Lab Assignment: 7

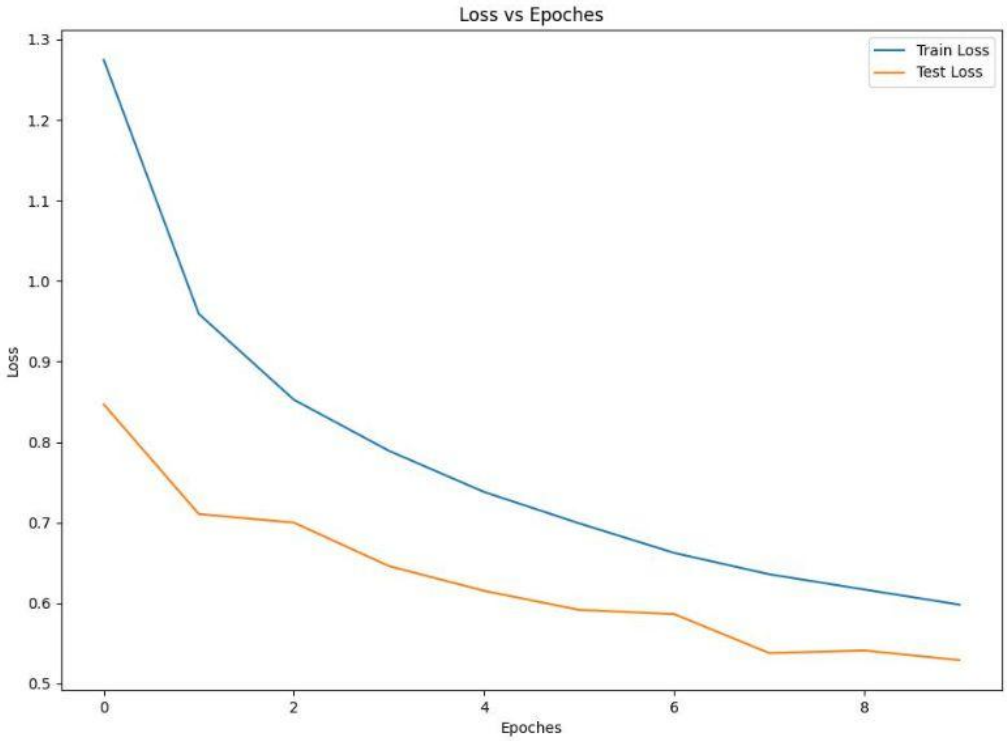
- Import require libraries
- Write device agnostic code
- Load dataset and make data loader with preprocessing
- Write train and test loop for model
- Take cross entropy as loss and write accuray function
- Write plot function for loss and accuracy vs epochs
- First, train model for 10 epochs then 15 epoche with learning rate 0.001
- After that, tune hyper parameter taking learning (0.01, 0.001) and betas [(0.85,0.8585), (0.95, 0.9595)]
- Note down the result

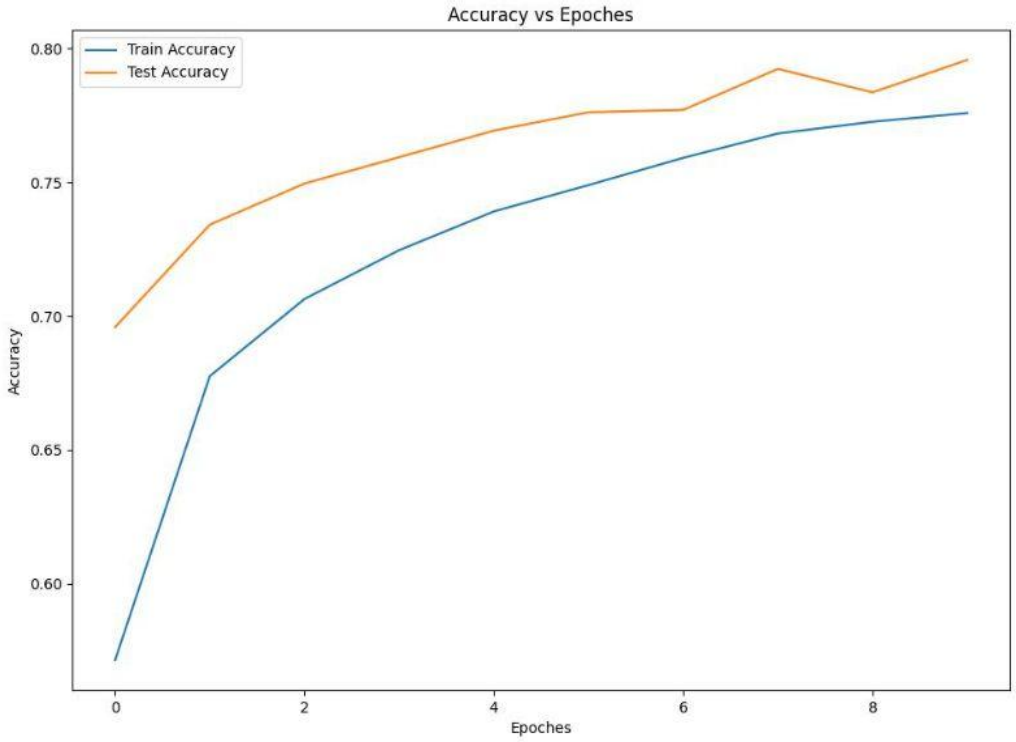
Result:

For 10 Epoches:

```
0%|          | 0/10 [00:00<?, ?it/s]
10%|▉         | 1/10 [00:47<07:03, 47.02s/it]
20%|██        | 2/10 [01:32<06:08, 46.01s/it]
30%|███       | 3/10 [02:19<05:26, 46.63s/it]
40%|████      | 4/10 [03:07<04:43, 47.21s/it]
50%|█████     | 5/10 [03:54<03:55, 47.04s/it]
60%|██████    | 6/10 [04:40<03:07, 46.78s/it]
70%|███████   | 7/10 [05:26<02:19, 46.52s/it]
80%|████████  | 8/10 [06:14<01:33, 46.93s/it]
90%|█████████ | 9/10 [07:00<00:46, 46.70s/it]
100%|██████████| 10/10 [07:46<00:00, 46.54s/it]
100%|██████████| 10/10 [07:46<00:00, 46.70s/it]
Epoch: 1
Train Loss: 1.2746 | Test Loss: 0.8468 || Train Accuracy: 0.5714 | Test
Accuracy: 0.6959
Epoch: 2
Train Loss: 0.9591 | Test Loss: 0.7106 || Train Accuracy: 0.6775 | Test
Accuracy: 0.7342
Epoch: 3
Train Loss: 0.8525 | Test Loss: 0.6999 || Train Accuracy: 0.7064 | Test
Accuracy: 0.7495
Epoch: 4
Train Loss: 0.7891 | Test Loss: 0.6460 || Train Accuracy: 0.7246 | Test
Accuracy: 0.7594
Epoch: 5
```

```
Train Loss: 0.7380 | Test Loss: 0.6152 || Train Accuracy: 0.7391 | Test
Accuracy: 0.7693
Epoch: 6
Train Loss: 0.6990 | Test Loss: 0.5916 || Train Accuracy: 0.7490 | Test
Accuracy: 0.7762
Epoch: 7
Train Loss: 0.6623 | Test Loss: 0.5863 || Train Accuracy: 0.7591 | Test
Accuracy: 0.7771
Epoch: 8
Train Loss: 0.6358 | Test Loss: 0.5379 || Train Accuracy: 0.7682 | Test
Accuracy: 0.7924
Epoch: 9
Train Loss: 0.6168 | Test Loss: 0.5411 || Train Accuracy: 0.7726 | Test
Accuracy: 0.7836
Epoch: 10
Train Loss: 0.5980 | Test Loss: 0.5291 || Train Accuracy: 0.7759 | Test
Accuracy: 0.7958
Time To Train Model: 466.97 seconds
```



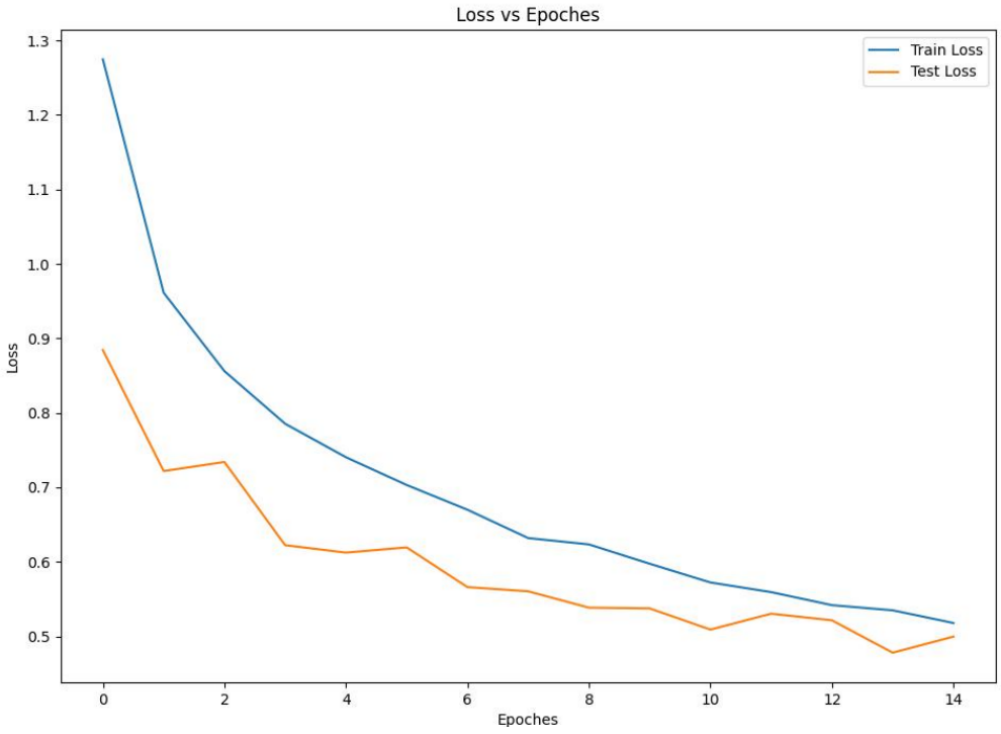


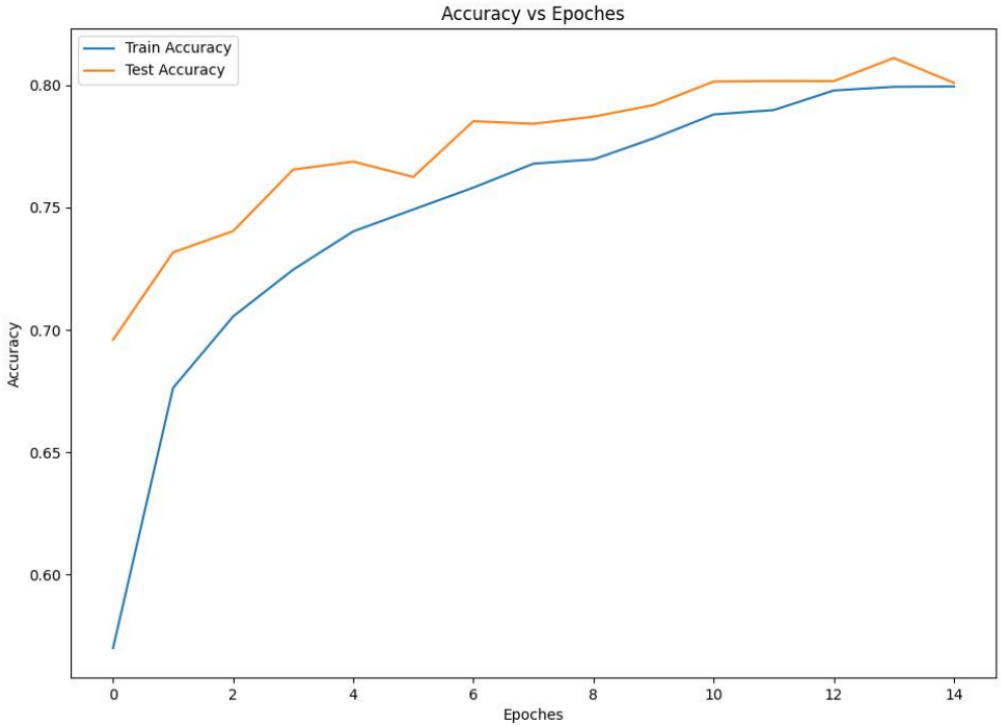
For 15 epochs:

```
0%|          | 0/15 [00:00<?, ?it/s]
 7%|▋         | 1/15 [00:46<10:53, 46.67s/it]
13%|█▎        | 2/15 [01:33<10:07, 46.76s/it]
20%|██        | 3/15 [02:20<09:20, 46.75s/it]
27%|██▋       | 4/15 [03:06<08:32, 46.63s/it]
33%|███▎      | 5/15 [03:53<07:46, 46.69s/it]
40%|████      | 6/15 [04:40<07:00, 46.71s/it]
47%|████▋     | 7/15 [05:26<06:12, 46.62s/it]
53%|█████▎    | 8/15 [06:13<05:26, 46.65s/it]
60%|██████    | 9/15 [06:59<04:39, 46.64s/it]
67%|██████▋   | 10/15 [07:46<03:53, 46.61s/it]
73%|███████▎  | 11/15 [08:33<03:06, 46.64s/it]
80%|████████  | 12/15 [09:19<02:19, 46.64s/it]
87%|████████▋ | 13/15 [10:06<01:33, 46.59s/it]
93%|█████████▎| 14/15 [10:53<00:46, 46.63s/it]
100%|██████████| 15/15 [11:39<00:00, 46.66s/it]
100%|██████████| 15/15 [11:39<00:00, 46.65s/it]
Epoch: 1
Train Loss: 1.2746 | Test Loss: 0.8844 || Train Accuracy: 0.5700 | Test
Accuracy: 0.6960
```

```
Epoch: 2
Train Loss: 0.9613 | Test Loss: 0.7218 || Train Accuracy: 0.6763 | Test
Accuracy: 0.7317
Epoch: 3
Train Loss: 0.8561 | Test Loss: 0.7340 || Train Accuracy: 0.7055 | Test
Accuracy: 0.7404
Epoch: 4
Train Loss: 0.7854 | Test Loss: 0.6223 || Train Accuracy: 0.7246 | Test
Accuracy: 0.7655
Epoch: 5
Train Loss: 0.7404 | Test Loss: 0.6123 || Train Accuracy: 0.7403 | Test
Accuracy: 0.7688
Epoch: 6
Train Loss: 0.7031 | Test Loss: 0.6193 || Train Accuracy: 0.7492 | Test
Accuracy: 0.7625
Epoch: 7
Train Loss: 0.6699 | Test Loss: 0.5660 || Train Accuracy: 0.7582 | Test
Accuracy: 0.7853
Epoch: 8
Train Loss: 0.6318 | Test Loss: 0.5604 || Train Accuracy: 0.7680 | Test
Accuracy: 0.7842
Epoch: 9
Train Loss: 0.6234 | Test Loss: 0.5384 || Train Accuracy: 0.7697 | Test
Accuracy: 0.7872
Epoch: 10
Train Loss: 0.5974 | Test Loss: 0.5374 || Train Accuracy: 0.7783 | Test
Accuracy: 0.7919
Epoch: 11
Train Loss: 0.5722 | Test Loss: 0.5090 || Train Accuracy: 0.7880 | Test
Accuracy: 0.8015
Epoch: 12
Train Loss: 0.5593 | Test Loss: 0.5303 || Train Accuracy: 0.7898 | Test
Accuracy: 0.8017
Epoch: 13
Train Loss: 0.5418 | Test Loss: 0.5214 || Train Accuracy: 0.7979 | Test
Accuracy: 0.8017
Epoch: 14
Train Loss: 0.5349 | Test Loss: 0.4780 || Train Accuracy: 0.7994 | Test
Accuracy: 0.8111
Epoch: 15
```

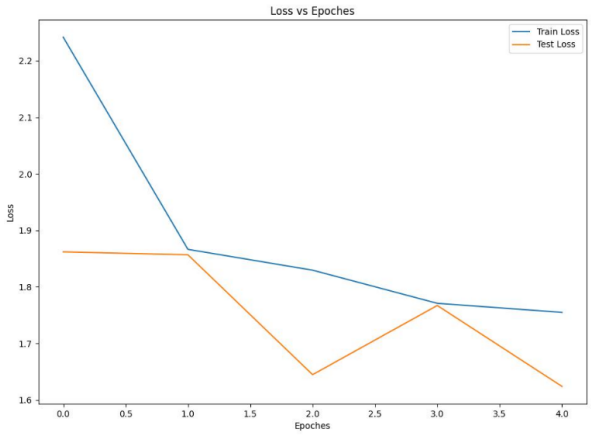
```
Train Loss: 0.5178 | Test Loss: 0.4995 || Train Accuracy: 0.7995 | Test
Accuracy: 0.8010
Time To Train Model: 699.79 seconds
```

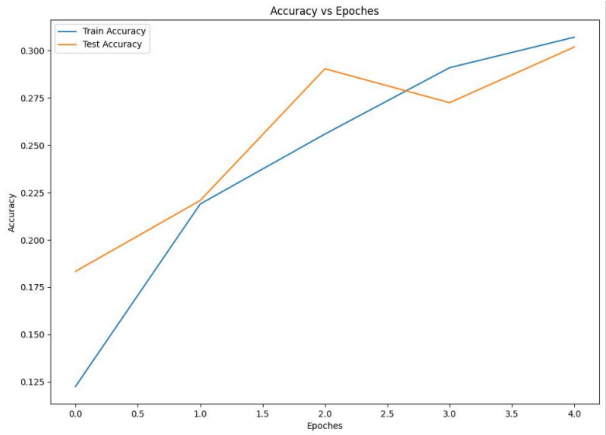




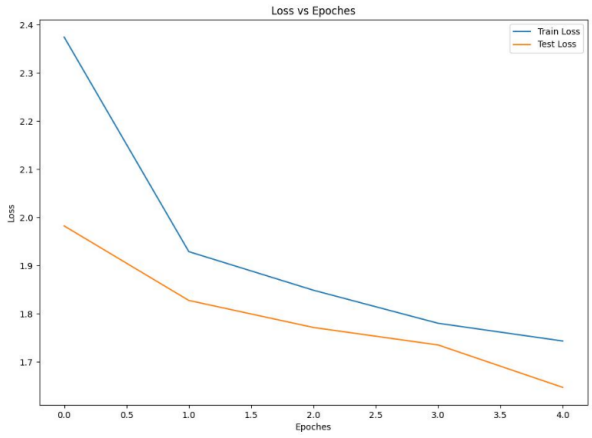
HYPER PARAMETER TUNING:

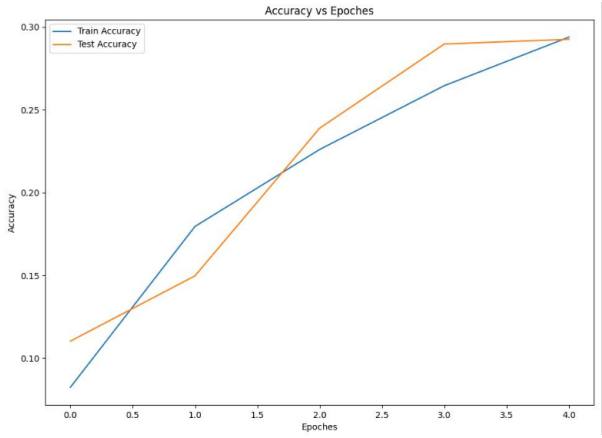
```
iter: 1 / 4
Tuning with --- lr: 0.01, betas: (0.85, 0.8585)

  0%|          | 0/5 [00:00<?, ?it/s]
 20%|██        | 1/5 [00:46<03:06, 46.63s/it]
 40%|████      | 2/5 [01:33<02:20, 46.69s/it]
 60%|██████    | 3/5 [02:20<01:33, 46.70s/it]
 80%|████████  | 4/5 [03:06<00:46, 46.70s/it]
100%|██████████| 5/5 [03:53<00:00, 46.69s/it]
100%|██████████| 5/5 [03:53<00:00, 46.69s/it]
Epoch: 1
Train Loss: 2.2418 | Test Loss: 1.8620 || Train Accuracy: 0.1226 | Test
Accuracy: 0.1834
Epoch: 2
Train Loss: 1.8665 | Test Loss: 1.8568 || Train Accuracy: 0.2189 | Test
Accuracy: 0.2208
Epoch: 3
Train Loss: 1.8296 | Test Loss: 1.6447 || Train Accuracy: 0.2559 | Test
Accuracy: 0.2904
Epoch: 4
Train Loss: 1.7709 | Test Loss: 1.7671 || Train Accuracy: 0.2909 | Test
Accuracy: 0.2725
Epoch: 5
Train Loss: 1.7549 | Test Loss: 1.6240 || Train Accuracy: 0.3070 | Test
Accuracy: 0.3018
Time To Train Model: 233.46 seconds
```





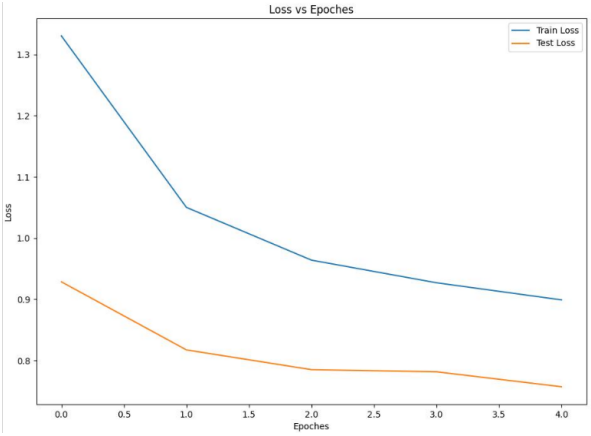
```
iter: 2 / 4
Tuning with --- lr: 0.01, betas: (0.95, 0.9595)

  0%|          | 0/5 [00:00<?, ?it/s]
 20%|██        | 1/5 [00:46<03:07, 46.77s/it]
 40%|████      | 2/5 [01:33<02:20, 46.74s/it]
 60%|██████    | 3/5 [02:20<01:33, 46.69s/it]
 80%|████████  | 4/5 [03:06<00:46, 46.73s/it]
100%|██████████| 5/5 [03:53<00:00, 46.71s/it]
100%|██████████| 5/5 [03:53<00:00, 46.72s/it]
Epoch: 1
Train Loss: 2.3741 | Test Loss: 1.9823 || Train Accuracy: 0.0824 | Test
Accuracy: 0.1103
Epoch: 2
Train Loss: 1.9289 | Test Loss: 1.8276 || Train Accuracy: 0.1796 | Test
Accuracy: 0.1497
Epoch: 3
Train Loss: 1.8488 | Test Loss: 1.7715 || Train Accuracy: 0.2260 | Test
Accuracy: 0.2389
Epoch: 4
Train Loss: 1.7802 | Test Loss: 1.7352 || Train Accuracy: 0.2646 | Test
Accuracy: 0.2897
Epoch: 5
Train Loss: 1.7434 | Test Loss: 1.6471 || Train Accuracy: 0.2939 | Test
Accuracy: 0.2926
Time To Train Model: 233.59 seconds
```

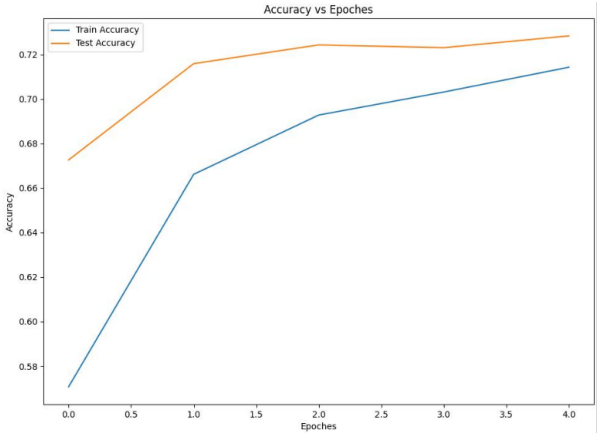





```
iter: 3 / 4
Tuning with --- lr: 0.001, betas: (0.85, 0.8585)
```

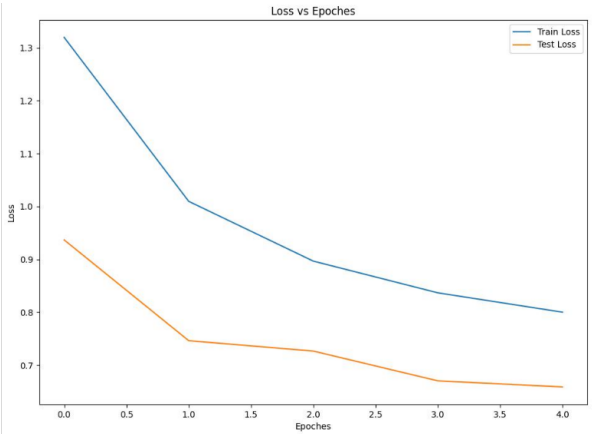
```
 0%|          | 0/5 [00:00<?, ?it/s]
20%|██        | 1/5 [00:46<03:06, 46.59s/it]
40%|████      | 2/5 [01:33<02:20, 46.72s/it]
60%|██████    | 3/5 [02:20<01:33, 46.78s/it]
80%|████████  | 4/5 [03:06<00:46, 46.74s/it]
100%|██████████| 5/5 [03:53<00:00, 46.81s/it]
100%|██████████| 5/5 [03:53<00:00, 46.77s/it]
Epoch: 1
Train Loss: 1.3304 | Test Loss: 0.9286 || Train Accuracy: 0.5707 | Test
Accuracy: 0.6726
Epoch: 2
Train Loss: 1.0502 | Test Loss: 0.8174 || Train Accuracy: 0.6661 | Test
Accuracy: 0.7158
Epoch: 3
Train Loss: 0.9640 | Test Loss: 0.7851 || Train Accuracy: 0.6928 | Test
Accuracy: 0.7243
Epoch: 4
Train Loss: 0.9271 | Test Loss: 0.7816 || Train Accuracy: 0.7031 | Test
Accuracy: 0.7230
Epoch: 5
Train Loss: 0.8991 | Test Loss: 0.7572 || Train Accuracy: 0.7142 | Test
Accuracy: 0.7283
Time To Train Model: 233.87 seconds
```

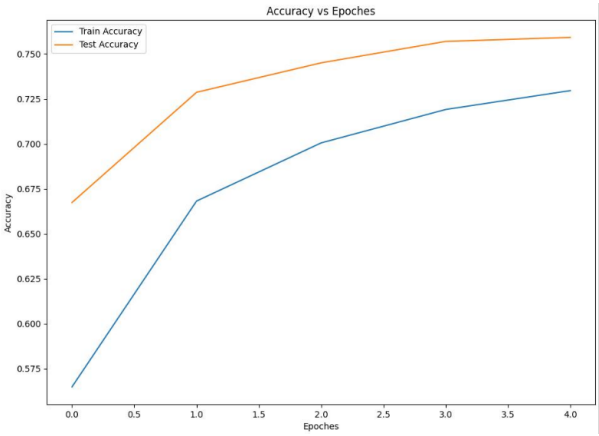





```
iter: 4 / 4
Tuning with --- lr: 0.001, betas: (0.95, 0.9595)

 0%|          | 0/5 [00:00<?, ?it/s]
```

```
20%|██          | 1/5 [00:46<03:06, 46.72s/it]
40%|████        | 2/5 [01:33<02:19, 46.65s/it]
60%|██████      | 3/5 [02:20<01:33, 46.74s/it]
80%|████████    | 4/5 [03:06<00:46, 46.76s/it]
100%|██████████| 5/5 [03:53<00:00, 46.74s/it]
100%|██████████| 5/5 [03:53<00:00, 46.73s/it]
Epoch: 1
Train Loss: 1.3195 | Test Loss: 0.9369 || Train Accuracy: 0.5649 | Test
Accuracy: 0.6674
Epoch: 2
Train Loss: 1.0097 | Test Loss: 0.7464 || Train Accuracy: 0.6682 | Test
Accuracy: 0.7287
Epoch: 3
Train Loss: 0.8967 | Test Loss: 0.7268 || Train Accuracy: 0.7006 | Test
Accuracy: 0.7450
Epoch: 4
Train Loss: 0.8368 | Test Loss: 0.6705 || Train Accuracy: 0.7191 | Test
Accuracy: 0.7569
Epoch: 5
Train Loss: 0.8003 | Test Loss: 0.6590 || Train Accuracy: 0.7296 | Test
Accuracy: 0.7592
Time To Train Model: 233.66 seconds
```





Observation:

- MobileNet-V2 perform good than previous custom build CNN
- SLURM perform better than Google Colab because colab is cloud based GPU Provider.

- Best hyperparameters are learning: 0.001, betas: (0.95, 0.9595) for 72.96% train and 75.92% test accuracy
- And for learning rate 0.01 and betas: (0.85, 0.8585) model give concave curve.