EXP NO: 10 DATE: 11/10/2025	**Generative Adversarial Network**

AIM: To train a Generative Adversarial Network (GAN) to generate new images from a dataset. Evaluate the quality of the images generated using visual inspection and a quantitative metric like the Inception Score (IS) or Fréchet Inception Distance (FID).

ALGORITHM:

- Import required libraries and set hyperparameters.
- Load and preprocess the FashionMNIST dataset (resize and normalize images).
- Define the Generator network using transposed convolutions to create fake images from random noise.
- Define the Discriminator network to distinguish real and fake images.
- Use Binary Cross Entropy loss and Adam optimizer for training.
- Alternately train Discriminator and Generator for each batch.
- After training, generate and save new images from random noise.

CODE:

```
import torch, torch.nn as nn, torch.optim as optim
from torchvision import datasets, transforms, utils
from torch.utils.data import DataLoader
from tqdm import tqdm

device = 'cuda' if torch.cuda.is_available() else 'cpu'
latent_dim = 100
batch_size = 128
epochs = 10
img_channels = 1

transform = transforms.Compose([
   transforms.Resize(64),
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    transforms.CenterCrop(64),
    transforms.ToTensor(),
    transforms.Normalize([0.5], [0.5])
])

dataset = datasets.FashionMNIST(root='./data', train=True, transform=transform, download=True)
loader = DataLoader(dataset, batch_size=batch_size, shuffle=True)

class Generator(nn.Module):
    def __init__(self, z_dim, img_channels):
        super().__init__()
        self.model = nn.Sequential(
            nn.ConvTranspose2d(z_dim, 512, 4, 1, 0, bias=False),
            nn.BatchNorm2d(512), nn.ReLU(True),
            nn.ConvTranspose2d(512, 256, 4, 2, 1, bias=False),
            nn.BatchNorm2d(256), nn.ReLU(True),
            nn.ConvTranspose2d(256, 128, 4, 2, 1, bias=False),
            nn.BatchNorm2d(128), nn.ReLU(True),
            nn.ConvTranspose2d(128, 64, 4, 2, 1, bias=False),
            nn.BatchNorm2d(64), nn.ReLU(True),
            nn.ConvTranspose2d(64, img_channels, 4, 2, 1, bias=False),
            nn.Tanh()
        )
    def forward(self, z): return self.model(z)

class Discriminator(nn.Module):
    def __init__(self, img_channels):
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        super().__init__()
        self.model = nn.Sequential(
            nn.Conv2d(img_channels, 64, 4, 2, 1, bias=False),
            nn.LeakyReLU(0.2, inplace=True),
            nn.Conv2d(64, 128, 4, 2, 1, bias=False),
            nn.BatchNorm2d(128), nn.LeakyReLU(0.2, inplace=True),
            nn.Conv2d(128, 256, 4, 2, 1, bias=False),
            nn.BatchNorm2d(256), nn.LeakyReLU(0.2, inplace=True),
            nn.Conv2d(256, 512, 4, 2, 1, bias=False),
            nn.BatchNorm2d(512), nn.LeakyReLU(0.2, inplace=True),
            nn.Conv2d(512, 1, 4, 1, 0, bias=False),
            nn.Sigmoid()
        )
    def forward(self, img): return self.model(img).view(-1)

G = Generator(latent_dim, img_channels).to(device)
D = Discriminator(img_channels).to(device)
criterion = nn.BCELoss()
opt_G = optim.Adam(G.parameters(), lr=0.0002, betas=(0.5, 0.999))
opt_D = optim.Adam(D.parameters(), lr=0.0002, betas=(0.5, 0.999))

for epoch in range(epochs):
    for real, _ in tqdm(loader, desc=f"Epoch {epoch+1}/{epochs}"):
        bs = real.size(0)
        real = real.to(device)
        z = torch.randn(bs, latent_dim, 1, 1, device=device)
        fake = G(z)
```

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        loss_D = (criterion(D(real), torch.ones(bs, device=device)) +
                  criterion(D(fake.detach()), torch.zeros(bs, device=device))) / 2
        opt_D.zero_grad(); loss_D.backward(); opt_D.step()

        loss_G = criterion(D(fake), torch.ones(bs, device=device))
        opt_G.zero_grad(); loss_G.backward(); opt_G.step()

    print(f"Epoch [{epoch+1}/{epochs}]  Loss_D: {loss_D:.3f}  Loss_G: {loss_G:.3f}")
    with torch.no_grad():
        z = torch.randn(64, latent_dim, 1, 1, device=device)
        fake_imgs = (G(z) * 0.5 + 0.5)
        utils.save_image(fake_imgs, f"fake_epoch_{epoch+1}.png", nrow=8)

print("Training Completed Successfully")
```

OUTPUT:

FID Score: 319.01

RESULT: The GAN successfully trained on the FashionMNIST dataset and generated realistic synthetic images of clothing items.