Week 1:

Activity : Cutting up Lena.bmp into 8*8 windows in RGB space.
Result : Activity was done successfully in Windows CodeLite platform. Found that cutting up was computationally very expensive.

Figure 1: Lena.bmp image

Week 2:

Activity 1: To convert RGB image into YCbCr image and retrieve the RGB back.

Observation: Not much change in perceived image quality was observed.

Figure 2: Retrieved RGB Image and YCbCr Components

Y-Component

U/Cb-Component

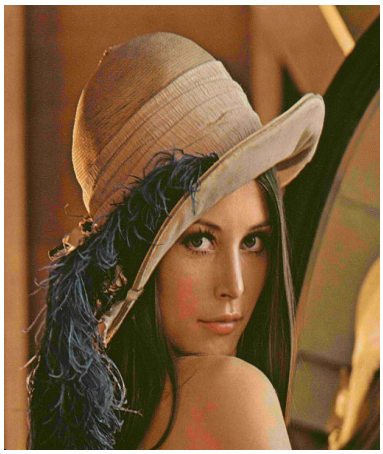
V/Cr-Component

Activity 2: PSNR discussions

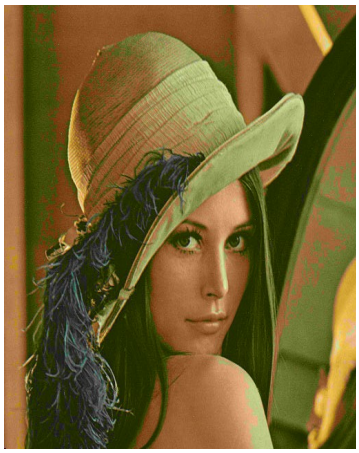
PSNR for an image which was transformed to YCbCr and back to RGB = 45.79 dB. (Figure 2)

Quantization effect (CbCr Only)

No Quantization



4-bit Quantization



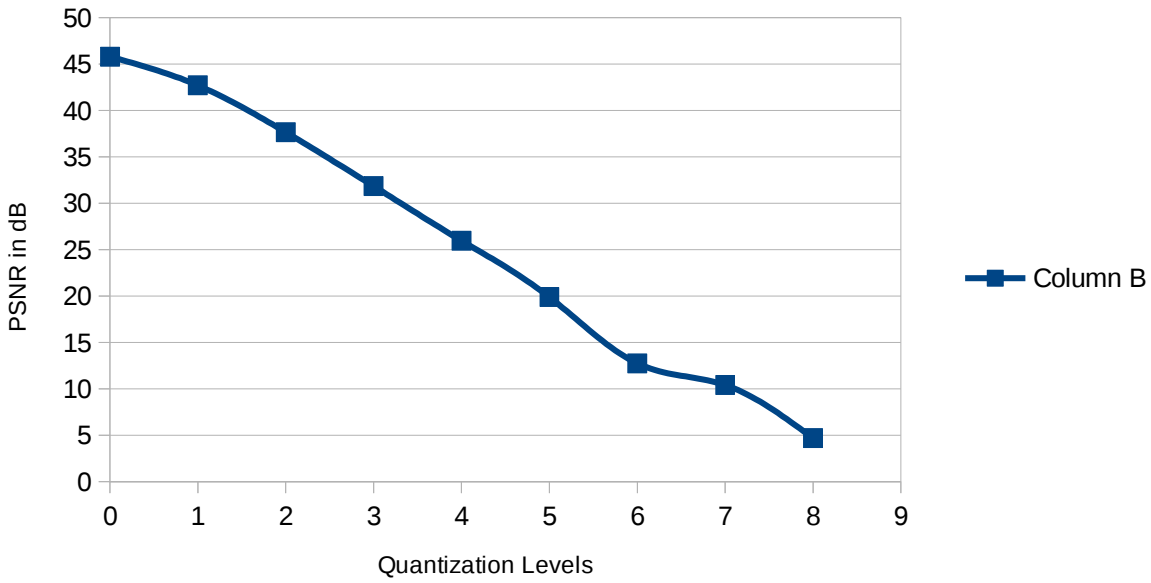
5-bit Quantization

6-bit Quantization

7-bit Quantization

8-bit Quantization

Quantisation Level	PSNR (in dB)
0	45.79
1	42.69
2	37.64
3	31.84
4	25.96
5	19.89
6	12.75
7	10.41
8	4.69



PSNR of Added Noise :

Figure 3: PSNR = 34.43 dB

The change in perceived quality of 4 bit quantized image is very little.
But numerically, its 20dB less.

Week 3:

Activity1 : DownSampling

Original Lena.bmp

4:1:1 down-sampling – 32.77 dB

4:2:2 down-sampling- 37.56 dB

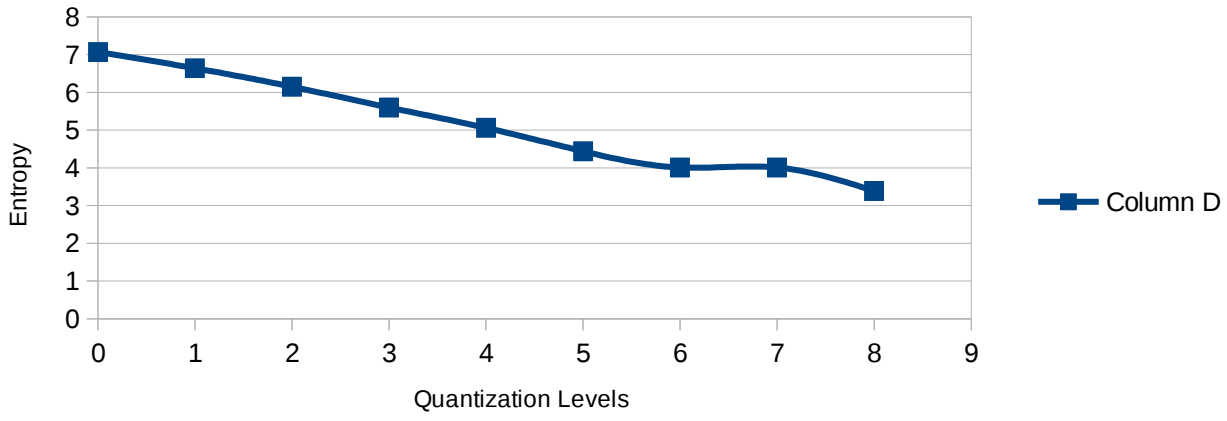
4:2:0 down-sampling – 35.63 dB

Activity 2 : Entropy

Entropy of a color plane = 8 bits , if all colors are equally probable.

Image	R_entropy(bits)	G_entropy(bits)	B_entropy(bits)	Image_entropy
4:4:4 Down-sampling	7.25	7.59	6.96	7.75
4:1:1 Down-sampling	7.29	7.58	7.08	7.76
4:2:2 Down-sampling	7.26	7.59	7.01	7.75
4:2:0 Down-sampling	7.28	7.59	7.01	7.75

Image	Y_entropy(bits)	Cb_entropy(bits)	Cr_entropy(bits)	Image_entropy	Number of Bytes	Compression Factor	Bytes(Entropy)	Compression Factor
4:4:4 Down-sampling	7.44	5.63	5.61	7.07	786432	1	695009	1.13
4:1:1 Down-sampling	7.44	5.63	5.61	7.07	393216	2	695009	1.13
4:2:2 Down-sampling	7.44	5.63	5.61	7.07	524288	1.50	695009	1.13
4:2:0 Down-sampling	7.44	5.63	5.61	7.07	393216	2	695009	1.13
0-bit Quantization	7.44	5.63	5.61	7.07	786432	1	695009	1.13
1-bit Quantization	7.44	4.64	4.61	6.64	720896	1.09	652738	1.2
2-bit Quantization	7.44	3.65	3.62	6.15	655360	1.2	604569	1.3
3-bit Quantization	7.44	2.69	2.66	5.6	589824	1.33	550502	1.43
4-bit Quantization	7.44	1.82	1.75	5.06	524288	1.5	497418	1.58
5-bit Quantization	7.44	0.96	0.91	4.44	458752	1.71	436469	1.8
6-bit Quantization	7.44	0.80	0.04	4.01	393216	2	393216	2
7-bit Quantization	7.44	0.38	0.001	4.01	327680	2.4	393216	2
8-bit Quantization	7.44	0	0	3.39	262144	3	333250	2.36



Week 4

Activity 1 – DCT application and verifying with given data

****

Printing given matrix

48 39 40 68 60 38 50 121
149 82 79 101 113 106 27 62
58 63 77 69 124 107 74 125
80 97 74 54 59 71 91 66
18 34 33 46 64 61 32 37
149 108 80 106 116 61 73 92
211 233 159 88 107 158 161 109
212 104 40 44 71 136 113 66

****

DCT Matrix

699.25 43.18 55.25 72.11 24.00 -25.51 11.21 -4.14
-129.78 -71.50 -70.26 -73.35 59.43 -24.02 22.61 -2.05
85.71 30.32 61.78 44.87 14.84 17.35 15.51 -13.19
-40.81 10.17 -17.53 -55.81 30.50 -2.28 -21.00 -1.26
-157.50 -49.39 13.27 -1.78 -8.75 22.47 -8.47 -9.23
92.49 -9.03 45.72 -48.13 -58.51 -9.01 -28.54 10.38
-53.09 -62.97 -3.49 -19.62 56.09 -2.25 -3.28 11.91
-20.54 -55.90 -20.59 -18.19 -26.58 -27.07 8.47 0.31

****

Activity 2: Applying DCT on a randomly generated 8*8 matrix

****

Printing given matrix

122 10 97 130 36 50 101 68
9 81 16 35 109 88 91 50
22 28 98 65 105 89 50 78
6 31 90 0 41 108 20 65
20 19 45 56 69 49 26 130
130 42 67 142 32 9 42 54
37 140 119 44 131 72 25 137
103 17 39 46 126 111 112 146

****

DCT Matrix

540.75 -67.93 -19.47 -23.86 45.25 -29.66 51.63 22.08
-48.29 0.04 -40.16 12.22 -45.70 56.55 -11.04 -6.21
96.89 -7.24 25.04 40.82 20.22 38.50 -39.19 21.11
-2.59 89.51 24.33 -52.50 56.08 86.06 -27.37 -34.89
-18.50 -52.35 36.20 14.12 14.50 46.74 52.11 2.83
23.53 55.25 -10.01 -47.96 -39.66 -17.06 51.28 7.70

15.07 37.18 2.06 0.69 62.52 130.69 22.21 -4.27
30.92 -30.23 -13.49 -43.25 23.93 -44.14 9.65 17.02

****

Activity 3 – Lena image

YUV Color space – Index 2,2

****
Printing given matrix
169 169 170 170 170 169 171 171
171 171 171 171 171 171 170 170
170 170 170 172 172 171 173 173
172 170 175 175 158 140 145 150
155 155 148 143 142 143 135 135
135 133 133 133 135 135 132 132
132 132 132 132 132 132 132 132
132 132 132 132 133 133 130 132
****
DCT Matrix

1214.62 17.73 -1.97 -3.38 3.38 -0.12 0.14 -0.07
132.31 -0.48 -0.11 -3.41 0.99 1.99 -1.69 0.87
-5.40 -24.07 1.07 4.71 -2.95 -0.92 0.69 0.32
-31.36 -2.49 2.10 6.03 -3.36 -1.87 1.40 -0.39
-0.63 18.40 -0.72 -5.18 2.12 0.13 -0.11 -0.15
5.42 3.98 -2.24 -8.76 4.49 3.98 -2.28 1.86
1.02 -11.47 0.19 2.98 -0.27 -0.34 0.18 0.39
2.17 -8.52 4.23 7.66 -5.26 -3.00 0.53 -1.53

****

RGB Color Space Index 2,2

****
Printing given matrix
65 70 76 74 74 82 74 78
85 78 83 80 82 76 80 81
81 80 79 81 80 75 69 77
69 70 62 61 48 41 58 59
69 70 57 51 53 49 37 33
31 31 32 34 33 30 30 30
31 31 31 31 31 31 31 31
32 32 32 32 30 29 36 30
****
DCT Matrix

437.38	18.82	1.96	-3.19	1.88	-0.57	-1.49	0.38
155.43	-3.61	-0.85	-3.12	2.11	-2.12	4.78	-0.39
-5.34	-28.83	-6.28	0.15	-3.13	2.48	5.13	1.31
-32.85	-2.93	-7.07	5.28	-4.45	-3.67	4.29	-1.79
-4.13	10.20	4.54	-0.64	-6.12	0.23	-3.10	-2.10
-15.44	-10.42	3.43	-7.95	-0.21	1.44	-0.88	-3.15
-6.04	-8.47	-6.37	-0.79	0.62	-1.69	2.03	-2.80
18.77	8.84	-7.83	9.33	-1.92	-7.91	4.99	-3.10

****