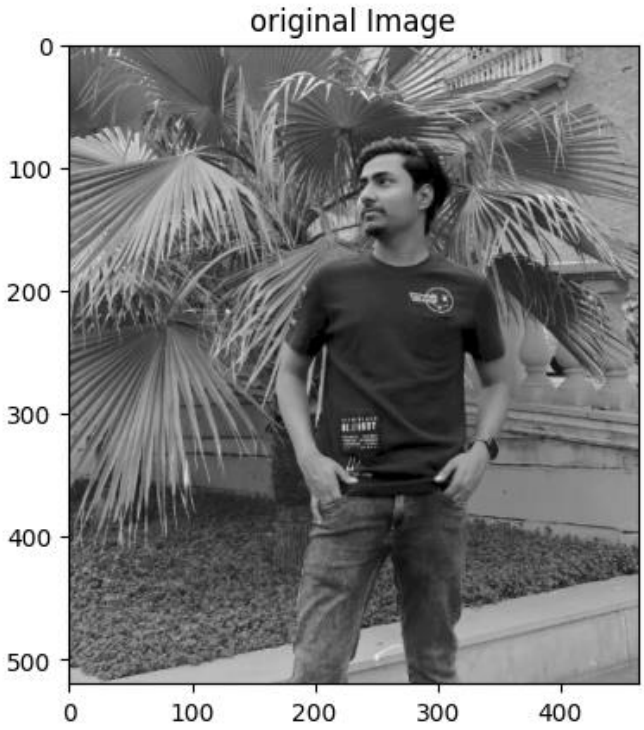
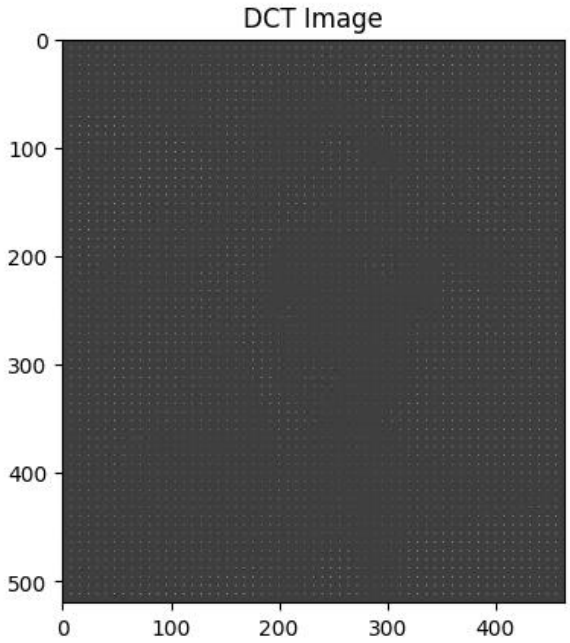
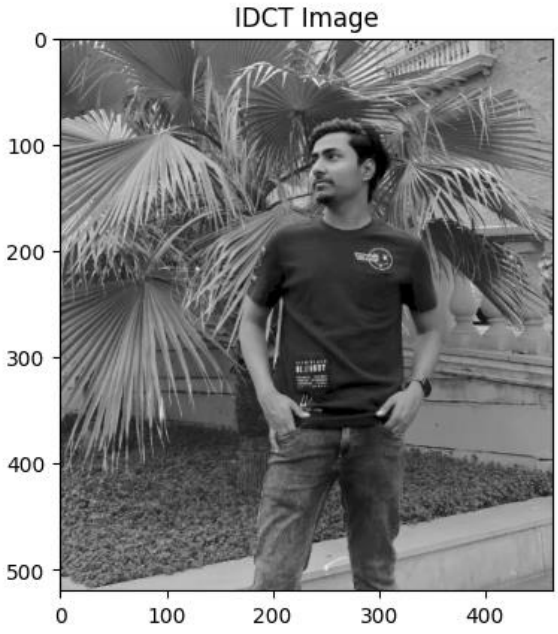
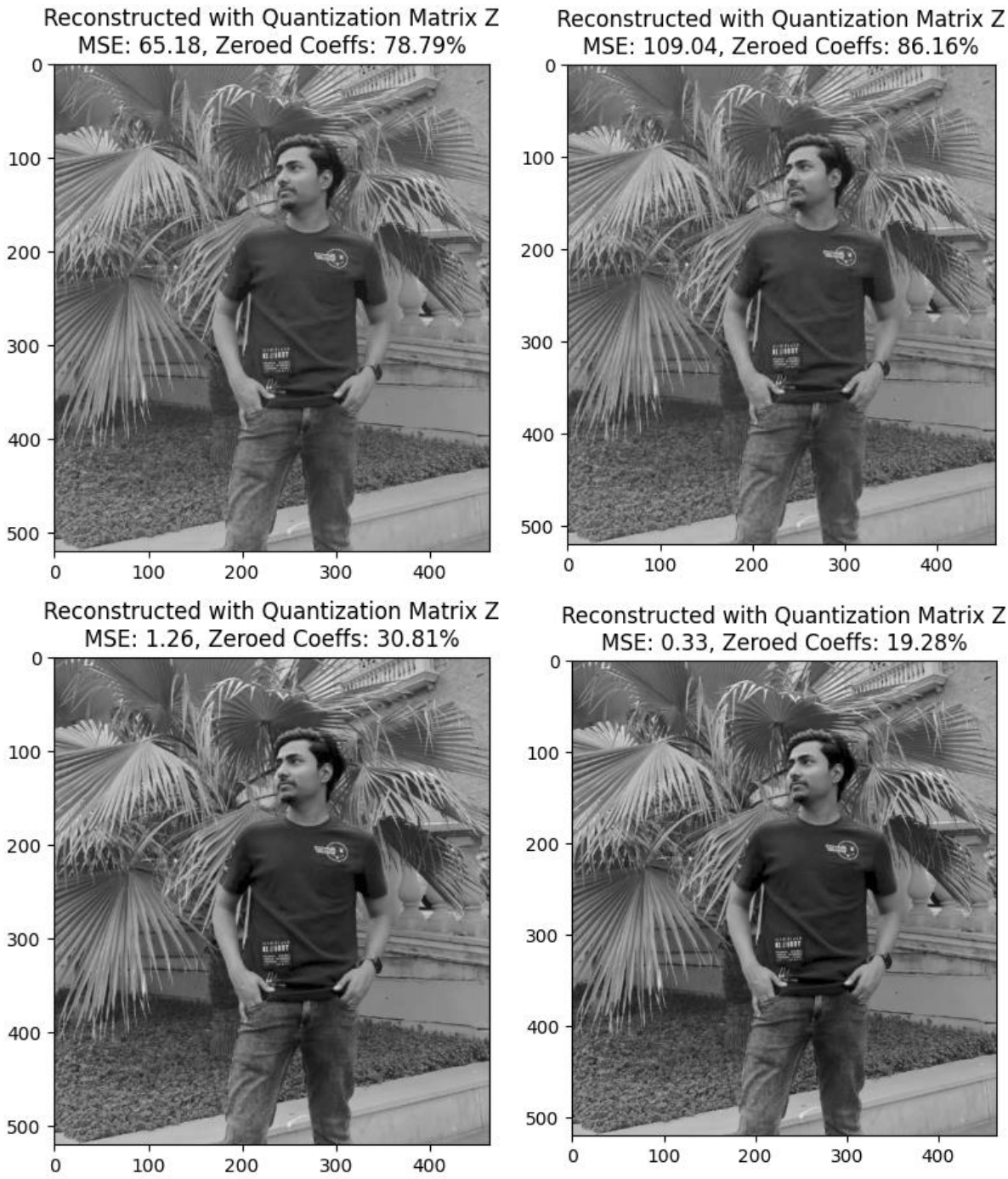
Q3
Part A



Size: (520, 464)



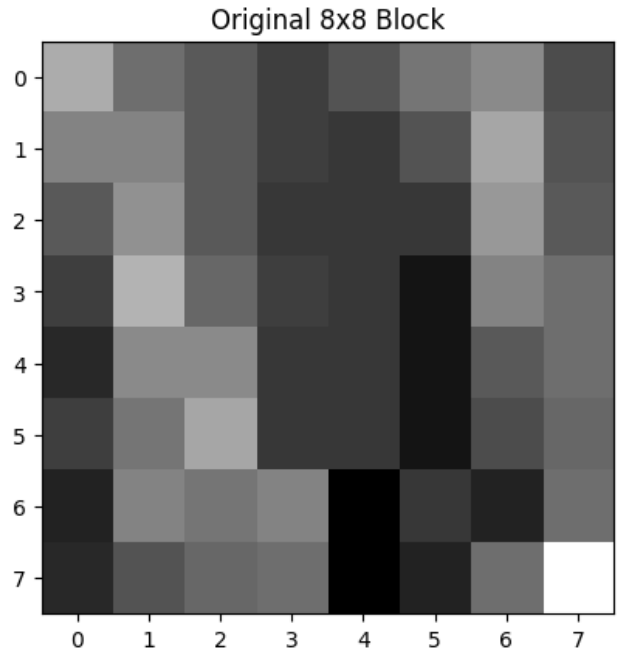




four different choices of Z:

```
quant_matrices = [
    jpeg_quant_matrix,
    jpeg_quant_matrix * 2,
    np.ones((8, 8)) * 4,
    np.ones((8, 8)) * 2
]
```

Part B




```
Quantized Block:
[[52.  0.  2. -1. -1. -0. -0.  0.]
 [ 1.  0.  0.  1. -0.  0. -0.  0.]
 [ 0. -1.  0.  0.  0.  0.  0. -0.]
 [-0.  1. -0.  0. -0. -0.  0.  0.]
 [ 0. -0.  0. -0.  0. -0. -0.  0.]
 [-0.  0. -0.  0. -0. -0. -0. -0.]
 [ 0. -0.  0.  0.  0.  0.  0.  0.]
 [-0.  0. -0.  0. -0. -0.  0. -0.]]
```

```
Reconstructed Quantized Block (8x8):
[[52.  0.  2. -1. -1.  0.  0.  0.]
 [ 1.  0.  0.  1.  0.  0.  0.  0.]
 [ 0. -1.  0.  0.  0.  0.  0.  0.]
 [ 0.  1.  0.  0.  0.  0.  0.  0.]
 [ 0.  0.  0.  0.  0.  0.  0.  0.]
 [ 0.  0.  0.  0.  0.  0.  0.  0.]
 [ 0.  0.  0.  0.  0.  0.  0.  0.]
 [ 0.  0.  0.  0.  0.  0.  0.  0.]]
```

Compression Ratio: 7.11

Part C:

Entropy = 5.322022440750344

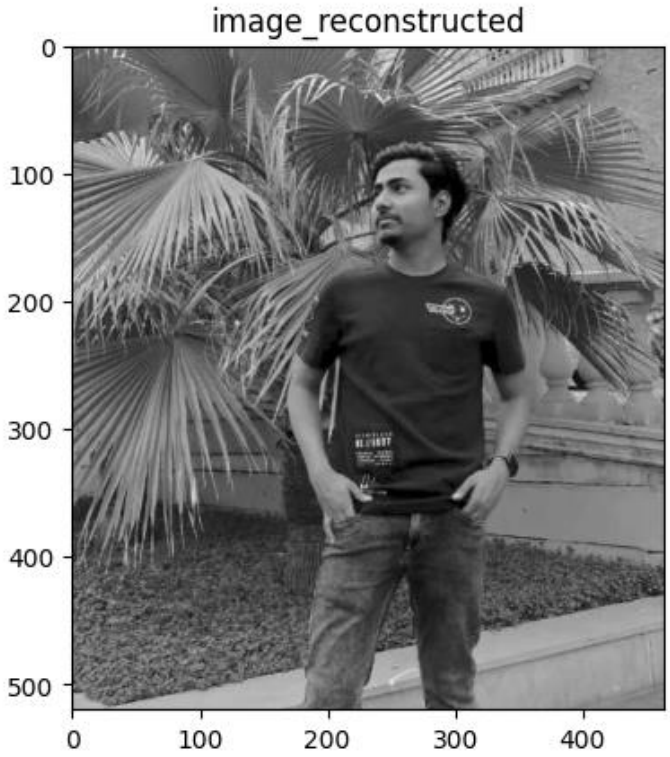
Average Huffman Code Length = 5.3470720966626635

Part D:

Entropy = 5.250353436975073

Average Huffman Code Length = 5.27453870509881

Part E:



final compression ratio = 6.65928371576329