```
In [16]: from math import exp
         import matplotlib.pyplot as plt
         hyperbolic_function = lambda z: np.array(np.exp((2*z)-1))/np.array(np.exp(2*z)
         +1)
         hyperbolic_2nd_function = lambda z: np.array(4*np.exp(2*z))/np.array((1 + np.e
         xp(2*z))**2)
```

```
In [ ]:
```

```
In [17]: # Loading in the data with scipy
         from scipy.io import loadmat
         data = loadmat('lorenz_mlp_data.mat')
```

```
In [18]: # choosing which category to show
         lorenz = data['sig_lorenz']
         lorenz
```

```
Out[18]: array([[-10.91626086],
                [-10.65440717],
                [-10.1190821 ],
                ...,
                [  6.7254883 ],
                [  8.37992054],
                [  8.67297783]])
```

```
In [19]: # calculating mean of the data
         lorenzMean = sum(lorenz)/len(lorenz)
         lorenzMean
```

```
Out[19]: array([-0.02085328])
```

```
In [20]: # subtracting the mean from the dataset
         newLorenz = lorenz - lorenzMean
         newLorenz
```

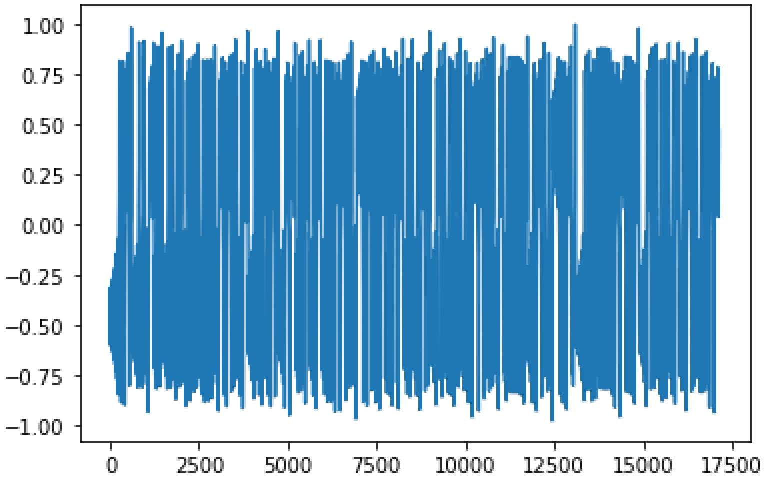
```
Out[20]: array([[-10.89540758],
                [-10.63355388],
                [-10.09822882],
                ...,
                [  6.74634159],
                [  8.40077382],
                [  8.69383111]])
```

```
In [21]: # maximum value
         maxi = max(abs(newLorenz))
         maxi
```

```
Out[21]: array([18.44608317])
```

In [22]:
```
# normalizing data by dividing by max val
newestLorenz = newLorenz/maxi
plt.plot(newestLorenz)
```

Out[22]:
```
[<matplotlib.lines.Line2D at 0x22ed3da3908>]
```



In [23]:
```
# initializing variables
ni = 20
nh = 200
no = 1
training = 700
testing = 800
```

In [24]:

In [25]:
```
# randomly assigning values to the sets
from random import random
w1_nh_ni = np.random.rand(200 , 21)
print(len(w1_nh_ni))
w1_no_nh = np.random.rand(1 , 200)
print(len(w1_no_nh))
dw1_nh_ni = np.random.rand(200 , 21)
print(len(dw1_nh_ni))
dw1_no_nh = np.random.rand(1 , 200)
print(len(dw1_no_nh))
alpha = 0.0
```

```
200
1
200
1
```

In [26]:
```
# initializing values to be used later
import numpy as np
start_data = 1e-1
end_data = 1e-5
num_epoch = 50
stepsize = (end_data - start_data)/(num_epoch-1);
eta = np.arange(start_data, end_data+stepsize, stepsize)
```

In [27]:

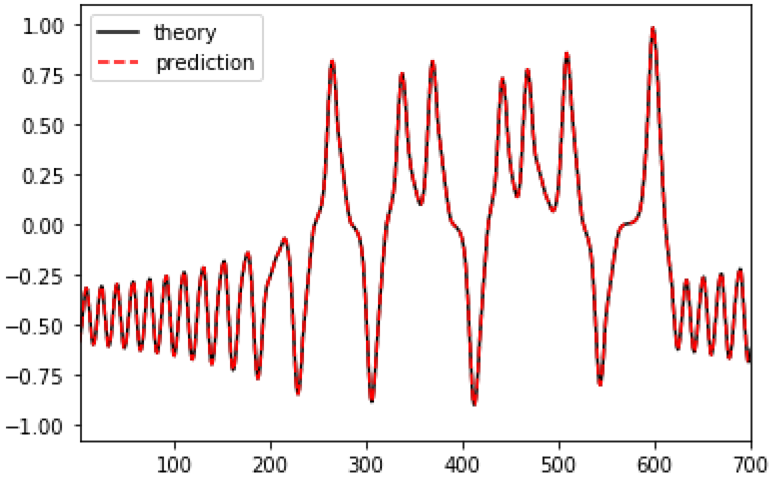
```
# calculating variables to be used later
subset_length = ni + no
t = np.arange(0, 0 + subset_length)

# initalizing lists to be written over later
err = np.ones(training)
hid = np.ones(training)
out = np.ones(training)

# variables created from other variables
MSE_threshold = end_data
MSE = start_data
d = np.ones(training)
```

In [28]:

```
# initializing in this block of code so that it runs
# each time without memory of previous lists/values
epoch = 0
mseList = []
epochs = []
while (MSE > MSE_threshold or epoch < num_epoch):

    if (epoch >= num_epoch):
        break

    for i in range(0, training):
        y = newestLorenz[t+i]
        x = y
        x[-1] = 1
        d[i] = y[0]
        hid = hyperbolic_function((w1_nh_ni).dot(x))
        out[i] = hyperbolic_function(w1_no_nh.dot(hid))
        err[i] = d[i]-out[i]

        delta_out = err[i] * hyperbolic_2nd_function(w1_no_nh.dot(hid))
        delta_hid = (np.array(w1_no_nh) * delta_out).dot(hyperbolic_2nd_function(w1_nh_ni.dot(x)))
        delta_weights_hid = delta_hid.dot(np.array(x).T)
        delta_weights_out = delta_out.dot(np.array(hid).T)

        w1_nh_ni_temp = w1_nh_ni + alpha*dw1_nh_ni + eta[epoch] * delta_weights_hid
        w1_no_nh_temp = w1_no_nh + alpha*dw1_no_nh + eta[epoch] * delta_weights_out

        mseList.append(sum(err**2)/len(err))

    epoch += 1
    epochs.append(epoch)
```

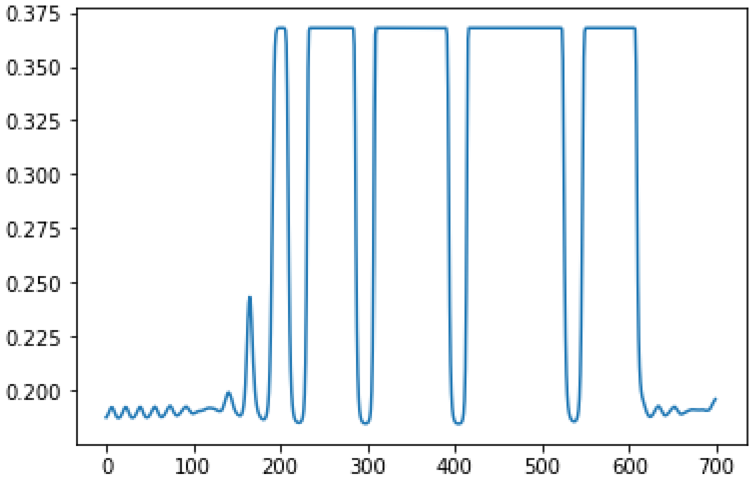
In [29]:
```
# plotting the values against the true values
plt.plot(newestLorenz, 'k')
plt.plot(d, 'r--')
plt.xlim([1,700])
plt.legend(['theory', 'prediction'])
```

Out[29]:
```
<matplotlib.legend.Legend at 0x22ed40d46c8>
```



In [30]:
```
# mroe plotting
plt.plot(out)
```

Out[30]:
```
[<matplotlib.lines.Line2D at 0x22ed41533c8>]
```

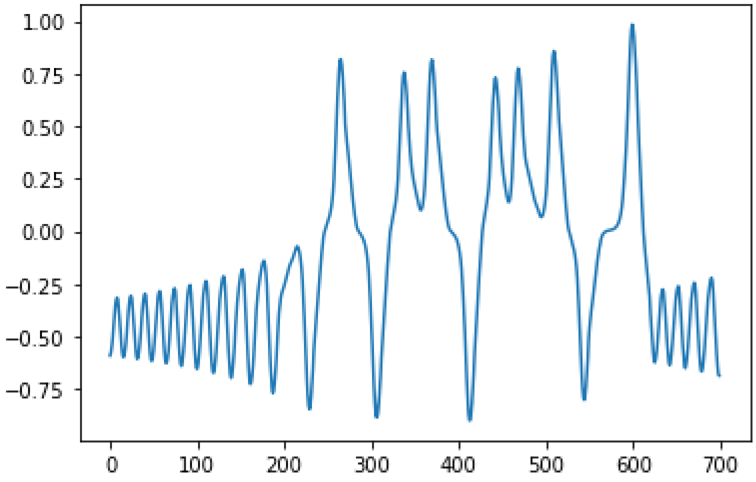


In [31]:

```
plt.plot(d)
```

Out[31]:

```
[<matplotlib.lines.Line2D at 0x22ed41c1c48>]
```



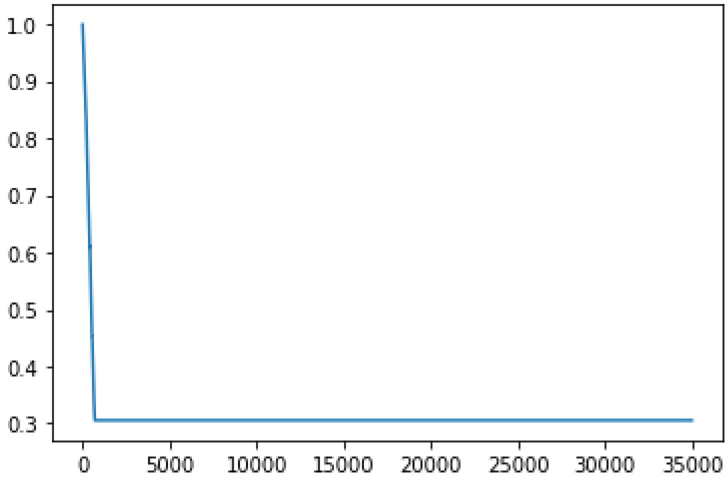
In [ ]:

In [35]:

```
# plotting error
plt.plot(mseList)
```

Out[35]:

```
[<matplotlib.lines.Line2D at 0x22ed52e9448>]
```



In [ ]:

In [ ]: