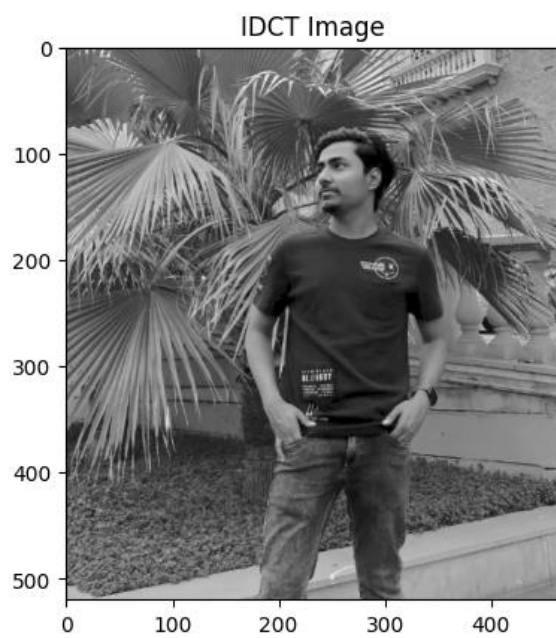
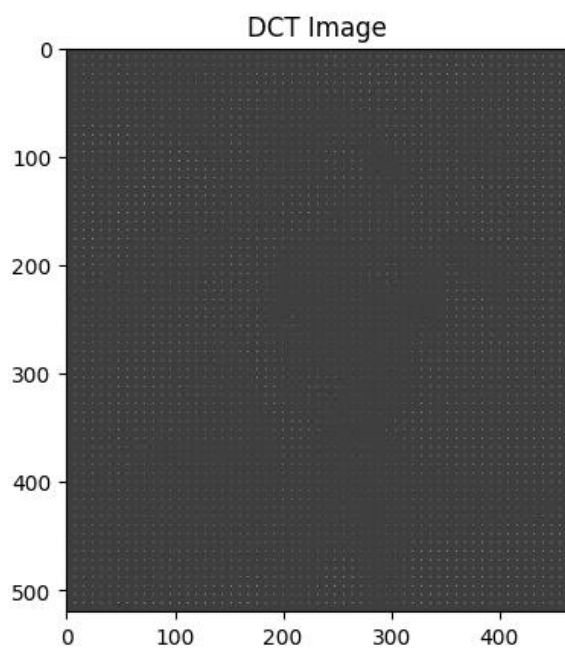
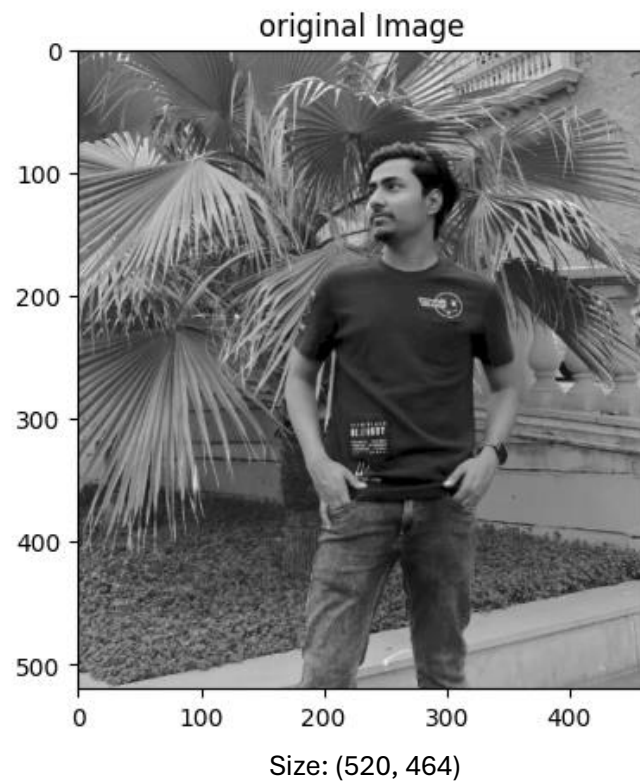
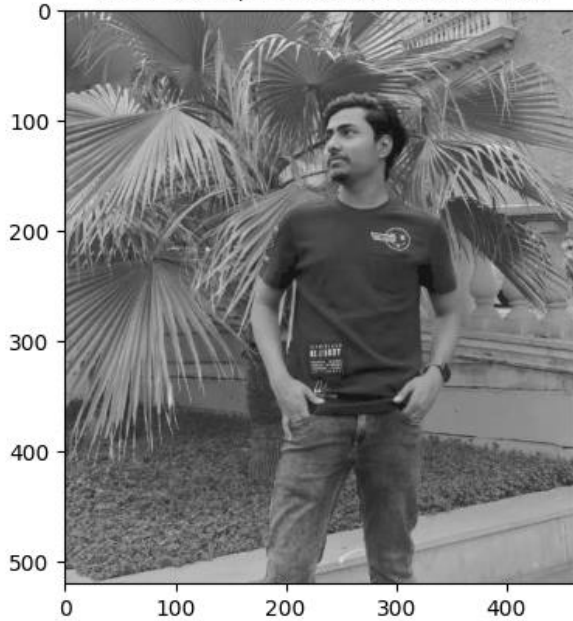


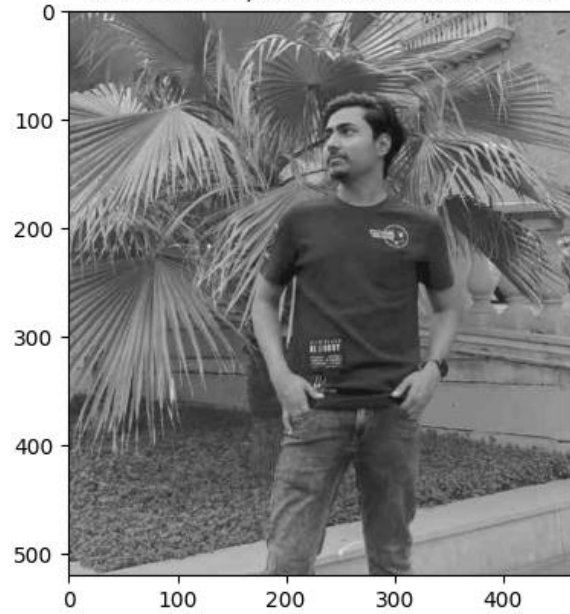
Q3
Part A



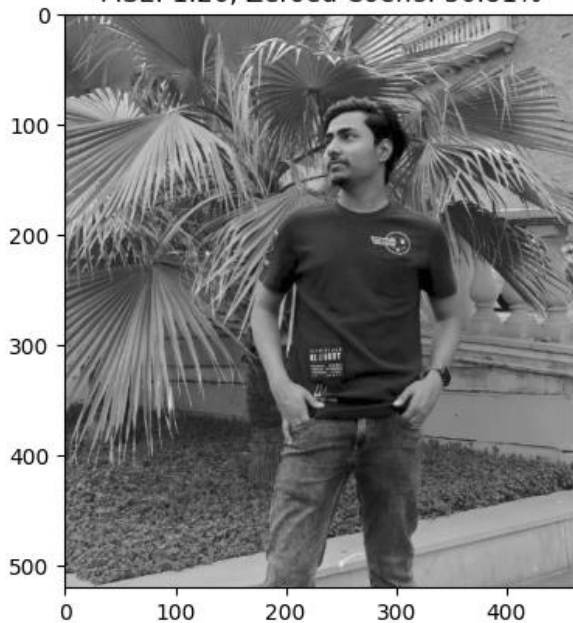
Reconstructed with Quantization Matrix Z
MSE: 65.18, Zeroed Coeffs: 78.79%



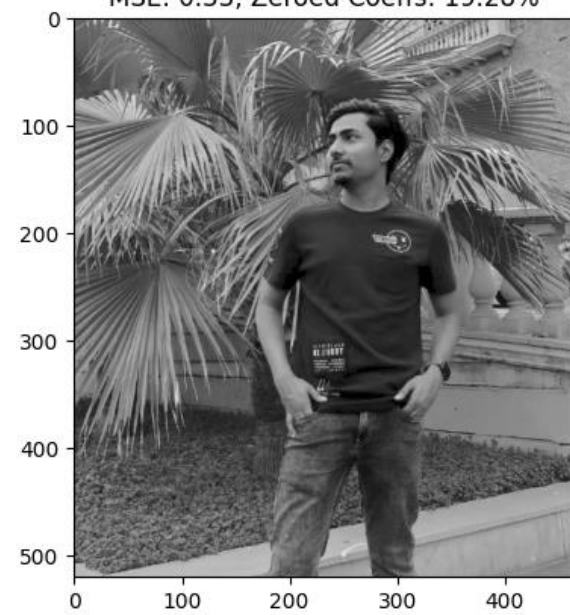
Reconstructed with Quantization Matrix Z
MSE: 109.04, Zeroed Coeffs: 86.16%



Reconstructed with Quantization Matrix Z
MSE: 1.26, Zeroed Coeffs: 30.81%



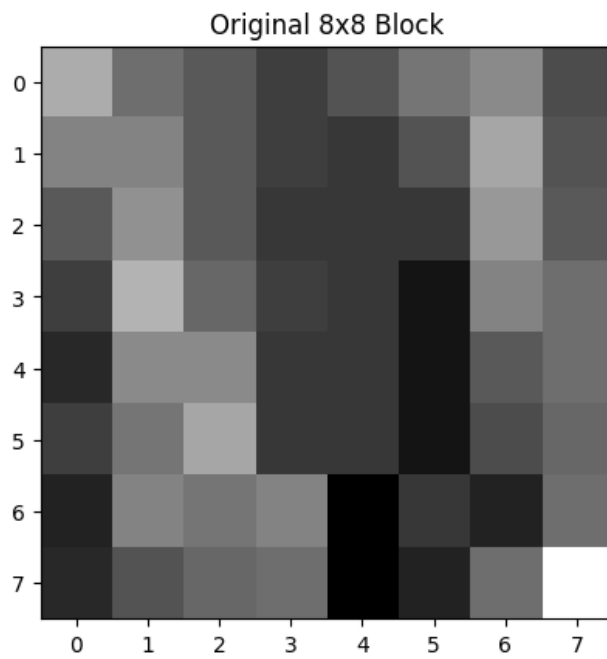
Reconstructed with Quantization Matrix Z
MSE: 0.33, Zeroed Coeffs: 19.28%



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

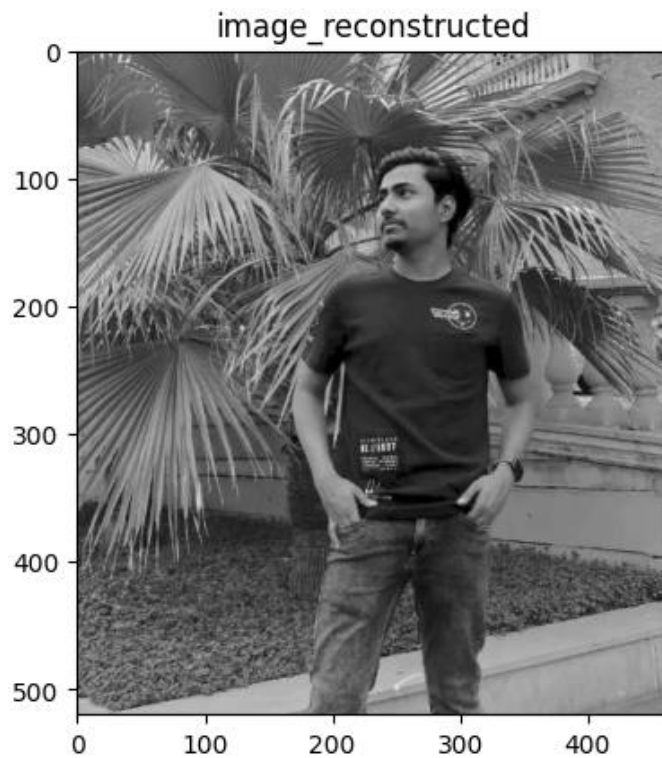
Average Huffman Code Length = 5.3470720966626635

Part D:

Entropy = 5.250353436975073

Average Huffman Code Length = 5.27453870509881

Part E:



final compression ratio = 6.65928371576329