Digital Image Processing
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Module 11 Lecture Number 52
Conversion of one Color Model to another – 1

Hello, welcome to the video lecture series on Digital image processing.

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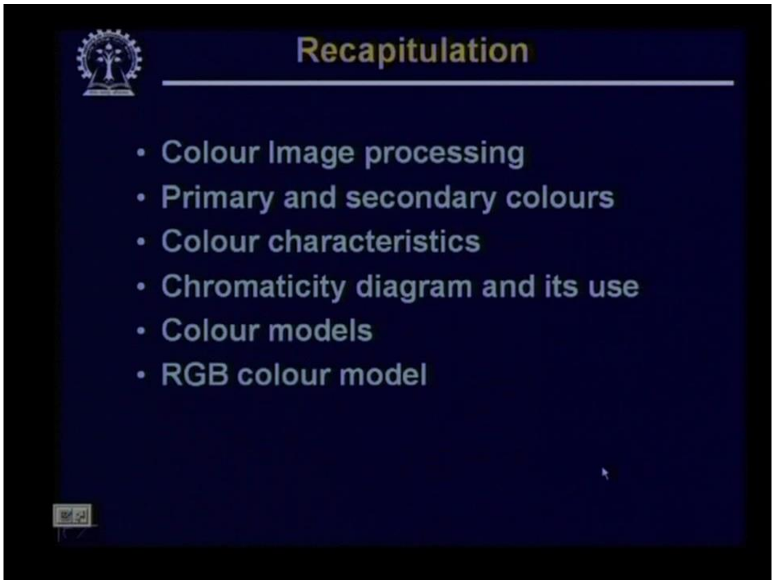

In our last class we have started our discussion, have covered the fundamentals of color image processing. We have seen what is a primary colour and what is secondary colour. We have seen the characteristics of different colours. We have seen the chromaticity diagram and the use of the chromaticity diagram. And we have started our discussion on colour models and there we just started the discussion on RGB colour model.

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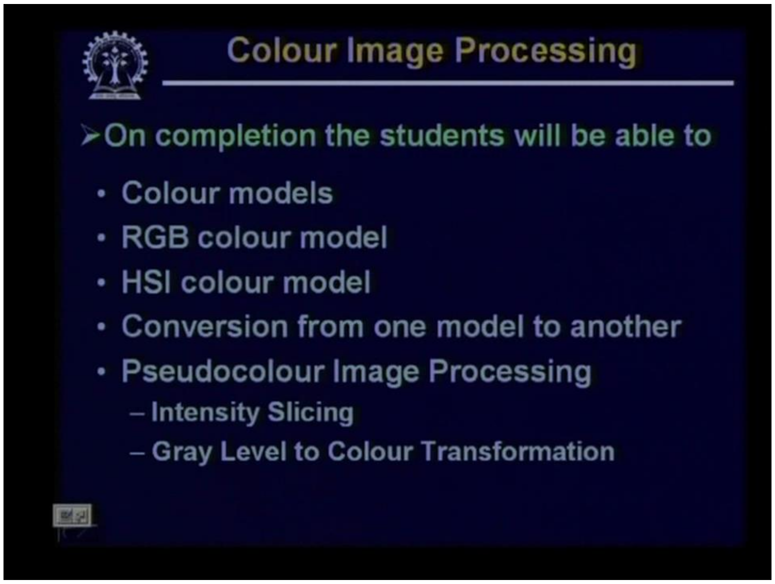

Today we will start our discussion with the colour model. So we will complete our discussion on RGB colour model. We will also talk about the HIS or hue, saturation and intensity colour model. We will see how we can convert the colours from one colour model to another colour model that is given a colour in the RGB in the RGB space how we can convert this a to a colour in the HIS space and similarly given a colour in the HIS space how we can convert that to the RGB space.

Then will start our discussion on colour image color image processing technique. So will talk about pseudo image color processing and there mainly we will talk about two techniques, one is called intensity slicing and the other one is gray level to colour image level transformation. So let just briefly recapitulate what we have done in the last class.

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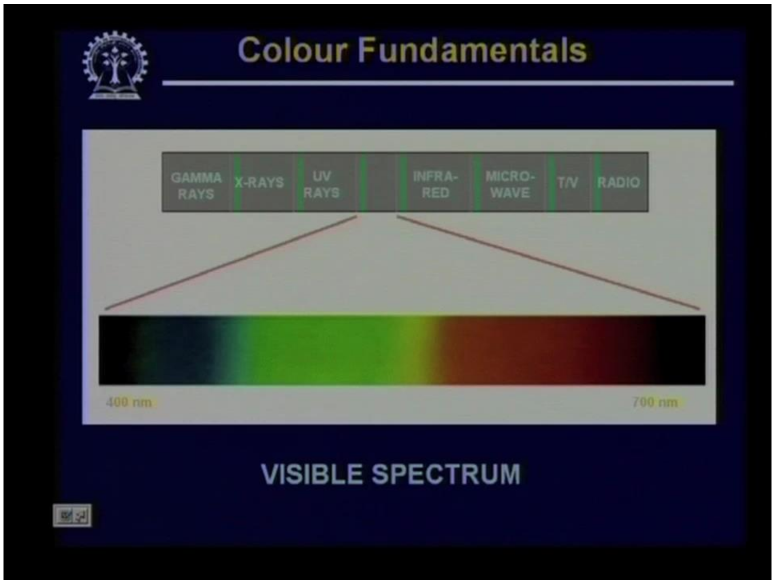

In the last class we have mentioned that all the colours of the visible light or the visible spectrum, colour spectrum occupies a very narrow spectrum in the total electromagnetic band of frequency or band of spectrum and the visible spectrum the wavelength normally varies, from 400 nanometer to 700 nanometer. So at one end we have the violet and in the other end we have the red colour. And out of this we normally take three colour components.

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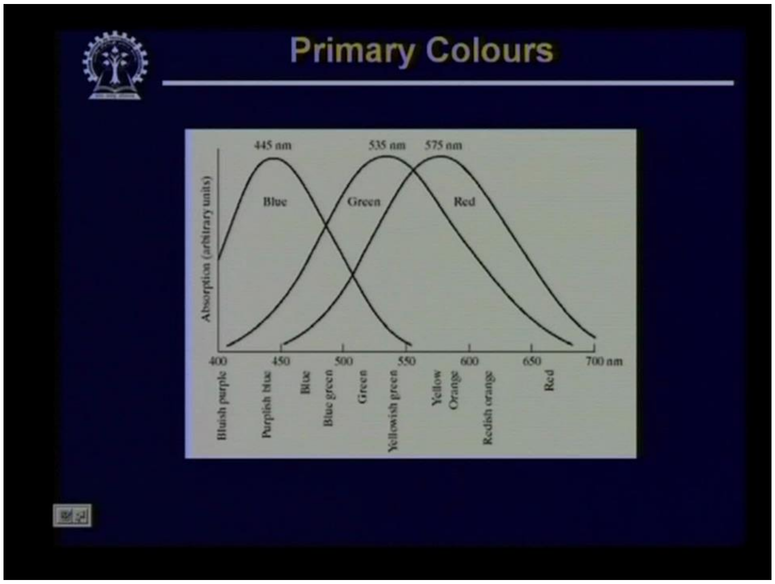

That is red, green and blue as the primary colour components because we have mentioned that in our eye there of three types of cells cone cells. Which are responsible for colour sensation. There are maximum, there are some uh cone say which are responsible for colour sensation, there are maximum there are some cone cells which are responsible which sense the light in the red wavelength. There are some cone cells which sense the green light, and there are some cone cells which sense the blue light.

And this light are mixed together in different proportions in an appropriate way so that we can have the sensation of different colours. And this is the main reason why we say that red, green and blue they are the primary colors and by mixing this three primary colour in different proportions we can generate almost all the colours in the visible spectrum.

Then we have talked about two different colours two types colours, One is the colour of light other one is the colour of the pigment. Now colour of the light as we see any particular object we can see the colour which is reflected from the object, because of the wavelength of the light which gets reflected from the object surface. Now when we pigments colour and the a colour falls on it then the pigments colour it absorbs a particular wavelength out of the three primary colours and reflects the other wavelengths.

So the primary colours of light are really the secondary colours of pigments and the secondary colours of light they are the primary colours of pigments. And because of this the colours of light they are called additive primaries whereas the colours of the pigments they are called subtractive primaries.

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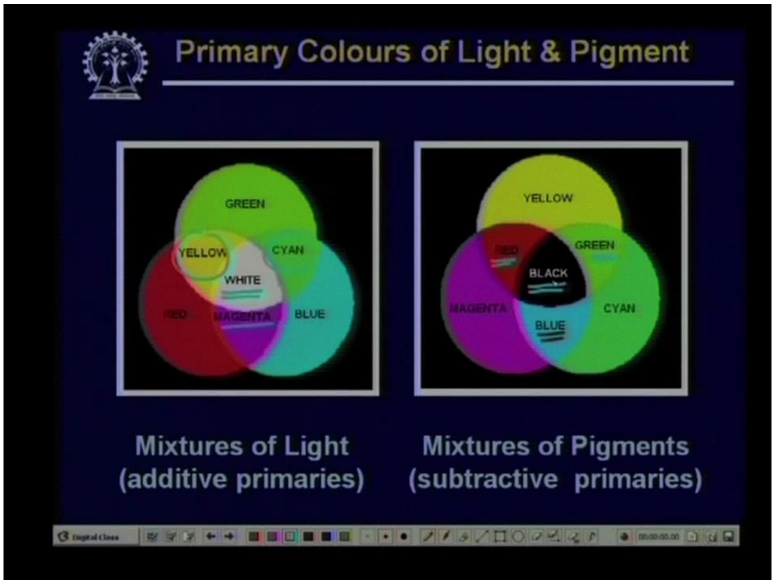

And here you can see in this particular slide that the three primaries of light red, green and blue when they are mixed together then red and green mixed together form what is called from the yellow light. Then green and blue when they are mixed together this two form cyan, and red and blue mixed together form the magenta and the red, green and blue all this three colours together form. What is the white light?

Similarly even it comes to pigments primaries yellow which is a secondary colour for light is a primary colour of a pigment. Similarly magenta which is a secondary colour of light is also a primary colour of pigment. Cyan which is a secondary colour of light is primary colour of pigments. And here you find that when this pigments primaries they are mixed together then they form what are the primary colours of light.

So yellow and magenta this two together form the red light. Yellow and cyan mixed together form the green light. And magenta and cyan joint together mixed together form the blue light. However all these three pigments primaries that is yellow, magenta and cyan mixed together form the black light. So this is the black colour so by mixing different colours of light or the different colours of different colours of primary colours of light or different primary of the pigments we can generate all types of different colours in the visible spectrum.

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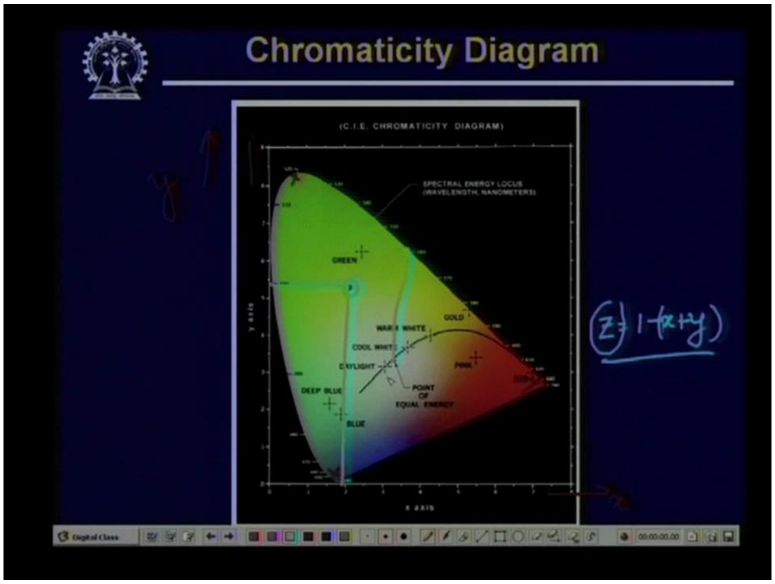

Then we have also seen what is the chromaticity diagram and we have seen the usefulness of the chromaticity diagram. So the chromaticity diagram is useful mainly to identify that in which proportions different primary colours are to be mixed together to generate any colour, so if I take three points in this chromaticity diagram. So one corresponding to green, one for the primary red, and other for the primary blue.

Then given any point within this chromaticity diagram I can find out that in which proportions red, green and blue there are to be mixed. So here you find the horizontal axis tells the red component. The vertical axis gives us the green component and the blue component so if I write this as x and this as y then the green component z is given by 1- (x+y).

So I can find out that how much of red, how much of green and how much of blue these three components are to be mixed to generate a colour which is at this particular location in this chromaticity diagram. It also tells us that what are all different possible shades of any of the pure colour which are available in the light spectrum that can be generated by mixing different amount of white light to it.

So you find that we have a point of equal energy that you have mentioned in the last class in this chromaticity diagram which is white as per CIE standard. So, if I take any pure colour on the boundary of this chromaticity diagram and join this with this with white point then all the colour point, all the colours along this line they tell us that if I mix different amount of white light to this pure colour then what are the different shades of this colour that can be generated.

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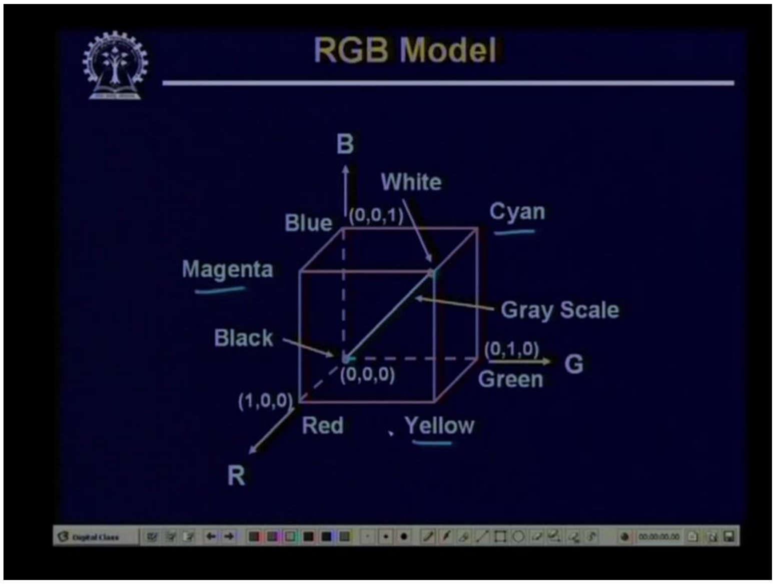

Then we have started our discussion on the colour model and we have said that colour model is very very useful to specify any particular colour. And the, we have said we started our discussion on RGB colour model and we have discussion in our last class that RGB colour model is basically represented by a Cartesian coordinate system.

Where the three primary colours of light that is red, green and blue they are represented along three Cartesian coordinate axes. So we have as per this diagram, we have this red axis, we have the green axis and we have the blue axis. And in this Cartesian coordinate system the colours, colours space is represented by a unit cube. So when I say it is unit that means the colours are represented in a normalized form.

So in this unit cube you find that at the center of the cube. We have R, G and B all this three components are equal to zero. So these points represent black. Similarly the furthest vertex from this black point or the origin where the red component is equal to one, green component it is equal to one and blue component is equal to one. That means all these three primary colours are mixed in equal proportions, at this point represents white.

The red colour is placed at location 1,0,0 where the red component is equal to 1, green components is equal to 0 and blue component also equal to zero. Green is located at location 0,1,0 where both red and blue components are equal to 0 and the green component is equal to 1. And blue is located at the vertex location 0,0,1 where both red and green component are equal to 0 wnd blue component is equal to one. So these are the locations red, green and blue. That is 1,0,0 0,1,0 and 0,0,1, these are the location of three primary colours of light that is red, green and blue.

And you find that in this cube we have also placed the secondary colours of light which are basically the primary colours of pigment that is cyan, magenta and yellow. So these three colours cyan, magenta and yellow they are placed in other three corners, other three vertices of this unit cube. Now find that from this diagram if I joined these two points that is black at location 0,0,0, with white at location 1,1,1 then the line re-joining this two points black and white this represents what is called a gray scale.

So all the points on this particular line will have different gray shades they will not exhibit any colours component. Now given any specific colours having some proportions of red, green and blue that colours will be represented by a single point in this unit cube, in a normalized form or we can also say that, that colours will be represented by a vector, or vector is drawn from the origin to the point repressing that particular colours having a specific proportions of red, green and blue.

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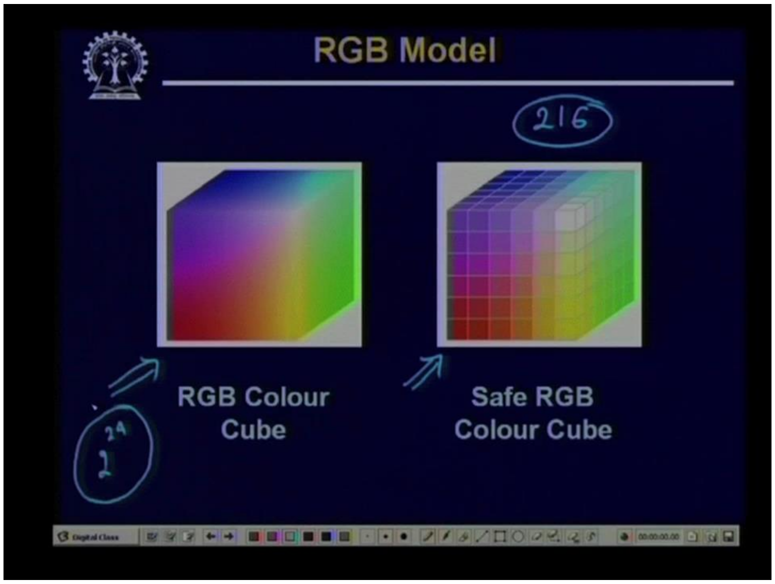

So this is what is the RGB colour model and you find that from this RGB colour model. We can also have the cyan, magenta and yellow components by simple transformation. So given any point in the RGB colour plane what we can do is, if I look at the different colour shades on different faces of this colours cube you find that the shades will appear like this. So in this colours cube you find that we have said that the point 1,0,0 that represents red and you find that along the horizontal axis the colour varies from red to yellow. Similarly this is a point which is 0,0 which is 1,1,1. So this point represents white colour.

And in this particular case all these colours components that is red, green and blue, each of this colour component are representing by 8 bit that means we have all together 24 different colours shades which can be generated in this particular colour model. So the total number of colours that can be generated is 2 to the power 24. And you can easily imaging that is huge number of colours which can be a generated, if we assign 8 bits to each of the colours components that is red, green and blue.

But in most of the cases what is useful is called safe RGB model. The safe RGB model, in safe RGB model we don't consider all possible colours that means all the 2 to the power 24 different colours. But rather the number of different colours which are used in such cases is 216. So this 216 colours can generated by having six different colours in red, six different colours shades in green and six different colours shades in blue.

So from the on right hand side we have drawn a safe RGB colour cube. So here you find that we have six different shades of any of the colours that is red, green and blue. And using the six different shades we can generate up to 2 to the power 16 different colours and this 2 to the 216 different colours and these 216 different colours are known as safe RGB colours because they can displayed in any type colours monitor. so you should remember that in case of two RGB then you can have total of 2 to the power 24 different colours but all the colour displays may not have the provision of displaying of 2 to the power 24 colours but we can display 216 colours in all in almost all the colour displays. So this is what is called safe RGB colour model. And the corresponding cube is the safe RGB colours cube.

So it is quite obvious from this discussion that any colour image will have three different colours component one colour for red, one colour component for green and one colour component for blue.

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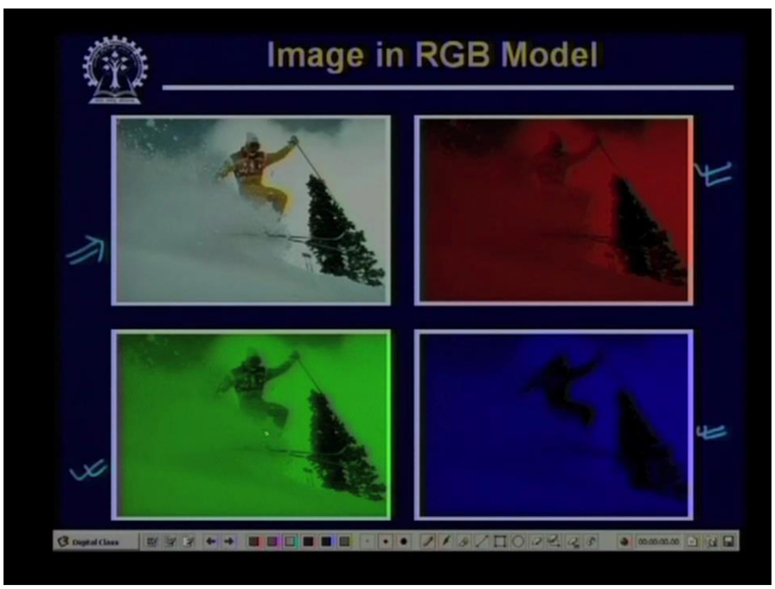

So if I take this particular colour image, you find that the top left image is a colours image and the other three are the three planes of it. So the red colour component of this color image is represented in red, the green colour component is represented in green and the blue colour component is represented in blue. So here you find that though here represented these three different components in different colours that is red, green and blue but they are actually monochrome images. And these monochrome images or black and white images and these black and white images are used to excite the corresponding phosphor dot on the colour screen.

So this, the red component will activate the red dot the green component will activate the green dots and the blue component will activate the blue dots and when these three dots are activating, activated together with different intensities that gives you different colour sensations. So obviously for any type color image like this we will have three different planes one plane corresponding to the red component the other plane corresponding to the green component and a plane corresponding to the blue component.

Now, as we said that this red, green and blue they are mostly useful of the display purpose. But when it comes to colour printing the model which is used is the CMY model or cyan, magenta and yellow model. So for the image colour, image printing purpose we have to talk about the CMY model. However the CMY can be very easily generated from the RGB model.

So as it is obvious from the colours cube the RGB cube that we have a drawn and the way the CYM cyan, magenta and yellow colours are placed at different vertices on that RGB cube from there it is quite obvious that specified any colour in the RGB model we can very easily convert that to CMY model.

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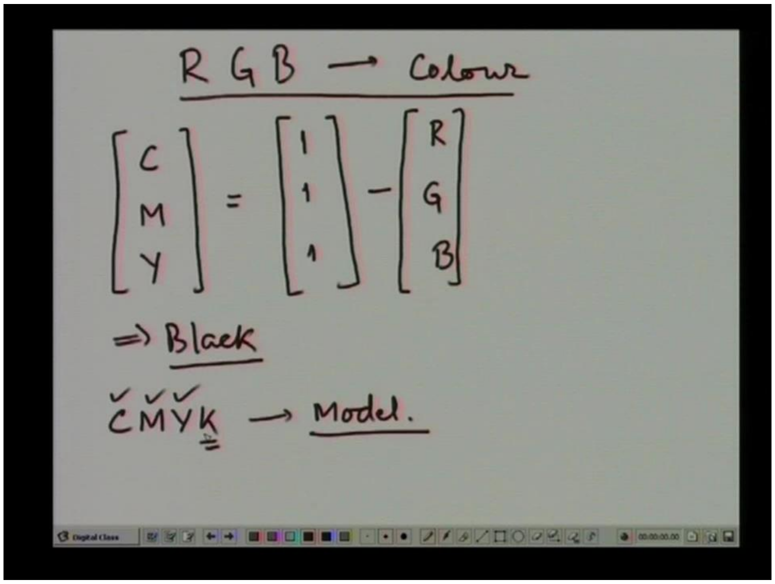

The conversion is simply like this that given RGB components, so we have the red, green and blue components of a particular colour. And what we want to do is, we want to convert this into CMY space. And the conversion from RGB to CMY is very simple. What we have to do is, we have to simply make this conversion that CMY is equal to 1,1,1 minus RGB. So here we remember that this RGB components are represented in the normalized for. And similarly by this expression the CMY components that we get that will also be represented in normalized form.

And as we have said earlier that equal amounts of cyan, magenta and yellow should give us what is a black colour. So if we mix cyan, magenta and yellow these three pigments primaries in equal proportions then I should then we should get the black colour. But in practice what we get is not a pure black but this generates a muddy black. So to take care of this problem along with CM and Y cyan, magenta and yellow another component is also specified which is the black component and when we also specify the black component.

In that case we get another colour model which is the CMYK model so the cyan, magenta and yellow, so this is CMYK model. So cyan, magenta and yellow that is they are same as in CMY model. But we are specifying an additional colour which is black giving us the CMYK model. So you find that in case of CMYK model we actually have four different components cyan, magenta, yellow and black. However given the RGB we can very easily convert that to CMY. Similarly the reverse is also true given a specification colour in the CMY space we can very easily convert that to a colour in the RGB space. Thank you.