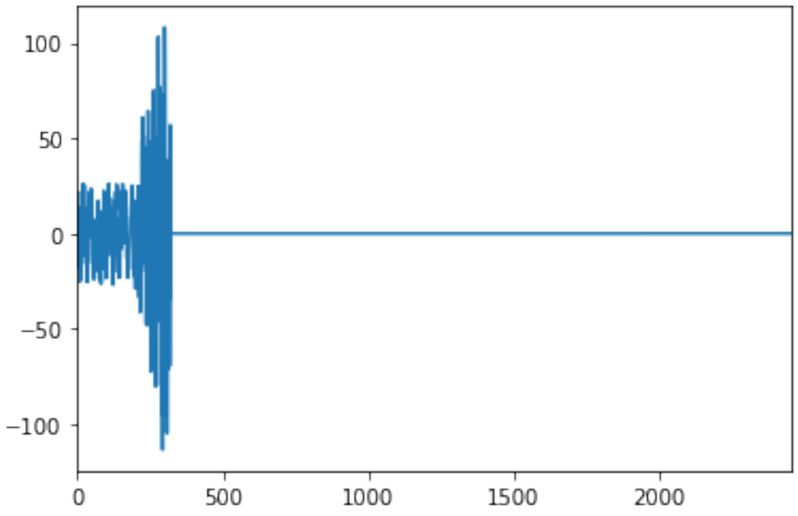


In [17]:
```
df['sensor3'].plot()
```

Out[17]:
```
<matplotlib.axes._subplots.AxesSubplot at 0x1bac7f6c908>
```



```
In [18]: df['sensor4'].plot()

Out[18]: <matplotlib.axes._subplots.AxesSubplot at 0x1bac7fc7320>
```



```
In [19]: df.head()

Out[19]:
```

	Date_created	sensor1	sensor2	sensor3	sensor4
0	2019-01-01 00:00:00.000000000	12.626096	8.803120	-11.809200	10.083961
1	2019-01-01 08:00:09.603201067	10.831994	2.816327	11.554778	21.892853
2	2019-01-01 16:00:19.206402134	21.083510	-0.672645	-17.839178	-1.349024
3	2019-01-02 00:00:28.809603201	32.294495	6.525132	-13.498586	-4.250752
4	2019-01-02 08:00:38.412804268	28.057100	3.691359	21.984744	13.670561

Checking with mean_value how the data varies

```
In [22]: df['mean_value']=df.apply(lambda row:(((row.sensor1)**2)+((row.sensor2
```

```
In [23]: df['square_root']=df.apply(lambda row:math.sqrt(row.mean_value),axis=1
```

In [24]:

```
df.head()
```

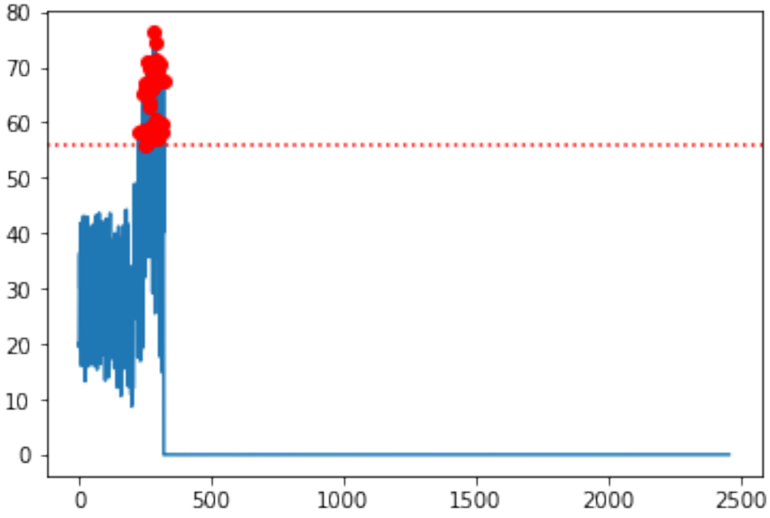
Out[24]:

	Date_created	sensor1	sensor2	sensor3	sensor4	mean_value	square_root
0	2019-01-01 00:00:00.000000000	12.626096	8.803120	-11.809200	10.083961	401.792003	20.044750
1	2019-01-01 08:00:09.603201067	10.831994	2.816327	11.554778	21.892853	378.600932	19.457670
2	2019-01-01 16:00:19.206402134	21.083510	-0.672645	-17.839178	-1.349024	763.658087	27.634364
3	2019-01-02 00:00:28.809603201	32.294495	6.525132	-13.498586	-4.250752	1272.240768	35.668484
4	2019-01-02 08:00:38.412804268	28.057100	3.691359	21.984744	13.670561	1330.877002	36.481187

Labelling of data is done by setting threshold value as 3 standard devaitions above mean

In [25]:

```
import matplotlib.pyplot as plt
import numpy as np

fig, ax = plt.subplots()


threshold = df['square_root'][:1500].mean()+3*df['square_root'][:1500]

ax.axhline(y=threshold, color='r', linestyle=':')
ax.plot(df['square_root'])

greater_than_threshold = [i for i, val in enumerate(df['square_root'][
ax.plot(greater_than_threshold, df['square_root'][:1500][greater_than_
        linestyle='none', color='r', marker='o')

plt.show()
```



Marking the labels

In [26]:

```
df['Labels']=df.apply(lambda row:0 if row.square_root>(threshold) else
```

In [27]:
```
df['Labels']
```

Out[27]:
```
0       1
1       1
2       1
3       1
4       1
       ..
2453    1
2454    1
2455    1
2456    1
2457    1
Name: Labels, Length: 2458, dtype: int64
```

Exploratory Data Analysis

When I have checked with all the different machine_Sensor values, I get to know that many of the machine sensors follow same pattern. As I have observed there are normal values at initial stages and slowly it starts to rise. So, we can check the region for Faulty values. As the different machine corresponding sensor values follow same pattern and each machine data consists of around 500 rows which is very less to apply any machine learning model. So, I have plan to concatenate all the data