EXERCISE NO. 10
GAN FOR HANDWRITTEN DIGITS

AIM:
To implement a GAN for generating handwritten digits.

ALGORITHM:

1. Import necessary libraries.
2. Load and preprocess the MNIST dataset.
3. Build the generator and the discriminator.
4. Define the losses and the optimisers.
5. Train the model to fit the dataset.
6. Display the sample generated images.

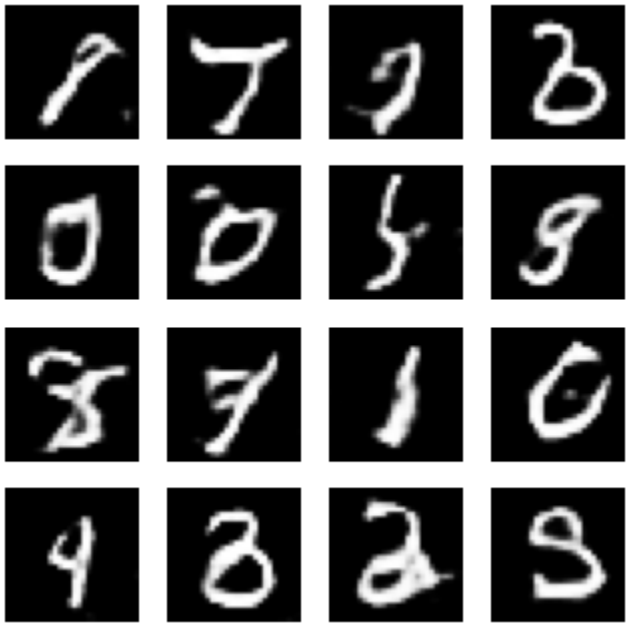
PROGRAM:

```
import tensorflow as tf
from tensorflow.keras import layers
import matplotlib.pyplot as plt

(x_train, _), _ = tf.keras.datasets.mnist.load_data()
x_train = (x_train - 127.5) / 127.5
x_train = x_train[..., tf.newaxis].astype('float32')  # (28, 28, 1)

BUFFER_SIZE = 60000
BATCH_SIZE = 64

train_dataset =
tf.data.Dataset.from_tensor_slices(x_train).shuffle(BUFFER_SIZE).batch(BATCH_SIZE)

def build_generator():
   model = tf.keras.Sequential([
      layers.Dense(7*7*256, use_bias=False, input_shape=(100,)),
      layers.BatchNormalization(),
      layers.LeakyReLU(),
      layers.Reshape((7, 7, 256)),
      layers.Conv2DTranspose(128, (5,5), strides=(1,1), padding='same', use_bias=False),
      layers.BatchNormalization(),
```

```
        layers.LeakyReLU(),
        layers.Conv2DTranspose(64, (5,5), strides=(2,2), padding='same', use_bias=False),
        layers.BatchNormalization(),
        layers.LeakyReLU(),
        layers.Conv2DTranspose(1, (5,5), strides=(2,2), padding='same', use_bias=False,
activation='tanh')
    ])
    return model

def build_discriminator():
    model = tf.keras.Sequential([
        layers.Conv2D(64, (5,5), strides=(2,2), padding='same', input_shape=[28,28,1]),
        layers.LeakyReLU(),
        layers.Dropout(0.3),
        layers.Conv2D(128, (5,5), strides=(2,2), padding='same'),
        layers.LeakyReLU(),
        layers.Dropout(0.3),
        layers.Flatten(),
        layers.Dense(1)
    ])
    return model

generator = build_generator()
discriminator = build_discriminator()

cross_entropy = tf.keras.losses.BinaryCrossentropy(from_logits=True)
gen_optimizer = tf.keras.optimizers.Adam(1e-4)
disc_optimizer = tf.keras.optimizers.Adam(1e-4)

@tf.function
def train_step(images):
    noise = tf.random.normal([BATCH_SIZE, 100])

    with tf.GradientTape() as gen_tape, tf.GradientTape() as disc_tape:
        generated = generator(noise, training=True)

        real_output = discriminator(images, training=True)
```

```
        fake_output = discriminator(generated, training=True)

        gen_loss = cross_entropy(tf.ones_like(fake_output), fake_output)
        disc_loss = (cross_entropy(tf.ones_like(real_output), real_output) +
                     cross_entropy(tf.zeros_like(fake_output), fake_output))

    gen_grads = gen_tape.gradient(gen_loss, generator.trainable_variables)
    disc_grads = disc_tape.gradient(disc_loss, discriminator.trainable_variables)

    gen_optimizer.apply_gradients(zip(gen_grads, generator.trainable_variables))
    disc_optimizer.apply_gradients(zip(disc_grads, discriminator.trainable_variables))

def generate_and_plot():
    noise = tf.random.normal([16, 100])
    predictions = generator(noise, training=False)

    fig = plt.figure(figsize=(4,4))
    for i in range(predictions.shape[0]):
        plt.subplot(4, 4, i+1)
        plt.imshow((predictions[i, :, :, 0] + 1) / 2, cmap='gray')
        plt.axis('off')
    plt.show()

def train(dataset, epochs):
    for epoch in range(epochs):
        for image_batch in dataset:
            train_step(image_batch)
        print(f"Epoch {epoch+1} completed")
        generate_and_plot()

train(train_dataset, epochs=25)
```

OUTPUT:



RESULT:

Thus the program has been successfully implemented and verified.