1) $C(X,Y,Z) = \alpha_1 P_1(X_1,Y_1,Z_1) + \alpha_2 P_2(X_2,Y_2,Z_2) + \alpha_3 P_3(X_3,Y_3,Z_3)$

i) Normalized chromaticity coordinates of P_1, P_2, P_3

$P_1 \Rightarrow \quad x_1 = \dfrac{X_1}{X_1+Y_1+Z_1} \qquad y_1 = \dfrac{Y_1}{X_1+Y_1+Z_1} \qquad z_1 = \dfrac{Z_1}{X_1+Y_1+Z_1}$

$P_2 \Rightarrow \quad x_2 = \dfrac{X_2}{X_2+Y_2+Z_2} \qquad y_2 = \dfrac{Y_2}{X_2+Y_2+Z_2} \qquad z_2 = \dfrac{Z_2}{X_2+Y_2+Z_2}$

$P_3 \Rightarrow \quad x_3 = \dfrac{X_3}{X_3+Y_3+Z_3} \qquad y_3 = \dfrac{Y_3}{X_3+Y_3+Z_3} \qquad z_3 = \dfrac{Z_3}{X_3+Y_3+Z_3}$

Normalized chromaticity coordinates of colour C

$C \Rightarrow \quad x = \dfrac{X}{X+Y+Z} \qquad y = \dfrac{Y}{X+Y+Z} \qquad z = \dfrac{Z}{X+Y+Z}$

ii) Normalized chromaticity coordinates of the color C in terms of normalized chromaticity coordinates of P_1, P_2, P_3 is given by

$$\left.\begin{aligned} X &= \alpha_1 X_1 + \alpha_2 X_2 + \alpha_3 X_3 \\ Y &= \alpha_1 Y_1 + \alpha_2 Y_2 + \alpha_3 Y_3 \\ Z &= \alpha_1 Z_1 + \alpha_2 Z_2 + \alpha_3 Z_3 \end{aligned}\right\} \text{Individual components}$$

$$x = \frac{\alpha_1 X_1 + \alpha_2 X_2 + \alpha_3 X_3}{\alpha_1(X_1+Y_1+Z_1) + \alpha_2(X_2+Y_2+Z_2) + \alpha_3(X_3+Y_3+Z_3)}$$

$$y = \frac{\alpha_1 Y_1 + \alpha_2 Y_2 + \alpha_3 Y_3}{\alpha_1(X_1+Y_1+Z_1) + \alpha_2(X_2+Y_2+Z_2) + \alpha_3(X_3+Y_3+Z_3)}$$

$$z = \frac{\alpha_1 Z_1 + \alpha_2 Z_2 + \alpha_3 Z_3}{\alpha_1(X_1+Y_1+Z_1) + \alpha_2(X_2+Y_2+Z_2) + \alpha_3(X_3+Y_3+Z_3)}$$

iii) Chromaticity coordinates of any color C can also be represented as a linear combination of the chromaticity coordinates of the respective primaries

$$x = \beta_1 x_1 + \beta_2 x_2 + \beta_3 x_3$$

$$y = \beta_1 y_1 + \beta_2 y_2 + \beta_3 y_3$$

$$z = \beta_1 z_1 + \beta_2 z_2 + \beta_3 z_3$$

$$x_1 = \frac{X_1}{X_1+Y_1+Z_1}$$

$$x = \frac{X}{X+Y+Z}$$

and $X = \alpha_1 X_1 + \alpha_2 X_2 + \alpha_3 X_3$

$\therefore\ x(X+Y+Z) = \alpha_1\, x_1(X_1+Y_1+Z_1) + \alpha_2 x_2(X_2+Y_2+Z_2) + \alpha_3 x_3(X_3+Y_3+Z_3)$

$\alpha_3(X_3+Y_3+Z_3) \longrightarrow (2)$

But $(X+Y+Z) = \alpha_1(X_1+Y_1+Z_1) + \alpha_2(X_2+Y_2+Z_2) + \alpha_3(X_3+Y_3+Z_3)$

$$\therefore\ x = \frac{\alpha_1 x_1(X_1+Y_1+Z_1)}{(X+Y+Z)} + \frac{\alpha_2 x_2(X_2+Y_2+Z_2)}{(X+Y+Z)} + \frac{\alpha_3 x_3(X_3+Y_3+Z_3)}{(X+Y+Z)}$$

$$\therefore\ \beta_1 = \frac{\alpha_1(X_1+Y_1+Z_1)}{X+Y+Z}$$

$$\therefore\ \beta_2 = \frac{\alpha_2(X_2+Y_2+Z_2)}{X+Y+Z}$$

$$\therefore\ \beta_3 = \frac{\alpha_3(X_3+Y_3+Z_3)}{X+Y+Z}$$

$$\therefore\ \beta_1 = \frac{\alpha_1(X_1+Y_1+Z_1)}{\alpha_1(X_1+Y_1+Z_1) + \alpha_2(X_2+Y_2+Z_2) + \alpha_3(X_3+Y_3+Z_3)}$$

$$\therefore\ \beta_2 = \frac{\alpha_2(X_2+Y_2+Z_2)}{\alpha_1(X_1+Y_1+Z_1) + \alpha_2(X_2+Y_2+Z_2) + \alpha_3(X_3+Y_3+Z_3)}$$

$$\therefore\ \beta_3 = \frac{\alpha_3(X_3+Y_3+Z_3)}{\alpha_1(X_1+Y_1+Z_1) + \alpha_2(X_2+Y_2+Z_2) + \alpha_3(X_3+Y_3+Z_3)}$$

Similarly

$Y = \alpha_1 Y_1 + \alpha_2 Y_2 + \alpha_3 Y_3$ and $y_1 = \dfrac{Y_1}{X_1+Y_1+Z_1}$ $\quad y = \dfrac{Y}{X+Y+Z}$

$y(X+Y+Z) = \alpha_1(X_1+Y_1+Z_1) + \alpha_2(X_2+Y_2+Z_2) + \alpha_3(X_3+Y_3+Z_3)$

$\therefore\ y = \beta_1 y_1 + \beta_2 y_2 + \beta_3 y_3$ (Same as above)

$\therefore\ z = \beta_1 z_1 + \beta_2 z_2 + \beta_3 z_3$ (Same as above)

2) Given sequence obtained by sampling a signal

{ 5.8, 6.2, 6.2, 7.2, 7.3, 7.3, 6.5, 6.8, 6.8, 6.8, 5.5, 5.0, 5.2, 5.2, 5.8, 6.2, 6.2, 6.2, 5.9, 6.3, 5.2, 4.2, 2.8, 2.8, 2.3, 2.9, 1.8, 2.5, 2.5, 3.3, 4.1, 4.9 }

The sequence is quantized by assuming level 0 at 0.25, level 1 at 0.5, level 2 at 0.75, level 3 at 1.0 and so on

(i) Thus the quantized sequence is

{ 22, 24, 24, 28, 28, 28, 25, 26, 26, 26, 21, 19, 20, 20, 22, 24, 24, 24, 23, 24, 20, 16, 10, 10, 8, 11, 6, 9, 9, 12, 15, 19 }

(ii) How many bits do need to transmit it

Number of uniformly distributed levels = $32 = 2^5$

Thus Number of bits $= 32 \times 5 = 160$ bits

(iii) To encode using DPCM, we need to compute the difference between the levels not the values and first difference successive values (consider value $22 - 0 = 22$ is ignored)

{ 2, 0, 4, 0, 0, −3, 1, 0, 0, −5, −2, 1, 0, 2, 2, 0, 0, −1, 1, −4, −4, −6, 0, −2, 3, −5, 3, 0, 3, 3, 4 }

Maximum difference is 4

Minimum difference is −6

[−6, 4]

−6	−5	−4	−3	−2	−1	0	1	2	3	4

No of levels $= 11 = 2^{3.31} \simeq 2^4$

So we need 4 bits per signal

Number of bits required to encode sequence $= \underline{31} \times 4 = 124$ bits (because we are not considering first difference value, is 31 instead of 32)

(iv) Compression Ratio $= \dfrac{160}{124} = 1.29$

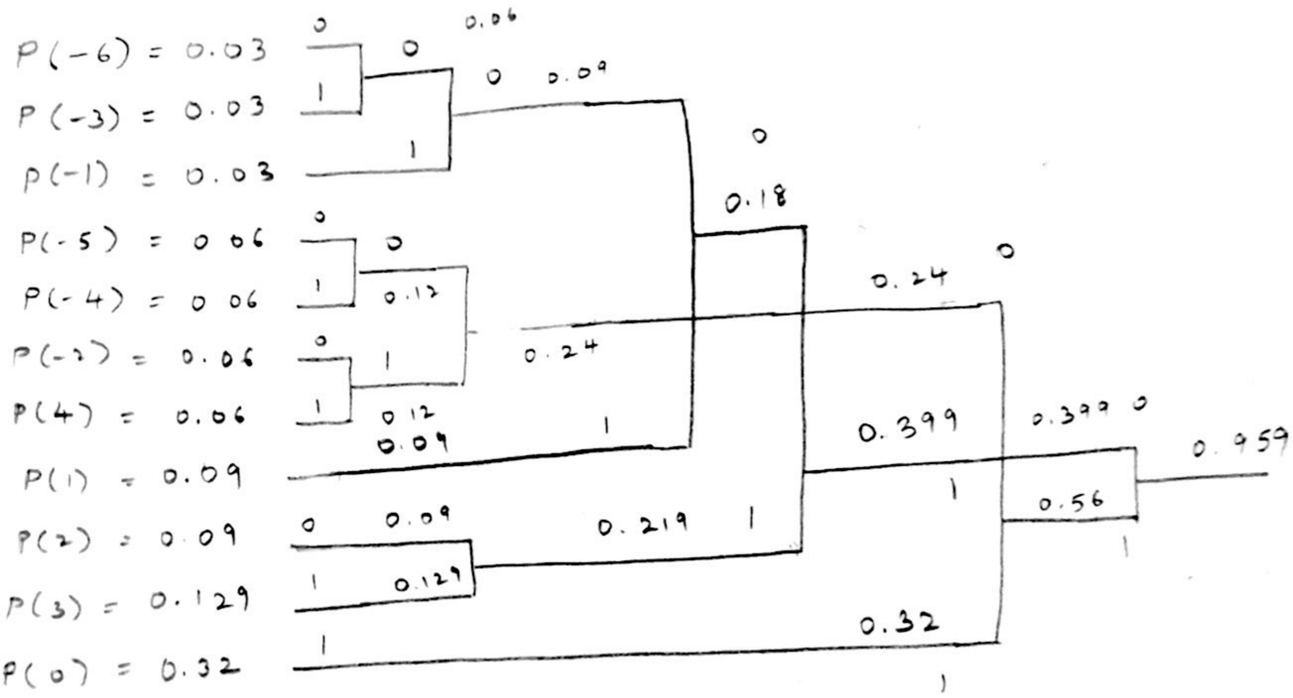
(v) Instead of transmitting differences use Huffman coded values for the differences. How many bits do you need now to encode the sequence

{2, 0, 4, 0, 0, −3, 1, 0, 0, −5, −2, 1, 0, 2, 2, 0, 0, −1, [illegible], −4
−4, −6, 0, −2, 3, −5, 3, 0, 3, 3, 4}

P(−6) = 1/31 = 0.0322
P(−5) = 2/31 = 0.0625
P(−4) = 2/31 = 0.0625
P(−3) = 1/31 = 0.0322
P(−2) = 2/31 = 0.0625
P(−1) = 1/31 = 0.0322
P(0) = 10/31 = 0.3226
P(1) = 3/31 = 0.0967
P(2) = 3/31 = 0.0967
P(3) = 4/31 = 0.129
P(4) = 2/31 = 0.0625

P(−6) = 0.03
P(−5) = 0.06
P(−4) = 0.06
P(−3) = 0.03
P(−2) = 0.06
P(−1) = 0.03
P(0) = 0.32
P(1) = 0.09
P(2) = 0.09
P(3) = 0.129
P(4) = 0.062

P(−6) = 0.03
P(−3) = 0.03
P(−1) = 0.03
P(−5) = 0.06
P(−4) = 0.06
P(−2) = 0.06
P(4) = 0.06
P(1) = 0.09
P(2) = 0.09
P(3) = 0.129
P(0) = 0.32



Symbol	Probability	Huffman Code	Code Length
−6 (1)	0.03	00000	5
−3 (1)	0.03	10000	5
−1 (1)	0.03	1000	4
−5 (2)	0.06	0001	4
−4 (2)	0.06	1000	4
−2 (2)	0.06	0100	4
4 (2)	0.06	1101	4
1 (3)	0.09	1000	4
2 (3)	0.09	010	3
3 (4)	0.129	110	3
0 (10)	0.32	11	2

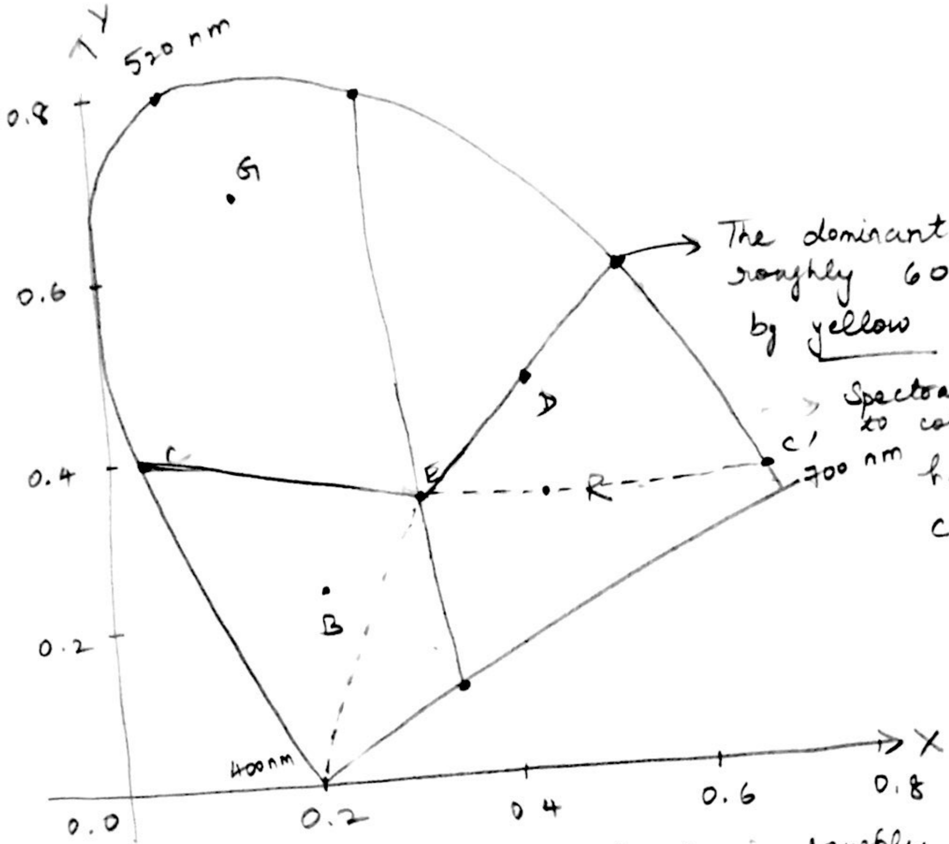
96

Compression Ratio of Quantized output using DPCM to quantized output using Huffman code is $\frac{124}{96}$

Compression Ratio of initial sequence to quantized output using Huffman code is $\frac{160}{96}$

And when we don't consider the first level, the compression Ratio is $\frac{155}{96}$ (31×5)

3)

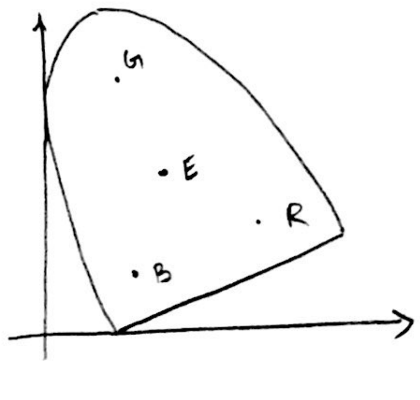


The dominant wavelength of color D is roughly 600 nm. The color is represented by yellow

Spectral color which is complimentary to color C is C' which roughly has a wavelength of 680nm C' is represented by red color

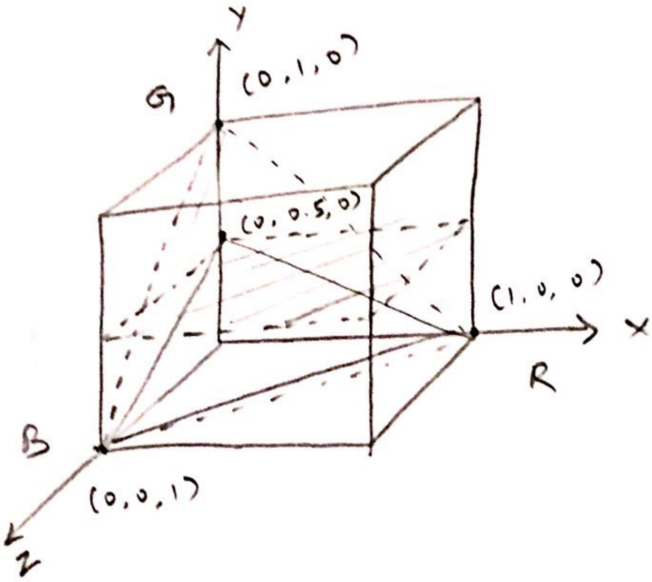
1. The dominant wavelength of color D is roughly 600 nm. The color is represented by yellow
2. No, all colors do not have a dominant wavelength. For some colors, the stimuli may intersect with purple line rather than the spectrum focus. From the figure, this happens when the chromaticity coordinates of a stimulus lie in the triangle whose apex is the achromatic stimulus. For such stimuli, we speak of complementary wavelength rather then dominant wavelength.
3. Spectral color which is complementary to color C is C' from figure, which roughly has a wavelength of 680 nm. C' is represented by red color

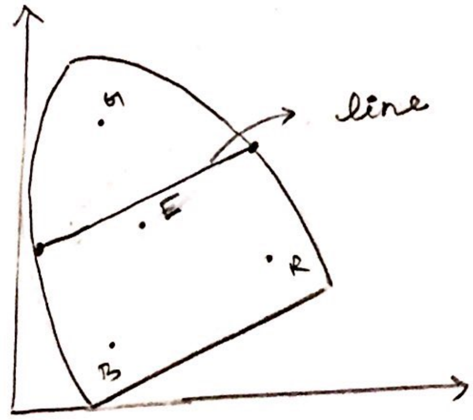
4.



R, G, B are primaries around the equiluminous point E

Find all points which have a value of G = 0.5





So when we keep G at constant value of 0.5 and with varying values of R and B, we will get a plane, as shown in the diagram which will contain all points with G = 0.5

When we obtain chromaticity diagram for it, it will show a line as shown in the diagram above. So different points on the line represent different mixtures of 2 colors (Red and Blue) at end points of line

v) Take G = 0.5 locus above, how does this map in the RGB space

Since it is a 2D plane in the RGB color space, the spectral locus which we will now obtain will be a line with different combinations of Red and Blue and constant value of Green = 0.5.