In [1]:

```
import torch
import numpy as np
import matplotlib.pyplot as plt
import torchvision
from torchvision import datasets
import torchvision.transforms as transforms
from torchvision.transforms import ToTensor
import torch.nn as nn
import torch.nn.functional as F
import torch.optim as optim
from torch.autograd import Variable
from torchvision.utils import make_grid
import time
import sys
import os
```

```
/home/arunima/aru_env/lib/python3.8/site-packages/tqdm/auto.py:22: Tqd
mWarning: IProgress not found. Please update jupyter and ipywidgets. S
ee https://ipywidgets.readthedocs.io/en/stable/user_install.html (http
s://ipywidgets.readthedocs.io/en/stable/user_install.html)
  from .autonotebook import tqdm as notebook_tqdm
```

In [2]:

```
import seaborn as sns
```

In [3]:

```
from sklearn.metrics import classification_report
from sklearn.metrics import confusion_matrix
```

In [4]:

```
### Fixing some values for the hyperparameters
batch_size=50
epochs=10
```

In [5]:

```
## If GPU is abailable, then the code will be pushed to it otherwise it will move t
use_cuda=torch.cuda.is_available()
device = torch.device("cuda" if use_cuda else "cpu")
```

In [6]:

```
##Loading the data
transform=transforms.Compose([
        transforms.ToTensor(),
        transforms.Normalize((0.1307,), (0.3081,))
        ])
train_data = datasets.MNIST(root='../data', train=True,download=True, transform=tra
test_data = datasets.MNIST(root='../data', train=False,download=True, transform=tra

train_loader = torch.utils.data.DataLoader(train_data, batch_size=batch_size,shuffl
test_loader = torch.utils.data.DataLoader(test_data, batch_size=batch_size)
```

In [7]:

```
##Building the CNN structure, without Batch-normalization

class CNN(nn.Module):
    def __init__(self):
        super(CNN,self).__init__()
        self.conv1=nn.Sequential(nn.Conv2d(in_channels=1, out_channels=32, kernel_s
                                 nn.ReLU(),nn.MaxPool2d(kernel_size=2,stride=2))
        self.conv2=nn.Sequential(nn.Conv2d(in_channels=32, out_channels=32, kernel_
                                 nn.ReLU(),nn.MaxPool2d(kernel_size=2,stride=2))
        self.fclayer1=nn.Sequential(nn.Linear(7*7*32, 500), nn.ReLU())
        self.fclayer2=nn.Linear(500,10)

    def forward(self,x):
        output=self.conv1(x)
        output=self.conv2(output)
        out=output.view(-1,7*7*32)
        output=self.fclayer1(out)
        output=self.fclayer2(output)
        output= F.log_softmax(output, dim=1)
        return output

##Building the CNN structure, with Batch-normalization

class CNN_with_BatchNorm(nn.Module):
    def __init__(self):
        super(CNN_with_BatchNorm,self).__init__()
        self.conv1=nn.Sequential(nn.Conv2d(in_channels=1, out_channels=32, kernel_s
                                 nn.BatchNorm2d(32),nn.ReLU(),nn.MaxPool2d(kernel_
        self.conv2=nn.Sequential(nn.Conv2d(in_channels=32, out_channels=32, kernel_
                                 nn.BatchNorm2d(32),nn.ReLU(),nn.MaxPool2d(kernel_
        self.fclayer1=nn.Sequential(nn.Linear(7*7*32, 500),nn.BatchNorm1d(500), nn.
        self.fclayer2=nn.Linear(500,10)

    def forward(self,x):
        output=self.conv1(x)
        output=self.conv2(output)
        out=output.view(-1,7*7*32)
        output=self.fclayer1(out)
        output=self.fclayer2(output)
        output= F.log_softmax(output, dim=1)
        return output
```

In [8]:

```
#Training on the images

def train(model,device,train_loader,optimizer,epoch,train_loss,train_accuracy):
    model.train()
    acc=0
    train_l=0
    for batch_idx, (data, target) in enumerate(train_loader):
        data, target = data.to(device), target.to(device)
        optimizer.zero_grad()
        output = model(data)
        loss = F.nll_loss(output, target)
        loss.backward()
        optimizer.step()

        #train_loss.append(loss.item())
        train_l+=loss.item()
        pred= output.argmax(dim=1, keepdim=True)
        acc+= pred.eq(target.view_as(pred)).sum().item()

    train_loss.append(train_l/len(train_loader.dataset))
    train_accuracy.append(100*acc/len(train_loader.dataset))
```

In [9]:

```
def test(model,device,test_loader,test_loss,test_accuracy):
    model.eval()
    loss = 0
    acc = 0
    with torch.no_grad():
        for data, target in test_loader:
            data, target = data.to(device), target.to(device)
            output = model(data)
            loss += F.nll_loss(output, target, reduction='sum').item()  # sum up ba
            pred = output.argmax(dim=1, keepdim=True)  # get the index of the max l
            acc += pred.eq(target.view_as(pred)).sum().item()

    loss /= len(test_loader.dataset)
    test_loss.append(loss)
    test_accuracy.append(100. * acc / len(test_loader.dataset))

    print('\nTest set: Average loss: {:.4f}, Accuracy: {}/{} ({:.0f}%)\n'.format(
        loss, acc, len(test_loader.dataset),
        100. * acc / len(test_loader.dataset)))
```

Question 1

In [10]:

```
cnn=CNN()
model=cnn.to(device)
optimizer = optim.Adam(model.parameters(), lr=0.0001)
```

In [11]:

```
train_loss=[]
train_accuracy=[]
test_loss=[]
test_accuracy=[]
start=time.time()
for epoch in range(1,epochs+1):
    train(model,device,train_loader,optimizer,epoch,train_loss,train_accuracy)

    test(model, device, test_loader,test_loss,test_accuracy)
end=time.time()
```

```
Test set: Average loss: 0.1097, Accuracy: 9676/10000 (97%)


Test set: Average loss: 0.0602, Accuracy: 9804/10000 (98%)


Test set: Average loss: 0.0526, Accuracy: 9824/10000 (98%)


Test set: Average loss: 0.0425, Accuracy: 9869/10000 (99%)


Test set: Average loss: 0.0371, Accuracy: 9871/10000 (99%)


Test set: Average loss: 0.0375, Accuracy: 9875/10000 (99%)


Test set: Average loss: 0.0318, Accuracy: 9893/10000 (99%)


Test set: Average loss: 0.0301, Accuracy: 9899/10000 (99%)


Test set: Average loss: 0.0283, Accuracy: 9899/10000 (99%)


Test set: Average loss: 0.0273, Accuracy: 9910/10000 (99%)
```

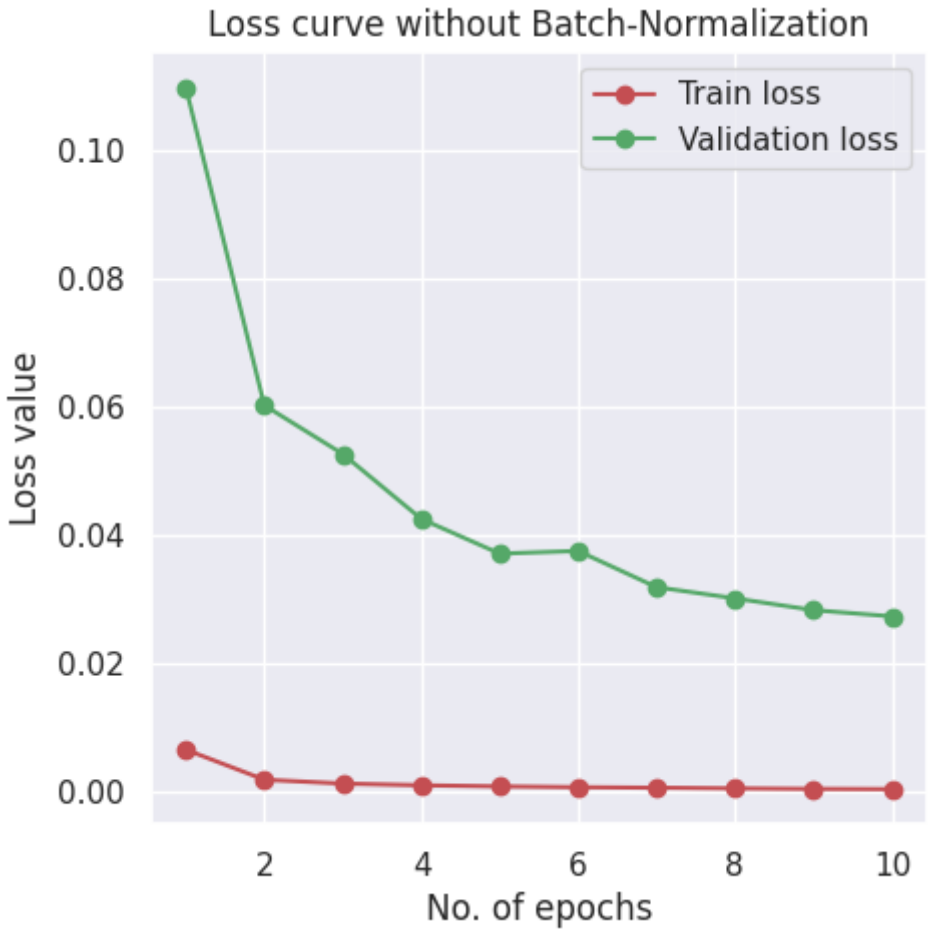
In [12]:

```
avg_acc=sum(test_accuracy)/10
print("The average accuracy of the test set is : {:.6f} without batch-normalization
```

```
The average accuracy of the test set is : 98.520000 without batch-norm
alization.
```

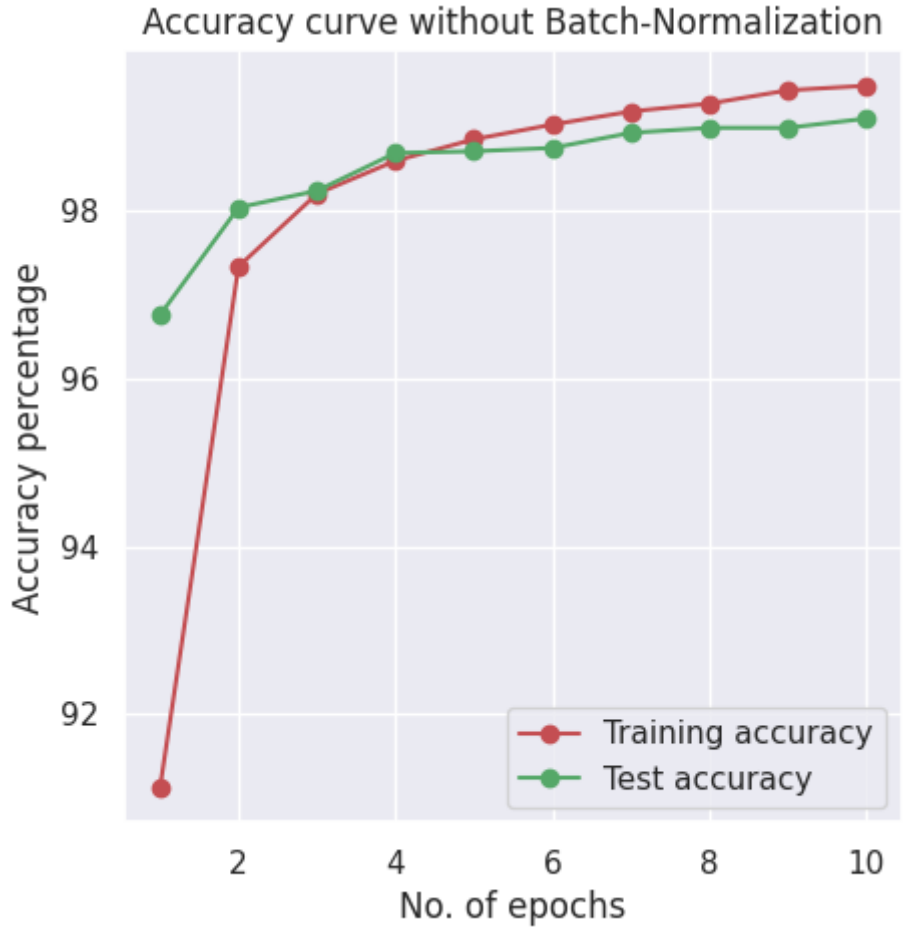
In [13]:

```
sns.set_theme()
plt.figure(figsize=(5, 5))
xval=np.arange(1,11,1)
plt.plot(xval,train_loss,color='r',marker='o')
plt.plot(xval,test_loss,color='g',marker='o')
plt.xlabel("No. of epochs")
plt.ylabel("Loss value")
plt.legend(["Train loss","Validation loss"])
plt.title("Loss curve without Batch-Normalization")
plt.grid(True)
```



In [14]:

```
plt.figure(figsize=(5, 5))
x=np.arange(1,11,1)
plt.plot(x,train_accuracy,color='r',marker='o')
plt.plot(x,test_accuracy,color='g',marker='o')
plt.xlabel("No. of epochs")
plt.ylabel("Accuracy percentage")
plt.legend(["Training accuracy","Test accuracy"])
plt.title("Accuracy curve without Batch-Normalization")
plt.grid(True)
```

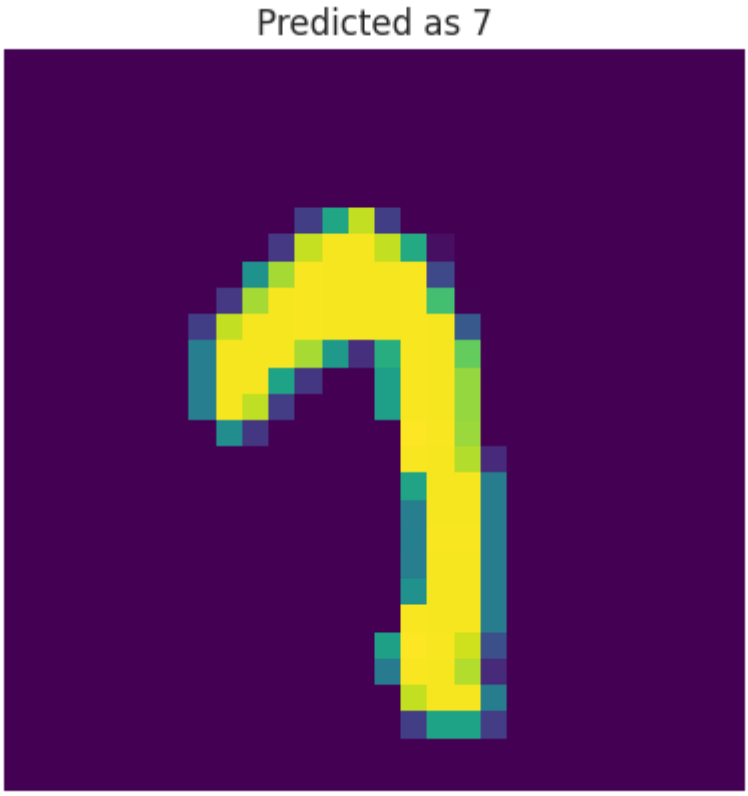


In [15]:

```
def random_plotting_of_test_images(network,test_loader):
    image_index= np.random.randint(low=0, high=9999, size=3) #test set has 10000 im
    for index in image_index:
        test_image = test_loader.dataset.data[index, :, :].clone()
        with torch.no_grad():#Using no_grad as it reduces memory consumption for co
            test_image = test_image.reshape(1,1,28,28).cuda().float()
            out = network.forward(test_image).detach().cpu().numpy()
        predicted=np.argmax(out)
        plt.imshow(test_image.detach().cpu().numpy().reshape(28,28),cmap='viridis')
        plt.axis('off')
        plt.title(f"Predicted as {predicted}")
```

In [16]:

```
random_plotting_of_test_images(model,test_loader)
```



In [17]:

```
print("The time taken to run the model without Batch-Normalization is {:.6f} second
```

```
The time taken to run the model without Batch-Normalization is 59.5121
61 seconds
```

In [18]:

```
##### Implementing Batch-Normalization

cnn_batch_norm=CNN_with_BatchNorm()
model_batch_norm=cnn_batch_norm.to(device)
optimizer_bn = optim.Adam(model_batch_norm.parameters(), lr=0.0001)
```

In [19]:

```
train_loss_bn=[]
train_accuracy_bn=[]
test_loss_bn=[]
test_accuracy_bn=[]
start_bn=time.time()
for epoch in range(1,epochs+1):
    train(model_batch_norm,device,train_loader,optimizer_bn,epoch,train_loss_bn,tra

    test(model_batch_norm, device, test_loader,test_loss_bn,test_accuracy_bn)
end_bn=time.time()
```

```
Test set: Average loss: 0.0506, Accuracy: 9867/10000 (99%)


Test set: Average loss: 0.0407, Accuracy: 9877/10000 (99%)


Test set: Average loss: 0.0315, Accuracy: 9902/10000 (99%)


Test set: Average loss: 0.0273, Accuracy: 9916/10000 (99%)


Test set: Average loss: 0.0271, Accuracy: 9912/10000 (99%)


Test set: Average loss: 0.0265, Accuracy: 9912/10000 (99%)


Test set: Average loss: 0.0308, Accuracy: 9896/10000 (99%)


Test set: Average loss: 0.0282, Accuracy: 9907/10000 (99%)


Test set: Average loss: 0.0276, Accuracy: 9911/10000 (99%)


Test set: Average loss: 0.0247, Accuracy: 9916/10000 (99%)
```

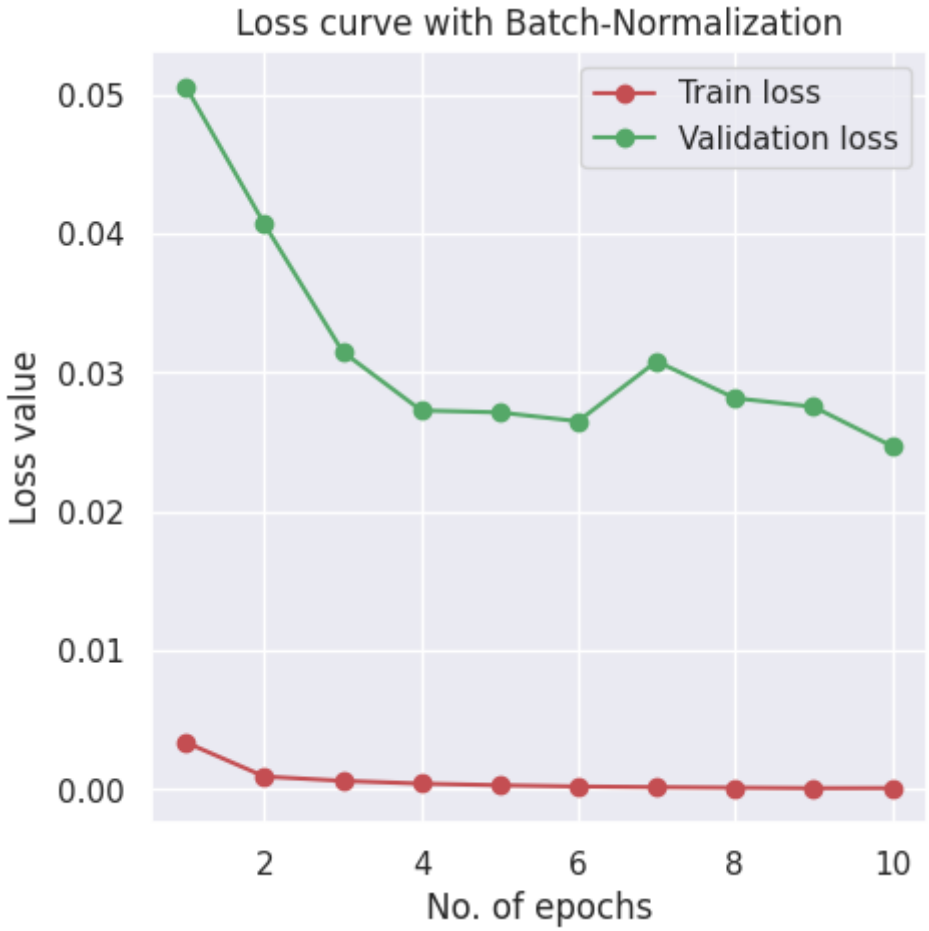
In [20]:

```
print("The time taken to run the model with Batch-Normalization is {:.6f} seconds".
```

```
The time taken to run the model with Batch-Normalization is 64.753434
seconds
```

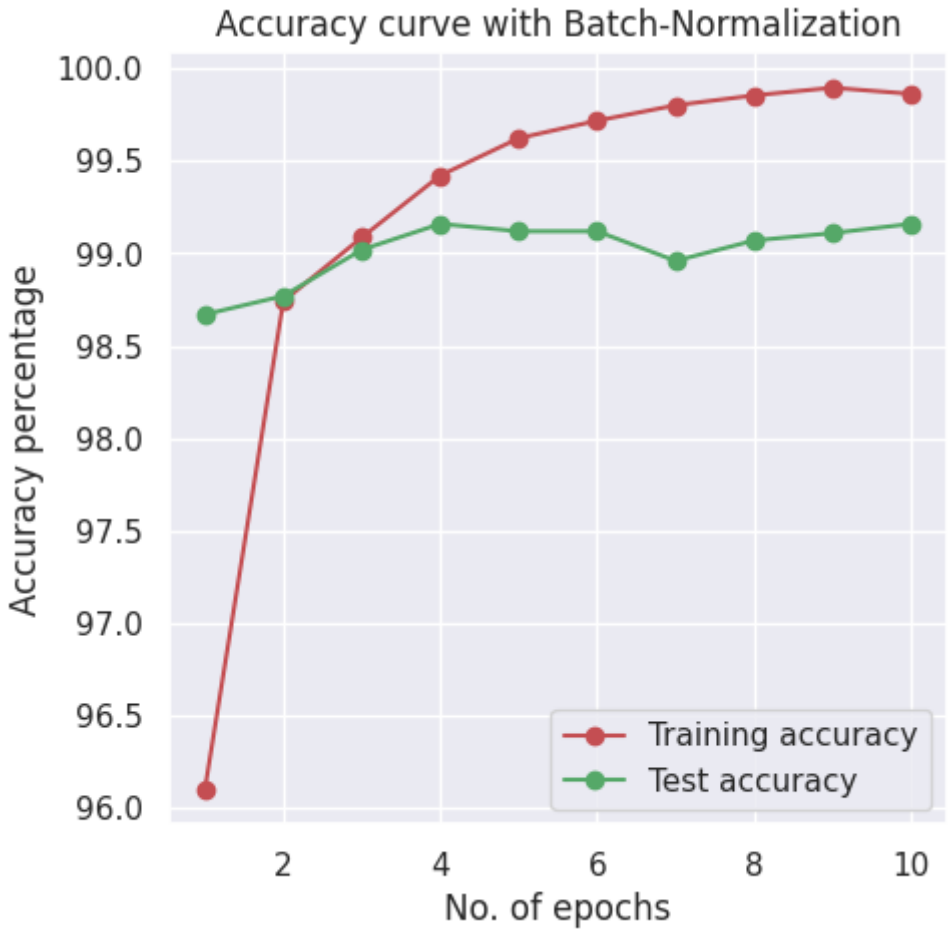
In [21]:

```
sns.set_theme()
plt.figure(figsize=(5, 5))
xval=np.arange(1,11,1)
plt.plot(xval,train_loss_bn,color='r',marker='o')
plt.plot(xval,test_loss_bn,color='g',marker='o')
plt.xlabel("No. of epochs")
plt.ylabel("Loss value")
plt.legend(["Train loss","Validation loss"])
plt.title("Loss curve with Batch-Normalization")
plt.grid(True)
```



In [22]:

```
plt.figure(figsize=(5, 5))
x=np.arange(1,11,1)
plt.plot(x,train_accuracy_bn,color='r',marker='o')
plt.plot(x,test_accuracy_bn,color='g',marker='o')
plt.xlabel("No. of epochs")
plt.ylabel("Accuracy percentage")
plt.legend(["Training accuracy","Test accuracy"])
plt.title("Accuracy curve with Batch-Normalization")
plt.grid(True)
```



In [23]:

```
avg_acc=sum(test_accuracy_bn)/10
print("The average accuracy of the test set is : {:.6f} without batch-normalization
```

```
The average accuracy of the test set is : 99.016000 without batch-norm
alization.
```

Question 2

In [24]:

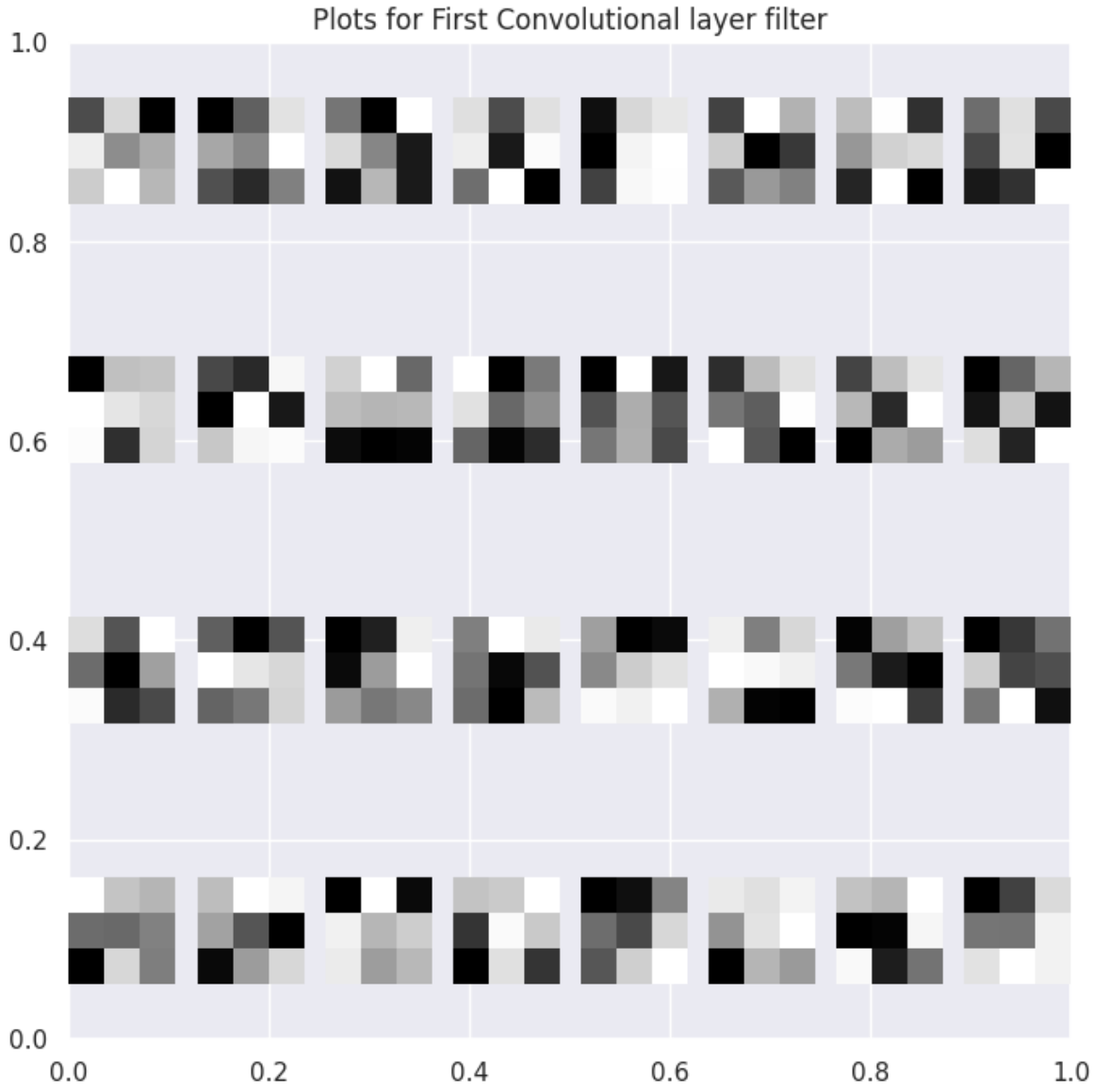
```
def visualize_filter_1(model,rows,column):
    conv1_weights=model.conv1[0].weight.detach().clone()
    conv1_weights=conv1_weights.cpu().numpy()# this is of size(32,1,3,3)

    fig = plt.figure(figsize=(8, 8))
    plt.title("Plots for First Convolutional layer filter")
    for i, filters in enumerate(conv1_weights):
        fig.add_subplot(rows,column , i+1)
        plt.imshow(filters[0,:,:],cmap='Greys')
        plt.axis('off')
```

In [25]:

```
def visualize_filter_2(model,rows,column,channel_for_conv2):

    conv2_weights=model.conv2[0].weight.detach().clone()
    conv2_weights=conv2_weights.cpu().numpy()# this is of size (32,32,3,3)

    fig = plt.figure(figsize=(5, 5))
    plt.title("Plots for second Convolutional layer for filter {}".format(channel_f
    for i, filters in enumerate(conv2_weights):
        fig.add_subplot(rows,column , i+1)
        plt.imshow(filters[channel_for_conv2,:,:])
        plt.axis('off')
```

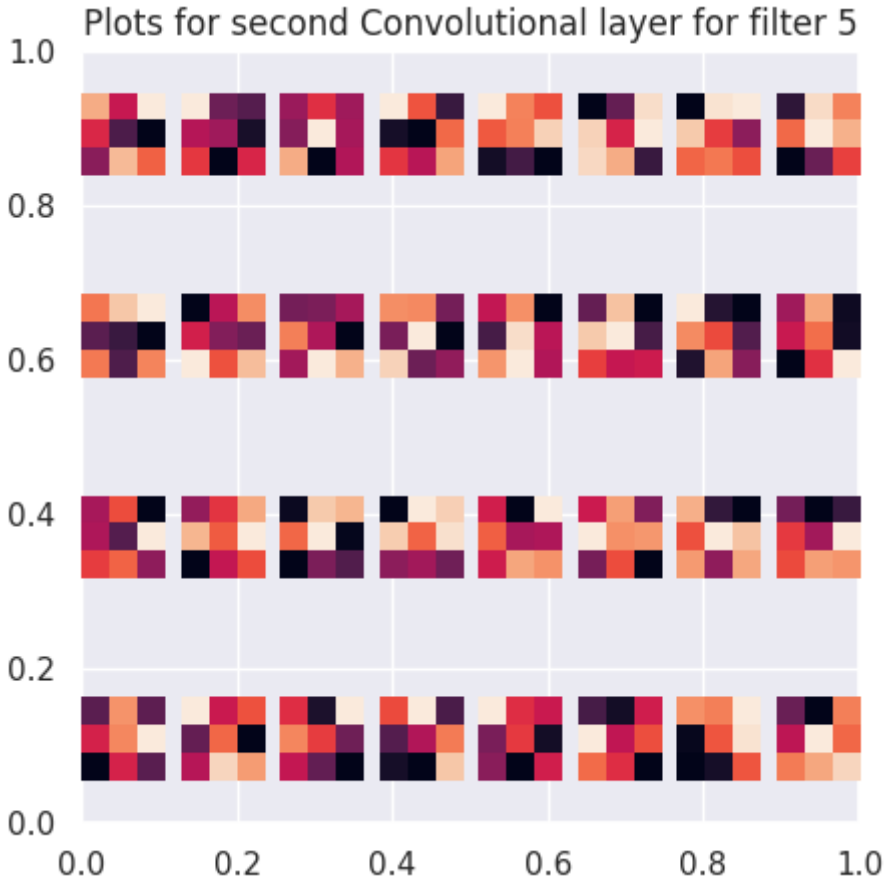
In [26]:

```
visualize_filter_1(model,rows=4,column=8) #first conv has 32 filters so 32 are show
```



In [27]:

```
visualize_filter_2(model,rows=4,column=8,channel_for_conv2=5)
```



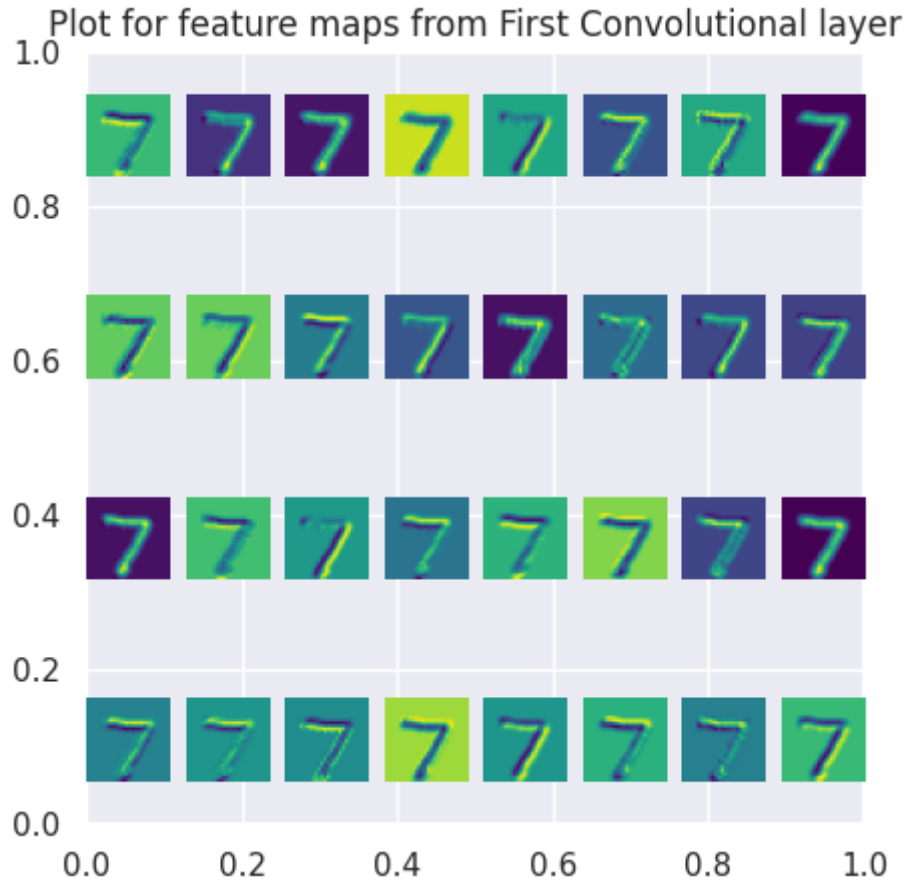
In [28]:

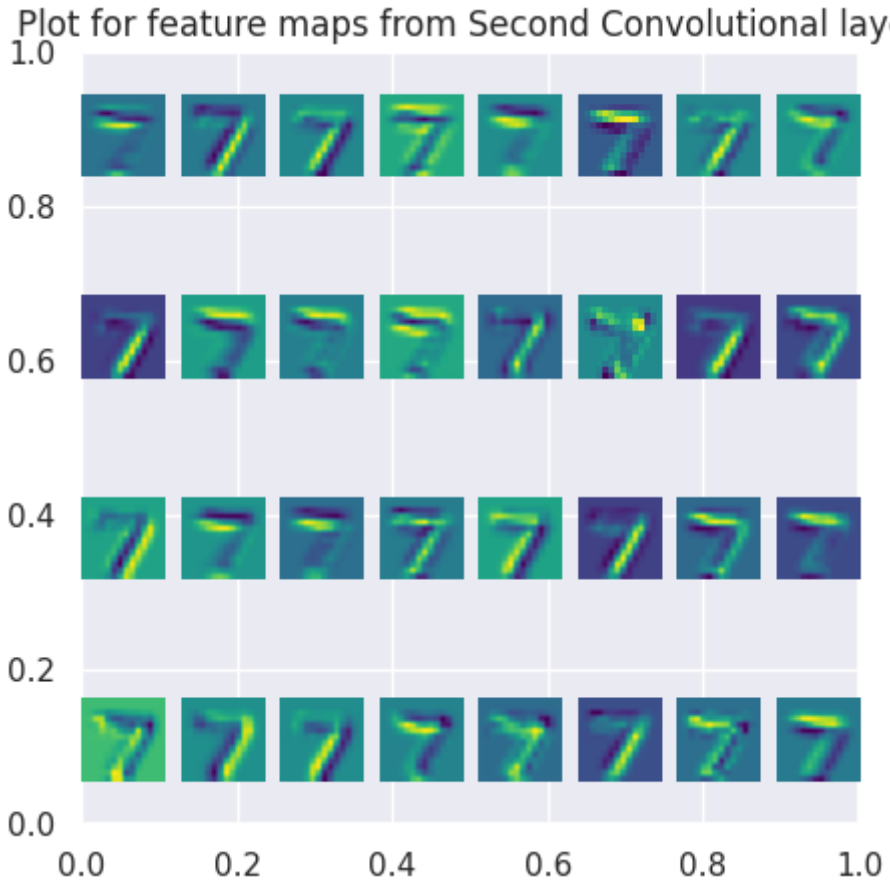
```
def feature_map(model,test_loader):
    image_idx=int(input("select a index from test set whose feature maps you want t
    test_image = test_loader.dataset.data[image_idx, :, :].clone().reshape(1, 1, 28

    val=test_loader.dataset.targets
    test_image_id=int(val[image_idx].detach().cpu().numpy())
    print("True label of the selected number is",test_image_id)
    #For the first conv2d

    with torch.no_grad():
        output_conv1=model.conv1[0].forward(test_image)# the shape is (1,32,28,28)
        output_conv1=output_conv1.reshape(32,1,28,28).cpu().numpy()

        fig = plt.figure(figsize=(5, 5))
        plt.title("Plot for feature maps from First Convolutional layer")
        for i, filters in enumerate(output_conv1):
            fig.add_subplot(4,8,i+1)
            plt.imshow(filters[0,:,:],cmap='viridis')
            plt.axis('off')

    #For second conv2d

    with torch.no_grad():
        output_conv1=model.conv1.forward(test_image)
        output_conv2=model.conv2[0].forward(output_conv1)# the shape is (1,32,14,14
        output_conv2=output_conv2.reshape(32,1,14,14).cpu().numpy()


        fig = plt.figure(figsize=(5, 5))
        plt.title("Plot for feature maps from Second Convolutional layer")
        for i, filters in enumerate(output_conv2):
            fig.add_subplot(4,8, i+1)
            plt.imshow(filters[0,:,:],cmap='viridis')
            plt.axis('off')
```

In [29]:

```
feature_map(model,test_loader)
```

```
select a index from test set whose feature maps you want to visualize
0
True label of the selected number is 7
```




Plot for feature maps from Second Convolutional layer
1.0
0.8
0.6
0.4
0.2
0.0
0.0
0.2
0.4
0.6
0.8
1.0

In [30]:

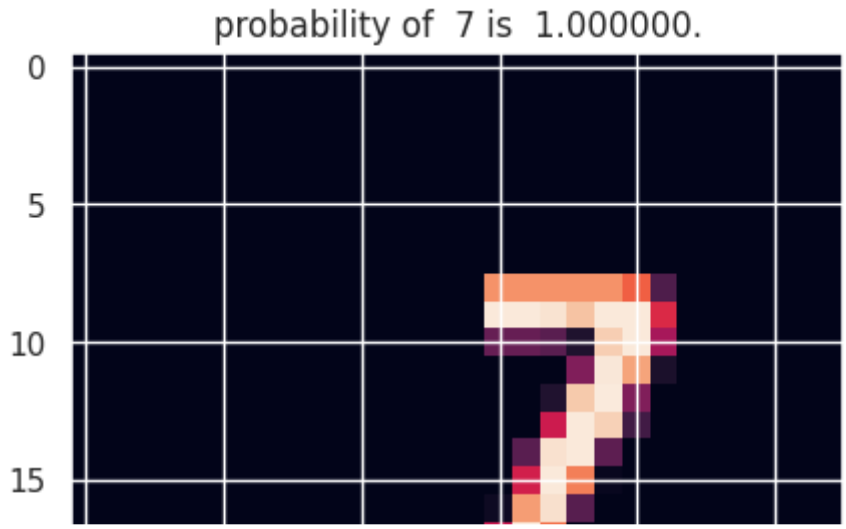
```
def occulusion_effects(model,occluding_size,occluding_stride):
    image_idx=int(input("Choose the index for test image for occulusion effect\n"))
    test_image=test_loader.dataset.data[image_idx, :, :].clone()

    val=test_loader.dataset.targets
    test_image_id=int(val[image_idx].detach().cpu().numpy())
    print("True label",test_image_id)

    height, width= test_image.size()
    output_height = int(np.ceil((height-occluding_size)/occluding_stride+1))
    output_width = int(np.ceil((width-occluding_size)/occluding_stride+1))

    probability_map = np.zeros((output_height, output_width))
    max_probable_class_map = np.zeros_like(probability_map)
    fig = plt.figure(figsize=(5, 5))
    for h in range(output_height):
        for w in range(output_width):
            #occluder region
            h_start = h*occluding_stride
            w_start = w*occluding_stride
            h_end = min(height, h_start + occluding_size)
            w_end = min(width, w_start + occluding_size)

            input_image = test_image.clone()
            input_image[h_start:h_end,w_start:w_end] =  0

            with torch.no_grad():
                input_image = input_image.clone().reshape(1,1,28,28).cuda().float()

                out=model.conv1.forward(input_image)
                out=model.conv2.forward(out)
                out=out.reshape(out.size(0), -1)
                out=model.fclayer1.forward(out)
                out=model.fclayer2.forward(out)
                probablities = F.softmax(out, dim=1).cpu().detach().numpy()

                prediction = np.argmax(probablities)
                probability = probablities[:, test_image_id]
                probability_map[int(h/2),int(w/2)] = probability[0]
                max_probable_class_map[int(h/2),int(w/2)] = prediction


            if ((w%4==0)&(h%4==0)):

                        plt.imshow(input_image.cpu().numpy().reshape(28,28))
                        plt.title("probability of  {} is  {:.6f}.".format(
                            test_image_id, probability[0]))
                        plt.show()

    print("\n\nProbability of {} as the patch is moved.".format(test_image_id))
    print(probability_map)
    print("\n\nMaximum probable class as the patch is moved.")
    print(max_probable_class_map)
    print("\n\n")
    print(f"predicted class {prediction}")
    ax1=sns.heatmap(probability_map,cmap='flare')
    ax1.set_title(f"Probability Heatmap of class {test_image_id}")
    plt.xlabel("x-patch")
    plt.ylabel("y-patch")
```

```
    plt.show()
```

In [31]:

```
## hyperparameters
occluding_patch=15
occlusing_stride=2

occulusion_effects(model,occluding_patch,occlusing_stride)
#Larger patch size makes the network inefficient
```

```
Choose the index for test image for occulusion effect
0
True label 7
```



Question 3.1 : *Non – Targeted attack*

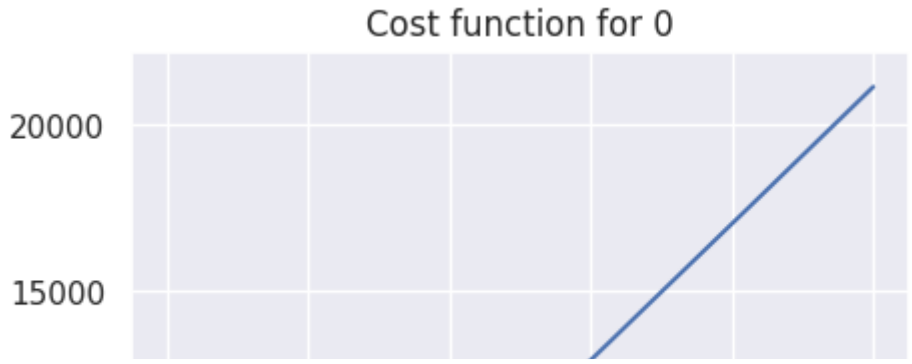
In [32]:

```
def non_targeted_attack(network,non_targetted_steps,step_size):

    noise = np.random.normal(loc=128, scale=10, size=(28,28))
    noise_tensor = torch.from_numpy(noise).reshape(1,1,28,28).cuda().float()

    for class_label in range(10):
        target_class=class_label

        noise_tensor =  torch.tensor(noise_tensor.type(torch.cuda.FloatTensor), req

        logit_values=[]#the output just after softmax

        for step in range(non_targetted_steps):

            noise_tensor = Variable(noise_tensor, requires_grad=True)
            out = network.conv1.forward(noise_tensor)
            out = network.conv2.forward(out)
            out = out.reshape(out.size(0), -1)
            out = network.fclayer1.forward(out)
            out = network.fclayer2.forward(out)
            loss=out[:,target_class]


            logit_values.append(loss.cpu().detach().numpy())

            loss.backward(retain_graph=True)#this will store the intermediatory res

            grad=torch.sign(noise_tensor.grad.data)

            noise_tensor=noise_tensor + grad*step_size #following gradient ascent n

        plt.clf()
        fig = plt.figure(figsize=(5, 5))
        plt.plot(np.asfarray(logit_values))
        plt.title(f"Cost function for {target_class}")
        plt.grid(True)
        plt.show()

        adversarial= noise_tensor.cpu().reshape(28,28).detach().numpy()
        adversarial = adversarial - np.min(adversarial)
        adversarial = adversarial/np.max(adversarial)
        plt.imshow(adversarial,cmap='crest')
        plt.title(f"Generated image of {target_class}")
        plt.show()
```

In [33]:

```
non_targeted_attack(model,non_targetted_steps=10000,step_size=0.1)
```

```
/tmp/ipykernel_99717/1118582683.py:9: UserWarning: To copy construct
from a tensor, it is recommended to use sourceTensor.clone().detach
() or sourceTensor.clone().detach().requires_grad_(True), rather tha
n torch.tensor(sourceTensor).
  noise_tensor =  torch.tensor(noise_tensor.type(torch.cuda.FloatTen
sor), requires_grad=True, device='cuda')

<Figure size 640x480 with 0 Axes>
```



Question 3.2 : Targeted Attack

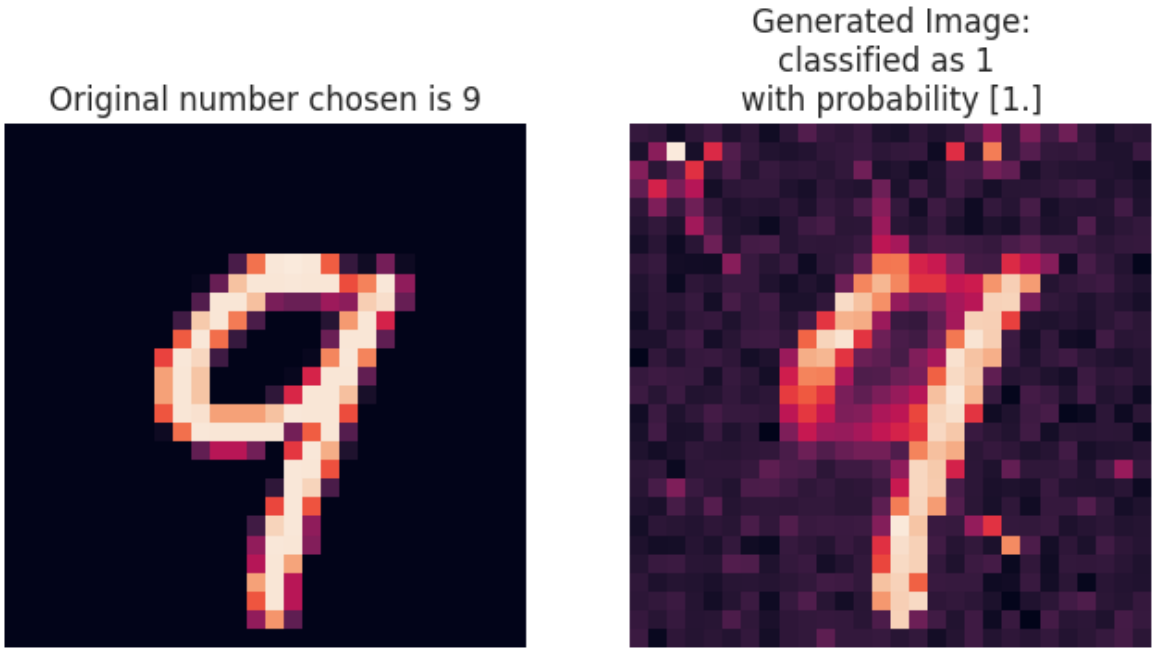
In [47]:

```
def targetted_attack(network,targetted_steps=1000,step_size=0.01,beta=0.00001):

    original_image_index=int(input("Enter a index value for the original image that
    misclassified_image_index=int(input("Enter the index for the target image that


    #the image that has to be generated
    target_image = test_loader.dataset.data[original_image_index, :,:].clone().resh

    val=test_loader.dataset.targets
    original_image_id=int(val[original_image_index].detach().cpu().numpy())
    misclassified_image_id=int(val[misclassified_image_index].detach().cpu().numpy(
    #print(f"Original number generated is {original_image_id}  and number it will m


    #Creating noise from which target_image will be generated

    noise = np.random.normal(loc=128, scale=10, size=(28,28))
    noise_tensor = torch.from_numpy(noise).reshape(1,1,28,28).cuda().float()


    for step in range(targetted_steps):

        noise_tensor = Variable(noise_tensor, requires_grad=True)
        out = network.conv1.forward(noise_tensor)
        out = network.conv2.forward(out)
        out = out.reshape(out.size(0), -1)
        out = network.fclayer1.forward(out)
        out = network.fclayer2.forward(out)
        probablities = F.softmax(out, dim=1)


        logit=out[:, misclassified_image_id]
        mse_error = F.mse_loss(noise_tensor, target_image)

        loss=logit-beta*mse_error

        loss.backward(retain_graph=True)
        input_grad = torch.sign(noise_tensor.grad.data)
        noise_tensor = noise_tensor+step_size*input_grad

    misclass_porb=probablities[:,misclassified_image_id].cpu().detach().numpy()
    img_gen= noise_tensor.cpu().reshape(28,28).detach().numpy()

    f,axarr=plt.subplots(1,2,figsize=(8, 8))
    axarr[0].imshow(target_image.cpu().reshape(28,28).numpy())
    axarr[0].set_title(f"Original number chosen is {original_image_id}")
    axarr[0].axis("off")
    axarr[1].imshow(img_gen)
    axarr[1].set_title(f"Generated Image:\nclassified as {misclassified_image_id} \
    axarr[1].axis("off")
    plt.show()
```

In [57]:

```
targetted_attack(model,targetted_steps=1000,step_size=0.1,beta=0.5)
```

```
Enter a index value for the original image that should be generated :
12
Enter the index for the target image that will misclassify to : 2
```



Question 3.3 : *Noise Addition*

In [91]:

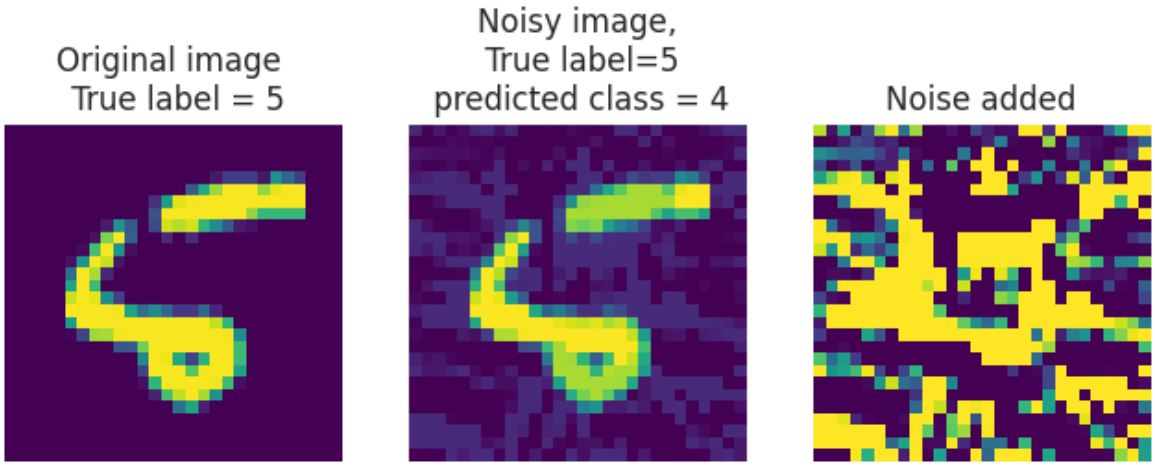
```
def noise_addition(network,original_image_index,misclassified_image_index,another_i

    #original_image_index=int(input("Enter a index value for the original image tha
    #misclassified_image_index=int(input("Enter the index for the target image that


    #the image that will be misclasisified by adding noise
    target_image = test_loader.dataset.data[original_image_index, :,:].clone().resh

    val=test_loader.dataset.targets
    original_image_id=int(val[original_image_index].detach().cpu().numpy())
    misclassified_image_id=int(val[misclassified_image_index].detach().cpu().numpy(


    #noise tensor that will be updated so that original class is misclassified
    noise = np.zeros((28,28))
    noise_tensor = torch.from_numpy(noise).reshape(1,1,28,28).cuda().float()

    class_max_prob=original_image_id

    while(class_max_prob!=misclassified_image_id):

        noise_tensor = Variable(noise_tensor, requires_grad=True)
        out = network.conv1.forward(noise_tensor+target_image)
        out = network.conv2.forward(out)
        out = out.reshape(out.size(0), -1)
        out = network.fclayer1.forward(out)
        out = network.fclayer2.forward(out)

        probablity = F.softmax(out, dim=1).cpu().detach().numpy()
        class_max_prob=int(np.argmax(probablity))

        prob_misclassified=probablity[:,misclassified_image_id]

        loss=out[:,misclassified_image_id]

        loss.backward(retain_graph=True)

        #Normalizing the derivatives
        grad = torch.sign(noise_tensor.grad.data)
        grad = grad - grad.min()
        grad = grad/grad.max()

        noise_tensor=noise_tensor+ alpha*grad

    noisy_image=(noise_tensor+target_image).cpu().reshape(28,28).detach().numpy()
    noise_of_image=noise_tensor.cpu().reshape(28,28).detach().numpy()

    plt.figure(figsize=(8,8))
    f, axarr = plt.subplots(1,3,figsize=(8, 8))
    axarr[0].imshow(target_image.cpu().reshape(28,28).numpy(),cmap='viridis')
    axarr[0].set_title(f"Original image \n True label = {original_image_id}")
    axarr[0].axis('off')
    axarr[1].imshow(noisy_image,cmap='viridis')
    axarr[1].set_title(f"Noisy image,\n True label={original_image_id}\n predicted
    axarr[1].axis('off')
    axarr[2].imshow(noise_of_image,cmap='viridis')
    axarr[2].set_title(f"Noise added")
    axarr[2].axis('off')
```

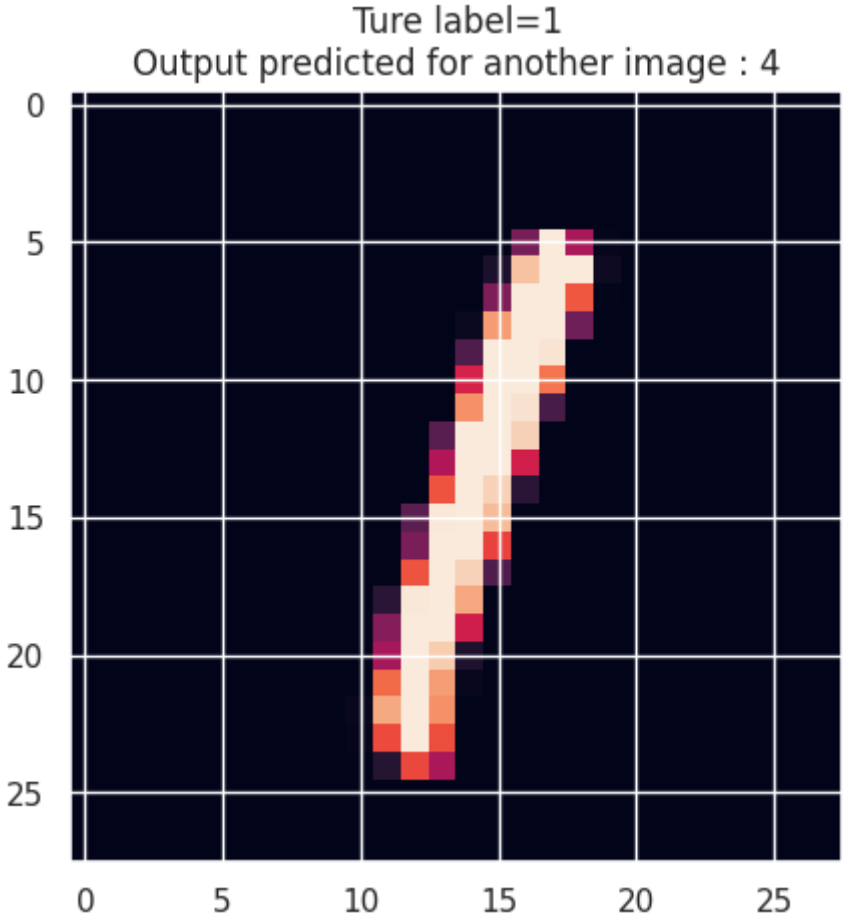
```
    plt.show()

    ##Adding the noise on another image to see how it clasifies

    another_image_id=int(val[another_image_index].detach().cpu().numpy())
    another_image=test_loader.dataset.data[another_image_index, :,:].clone().reshap



    out = network.conv1.forward(noise_tensor+another_image)
    out = network.conv2.forward(out)
    out = out.reshape(out.size(0), -1)
    out = network.fclayer1.forward(out)
    out = network.fclayer2.forward(out)
    prob = F.softmax(out, dim=1).cpu().detach().numpy()
    output_class=int(np.argmax(probablity))

    plt.figure(figsize=(5,5))
    plt.imshow(another_image.cpu().reshape(28,28).detach().numpy())
    plt.title(f"Ture label={another_image_id}\nOutput predicted for another image :
```

In [92]:

```
index_list=[13,5,1,18,6,8,11,0,61,12]#Manually hardcoded
import random
original_image_index,misclassified_image_index,another_image=random.sample(index_li
output=noise_addition(model,original_image_index,misclassified_image_index,another_
```

```
<Figure size 800x800 with 0 Axes>
```





In [ ]:

```
```