Index No: 190643G

Name: Vakeesan.K

Q1)

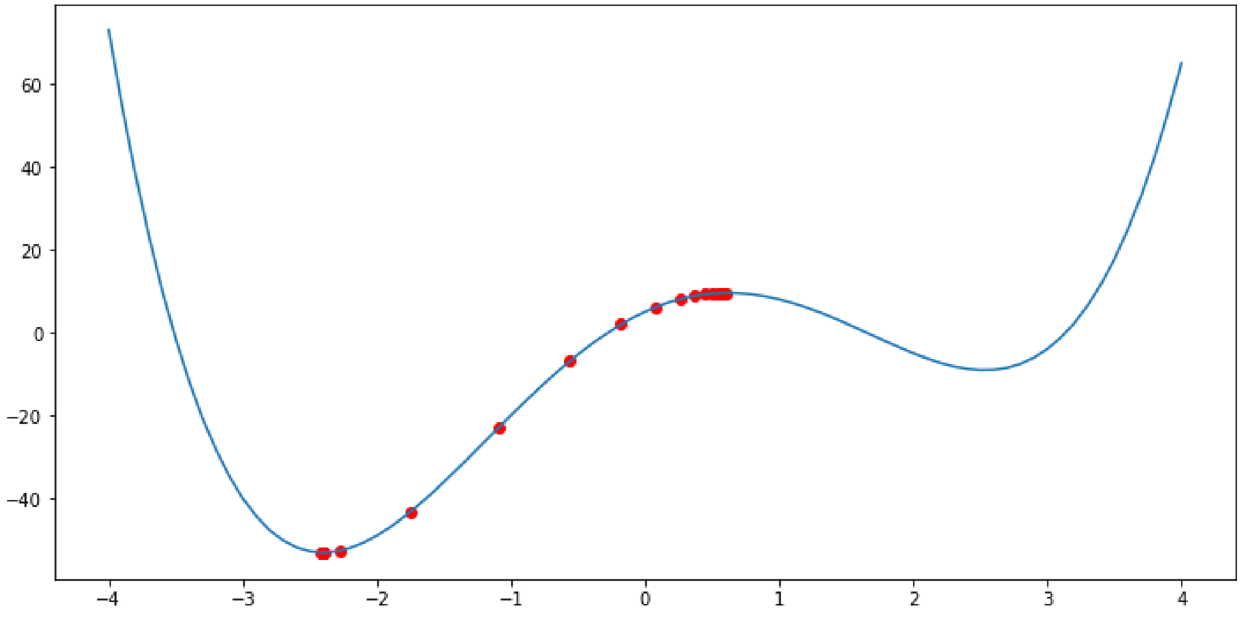
In [3]:

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

def f(x):
    w = np.array([1,-1,-12,15,5])
    M = np.size(w)-1
    return np.sum([x**i*w[M-i] for i in range(0,M+1)], axis=0)

def g(x):
    w = np.array([1,-1,-12,15,5])
    M = np.size(w)-1
    return np.sum([i*x**(i-1)*w[M-i] for i in range(0,M+1)], axis=0)

alpha = 0.02
x = 0.6
x_hist = np.array(x)
fx_hist = np.array(f(x))
for i in range(20):
    x = x - alpha*g(x)
    x_hist= np.append(x_hist, x)
    fx_hist= np.append(fx_hist, f(x))

print('x= ',x,'f(x) = ',f(x))

fig = plt.figure(figsize = (12,6))
ax = plt.subplot(1,1,1)
delta = 0.1
x_ = np.arange(-4,4+delta,delta)
ax.plot(x_,f(x_))
ax.scatter(x_hist,fx_hist, c='r')
```

```
x=  -2.4003994283530288 f(x) =  -53.11840483760499
```

Out[3]:

```
<matplotlib.collections.PathCollection at 0x2a244d58130>
```



In [4]:

```
from scipy.optimize import fsolve
from scipy.optimize import minimize

x0=0.7
root = fsolve(g,x0) #gardient is zero at the hill
print(root)

#using scipy to find the minimum
minimum= minimize(f,x0)
print(minimum)
```

```
[0.61654501]
      fun: -9.083837308515939
 hess_inv: array([[0.02625738]])
      jac: array([-7.62939453e-06])
  message: 'Optimization terminated successfully.'
     nfev: 16
      nit: 3
     njev: 8
   status: 0
  success: True
        x: array([2.53385792])
```

Q2)

In [6]:

```
import numpy as np
import tensorflow as tf
from tensorflow import keras
import matplotlib.pyplot as plt
from tensorflow.keras.datasets import cifar10 , mnist

( x_train , y_train ),( x_test , y_test ) = cifar10.load_data ( )
# ( x_train , y_train ) , ( x_test , y_test ) = mnist . load_data ( )
print ( " x_train => " , x_train . shape )

Ntr = x_train . shape [ 0 ]
Nte = x_test . shape [ 0 ]
Din = 3072 # CIFAR10
# Din = 784 # MINIST
x_train = x_train [ range ( Ntr ) , : ]
x_test = x_test [ range ( Nte ) , : ]
y_train = y_train [ range ( Ntr ) ]
y_test = y_test [ range ( Nte ) ]

K= len(np.unique(y_train)) #10 classses

y_train=tf.keras.utils.to_categorical(y_train,num_classes=K)
y_test = tf.keras.utils.to_categorical(y_test,num_classes =K)

x_train = np.reshape(x_train, (Ntr,Din))
x_test = np.reshape(x_test, (Nte,Din))
x_train = x_train.astype(np.float32)
x_test = x_test.astype(np.float32)

x_train/=255
x_test/=255.
```

```
 x_train =>  (50000, 32, 32, 3)
```

In [19]:

```
# Utility function for diaplaying
def display(y_train, y_test, y_train_pred, y_test_pred, loss_history, w, showim = True):
    plt.plot(loss_history)


     # For diapaying the weights matrix w as an image. 32*32*3 assumption is there
    if showim:
        f, axarr = plt.subplots(2, 5)
        f.set_size_inches(16, 6)
        for i in range(10):
            img = w[:, i].reshape(32, 32, 3)# CIFAR10
            # img = w1[:, i].reshape(28, 28)# MNIST
            img = (img - np.amin(img))/(np.amax(img) - np.amin(img))
            axarr[i//5, i%5].imshow(img)
        plt.show()

    train_acc = np.mean(np.abs(np.argmax(y_train, axis=1) == np.argmax(y_train_pred, axis=1)))
    print("train_acc = ", train_acc)

    test_acc = np.mean(np.abs(np.argmax(y_test, axis=1) == np.argmax(y_test_pred, axis=1)))
    print("test_acc = ", test_acc)
```

In [17]:

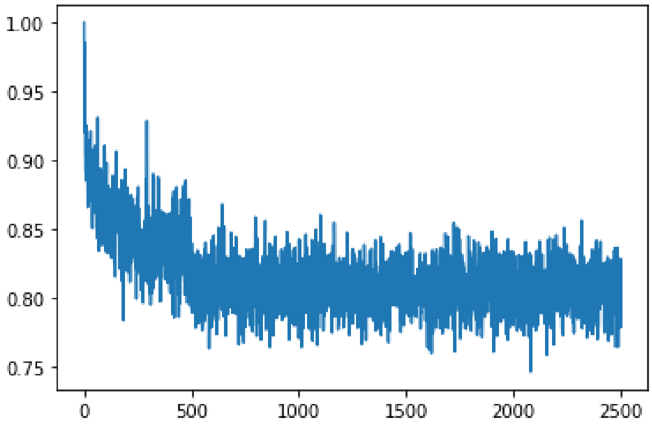
```
std = 1e-5
w = std*np.random.randn(Din, K)
b = np.zeros(K)
lr = 1e-3
lr_decay = 0.1
epochs = 5
batch_size = 100
loss_history = []
```

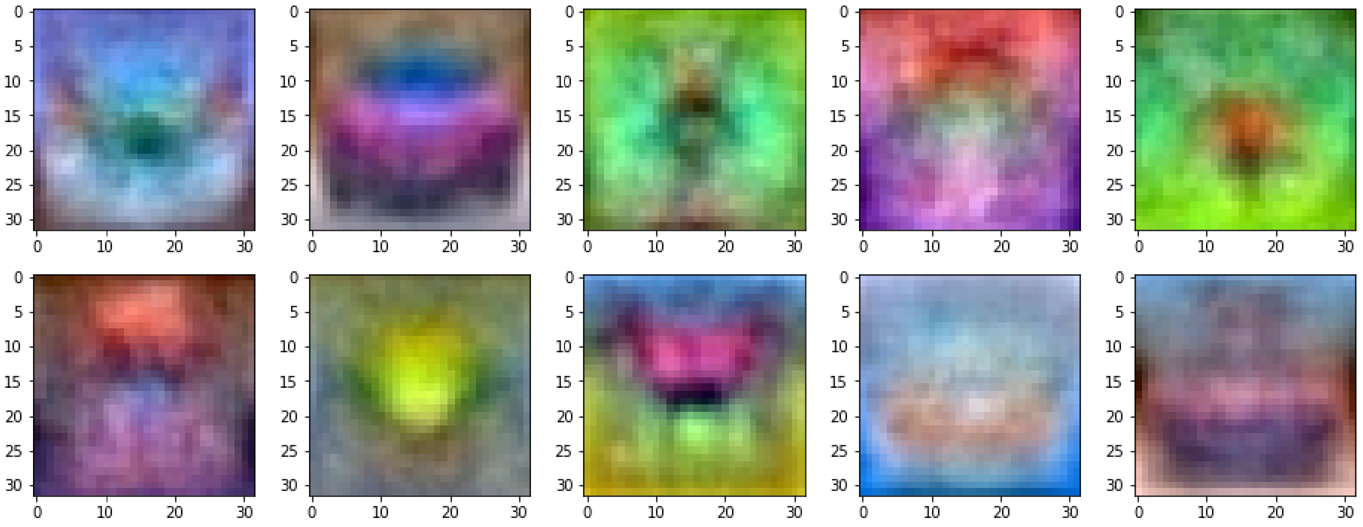
```
rng = np.random.default_rng(seed = 0)

for e in range(epochs):
    indices = np.arange(Ntr)
    rng.shuffle(indices)

    for batch in range(Ntr//batch_size):
        batch_indices = indices[batch*batch_size:(batch+1)*batch_size]
        x = x_train[batch_indices]
        y = y_train[batch_indices]

        #forward pass
        y_pred = x@w + b
        loss = 1./batch_size*np.square(y_pred-y).sum()
        loss_history.append(loss)

        #backward pass
        dy_pred = 1./batch_size* 2.0*(y_pred - y)
        dw = x.T @ dy_pred
        db = dy_pred.sum(axis = 0)*1
        w = w - lr*dw #dw is daba L/daba w
        b = b - lr*db

    if e % 5 == 0:
        print("Iteration %d / %d: loss %f"%(e, epochs,loss))
    if e % 10 == 0:
        lr *= lr_decay
```

```
Iteration 0 / 5: loss 0.813423
```

In [18]:

```
y_train_pred = x_train.dot(w) + b
y_test_pred = x_test.dot(w) + b
display(y_train,y_test,y_train_pred,y_test_pred,loss_history,w,showim = True)
```





```
train_acc =  0.38748
test_acc =  0.382
```