Ex No: 9 Date:	Generation of MNIST image using generative adversarial network.

AIM:

To write a program to generate MNIST image using generative adversarial network.

ALGORTIHM:

Step 1 : Start

Step 2 : Import the necessary library packages such as tensorflow,numpy, matplotlib

Step 3 : Load the MNIST dataset

Step 4 : Define the values for epochs,batch_size and z_dim

Step 5 : Split the MNIST dataset into x_train,x_test,y_train,y_test

Step 6 : Define the generator and discriminator function

Step 7 : Train the model and print the resulted image

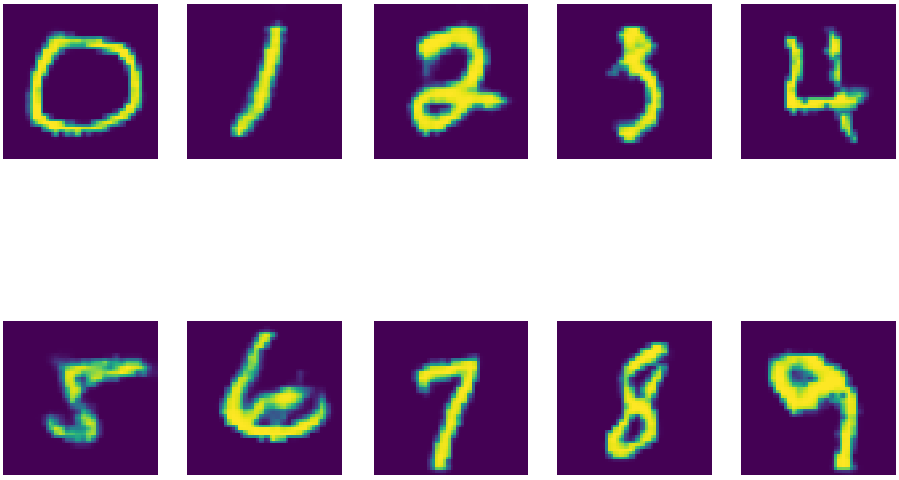
Step 8 : Stop

PROGRAM:

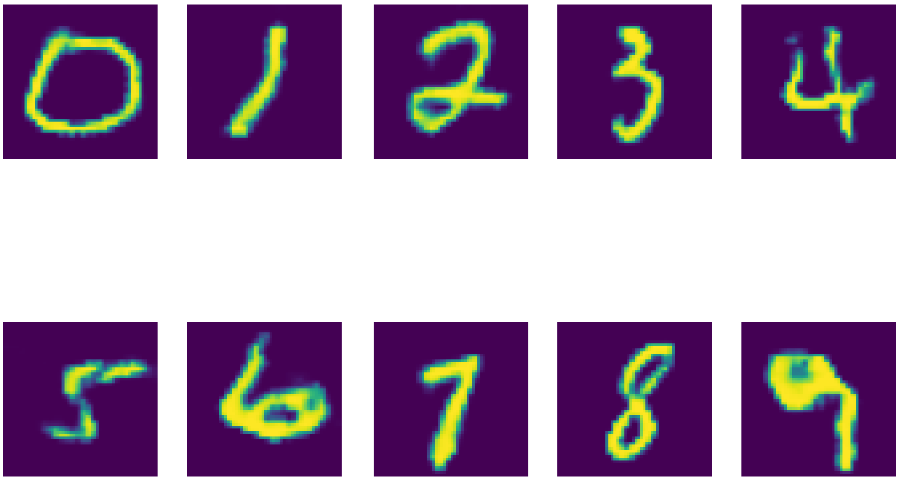
```
import tensorflow as tf
import numpy as np
import matplotlib.pyplot as plt

batch_size = 200
epochs = 1600
z_dim = 100

z_vis = tf.random.normal([10, z_dim])
y_vis = tf.constant(np.eye(10), dtype='float32')

(x_train, y_train), (x_test, y_test) = tf.keras.datasets.mnist.load_data()
x_train = x_train / 255.0
y_train = tf.one_hot(y_train, depth=10, dtype='float32')
data_iter = iter(tf.data.Dataset.from_tensor_slices((x_train, y_train)).shuffle(4 *
batch_size).batch(batch_size).repeat())

def Generator():
  z = tf.keras.layers.Input(shape=(z_dim,), dtype='float32')
  y = tf.keras.layers.Input(shape=(10,), dtype='float32')
  tr = tf.keras.layers.Input(shape=(1,), dtype='bool')

  x = tf.keras.layers.concatenate([z, y])
  x = tf.keras.layers.Dense(3 * 3 * 512)(x)
  x = tf.keras.layers.Reshape((3, 3, 512))(x)

  x = tf.keras.layers.Conv2DTranspose(256, 3, 2, 'valid')(x)
  x = tf.nn.leaky_relu(tf.keras.layers.BatchNormalization()(x, training=tr))

  x = tf.keras.layers.Conv2DTranspose(128, 4, 2, 'same')(x)
  x = tf.nn.leaky_relu(tf.keras.layers.BatchNormalization()(x, training=tr))

  x = tf.keras.layers.Conv2DTranspose(1, 4, 2, 'same', activation='sigmoid')(x)
  out = tf.keras.layers.Reshape((28, 28))(x)

  return tf.keras.Model(inputs=[z, y, tr], outputs=out)

def Discriminator():
  X = tf.keras.layers.Input(shape=(28, 28), dtype='float32')
  Y = tf.keras.layers.Input(shape=(10,), dtype='float32')
  tr = tf.keras.layers.Input(shape=(1,), dtype='bool')

  y = tf.tile(tf.reshape(Y,[-1, 1, 1, 10]), [1, 28, 28, 1])
  x = tf.keras.layers.Reshape((28, 28, 1))(X)
  x = tf.keras.layers.concatenate([x, y])

  x = tf.keras.layers.Conv2D(128,  4, 2, 'same')(x)

  x = tf.keras.layers.Conv2D(256,  4, 2, 'same')(x)
  x = tf.nn.leaky_relu(tf.keras.layers.BatchNormalization()(x, training=tr))

  x = tf.keras.layers.Conv2D(512, 4, 2, 'same')(x)
  x = tf.nn.leaky_relu(tf.keras.layers.BatchNormalization()(x, training=tr))

  out = tf.keras.layers.Dense(1)(x)

  return tf.keras.Model(inputs=[X, Y, tr], outputs=out)

G = Generator()
D = Discriminator()

cross_entropy = tf.keras.losses.BinaryCrossentropy(from_logits = True)
def G_loss(D, x_fake, y):
  return cross_entropy(tf.ones_like(D([x_fake, y, True])), D([x_fake, y, True]))
def D_loss(D, x_real, x_fake, y):
  return cross_entropy(tf.ones_like(D([x_real, y, True])), D([x_real, y, True])) \
      + cross_entropy(tf.zeros_like(D([x_fake, y, True])), D([x_fake, y, True]))

G_opt = tf.keras.optimizers.Adam(2e-4)
D_opt = tf.keras.optimizers.Adam(2e-4)
```

```
for epoch in range(epochs):
  z_mb = tf.random.normal([batch_size, z_dim])
  x_real, y = next(data_iter)

  with tf.GradientTape() as G_tape, tf.GradientTape() as D_tape:
    x_fake = G([z_mb, y, True])
    G_loss_curr = G_loss(D, x_fake, y)
    D_loss_curr = D_loss(D, x_real, x_fake, y)

  G_grad = G_tape.gradient(G_loss_curr, G.trainable_variables)
  D_grad = D_tape.gradient(D_loss_curr, D.trainable_variables)

  G_opt.apply_gradients(zip(G_grad, G.trainable_variables))
  D_opt.apply_gradients(zip(D_grad, D.trainable_variables))

  if epoch % 100 == 0:
    print('epoch: {}; G_loss: {:.6f}; D_loss: {:.6f}'.format(epoch+1, G_loss_curr, 
D_loss_curr))
    for i in range(10):
      plt.subplot(2, 5, i+1)
      plt.imshow(G([z_vis, y_vis, False])[i,:,:] * 255.0)
      plt.axis('off')
    plt.show()
```

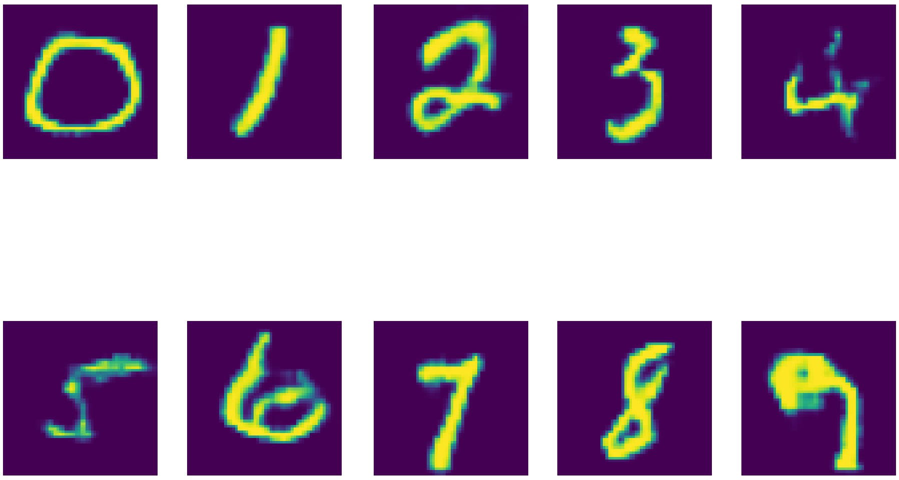
```
epoch: 1; G_loss: 0.932448; D_loss: 1.184511
```



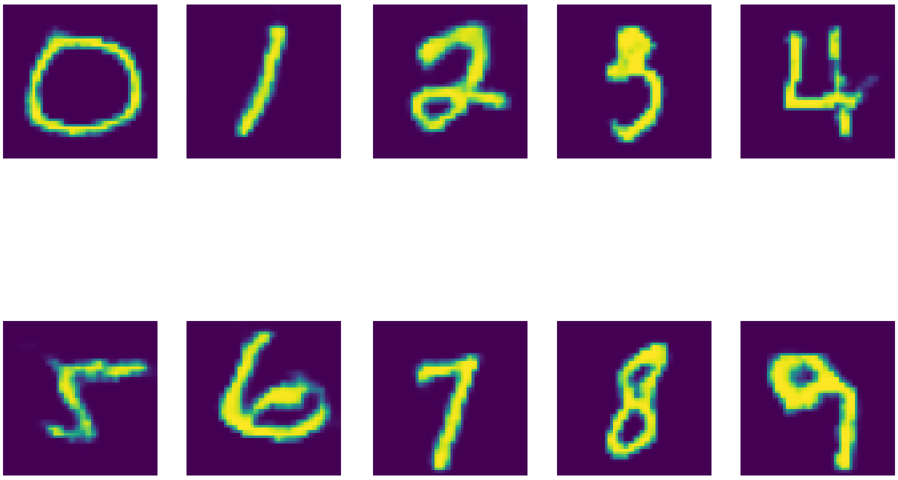
```
epoch: 101; G_loss: 0.949664; D_loss: 1.168088
```



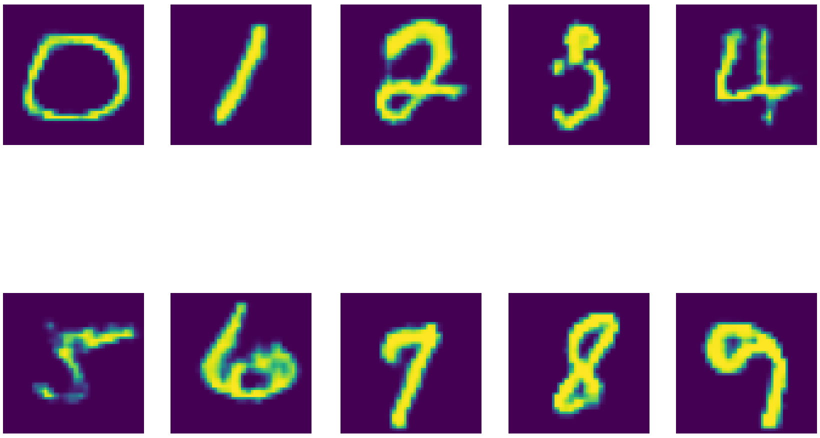
epoch: 201; G_loss: 0.971315; D_loss: 1.141035



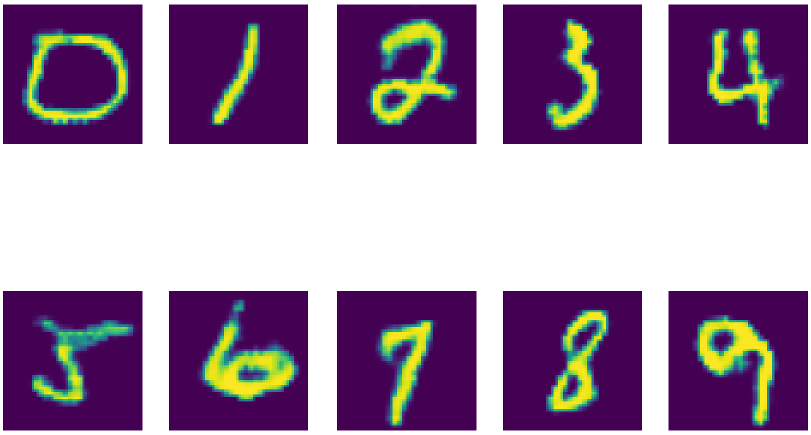
epoch: 301; G_loss: 0.929943; D_loss: 1.164442



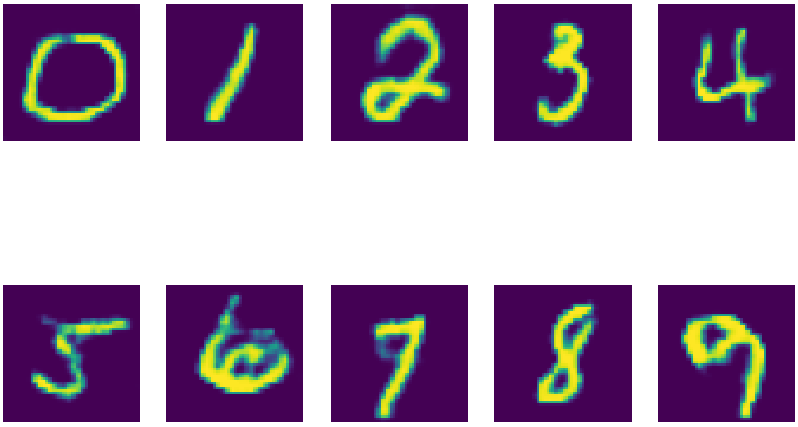
epoch: 401; G_loss: 0.951793; D_loss: 1.212433



```
epoch: 1201; G_loss: 0.865578; D_loss: 1.241658
```



```
epoch: 1401; G_loss: 1.012199; D_loss: 1.054802
```



```
epoch: 1501; G_loss: 0.841157; D_loss: 1.351191
```

RESULT:

Thus the program to generate MNIST image using generative adversarial network is executed successfully and output is verified.