Illumination Engineering and Electric Utility Services
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Lecture No. # 6
Photometry

Yeah, welcome to this lecture number 6 on illumination engineering.

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This lecture is titled photometry. Recall that we mentioned in the last class that in order to understand anything, it's necessary to be able to speak in terms of certain quantitative numbers that is to say any quantities that needs to be assessed we have to hang a number. In fact this is, measurement becomes a very important issue and anything when you want to measure, it is necessary that you should be able to have reproducible measurement issues. So all this calls for having a standard and this is done by way of having standardization which we saw in the last class.

So what do we do in this today's class is essentially having learnt what is a standard unit of a light adapted for illumination purposes, we need to measure some of these things of our other sources and this branch what we call photometry and in fact the objectives of this lecture listed are one to be able to understand what is the photometric bench.

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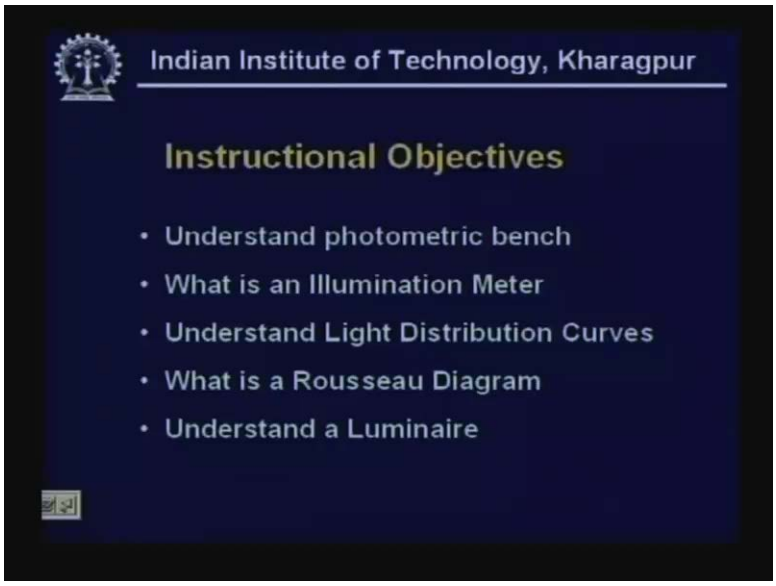

What is an illumination meter, understand the light distribution curves, what is a Rousseau diagram and what is a luminaire. So this is the framework under which we are going to address this particular lecture. Repeat that we are looking at measurement aspects; understanding of no subject is complete unless we are able to measure and express it in numbers. This is in fact based on a quotation by the Lord Kelvin.

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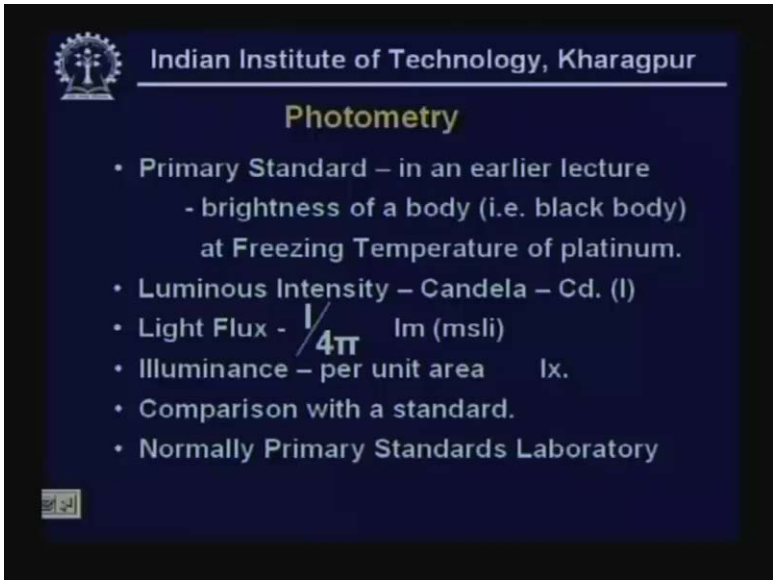

Now in a last class we did look at what should be a primary standard as far as this goes which went through series of changes beginning with the wax candle and Pentium lamp. Finally the primary standard was adapted as the array, a good radiator whose is maintained at the freezing

temperature of platinum. Having looked at the standard, the immediate thing was to talk in terms of units in which we are going to express these radiations because there is no point in measuring and giving a number, if we are not able to express it in certain units. And that is how we have defined the right output from any of these sources in terms of the original candle. That's how the term candela has come is the luminous intensity and the total flux which comes out of a source assuming it is a sort of a point source was given out as 1 I, if I is the illumination intensity I over 4 pi lumen. Lumen was the unit of light flux and since more sources to begin with were based on what we know today as incandescent lamps which can be approximated by point sources. So based on the light flux available in all four directions, as we said it can be viewed as a point source so at radially away from the source, the light flux is going to be of this similar level effect of the light so that is expressed as a mean spherical luminous intensity.

And the effect of this light on any test object is talked in terms of illuminance per unit area that is lumens per unit area which is expressed in lux. Recall in the last lecture on loss of illumination we define this. Now all natural things follow some form of an inverse square law, same thing holds good for light also that is what we saw. We had illuminance inverse square law and that's opposing the light or the test object, we service the light are inclined then we also saw in order to arrive at the illuminance the Lambert's cosine law comes into picture.

So this is illuminance is the effect of this light on the test object or the object that is being perceived or viewed just as you have in an electric field, electric field intensity at any point which is the effect of the system of charges that are available to us. And how do we measure that is where the issue is. In fact I said right in the beginning of this lecture that we need to measure, we need to give some number so that we understand the phenomena little more. And any measurement would call for having a standard and that's what we saw in the last class and that was a good radiator or a black body maintained at freezing temperature of platinum. Now the easiest way to measure would be to have a comparison with a standard, that is how one could do.

Now the issue is very simple, we do not this thing, we do not use the primary standard for all measurements in fact primary standards are maintained in the standards laboratories. So we do not have the, we have lamps compared with the primary standard which can be viewed as secondary standards like for any other measurements. Let us look at our measurement of length, weight or voltage or current, we have standard meters maintained at standard laboratories and secondaries are substandard meters used for our laboratories calibration at the... So similar way we have the incandescent lamp is used, it's compared with a primary standard and is used as a laboratory standard.

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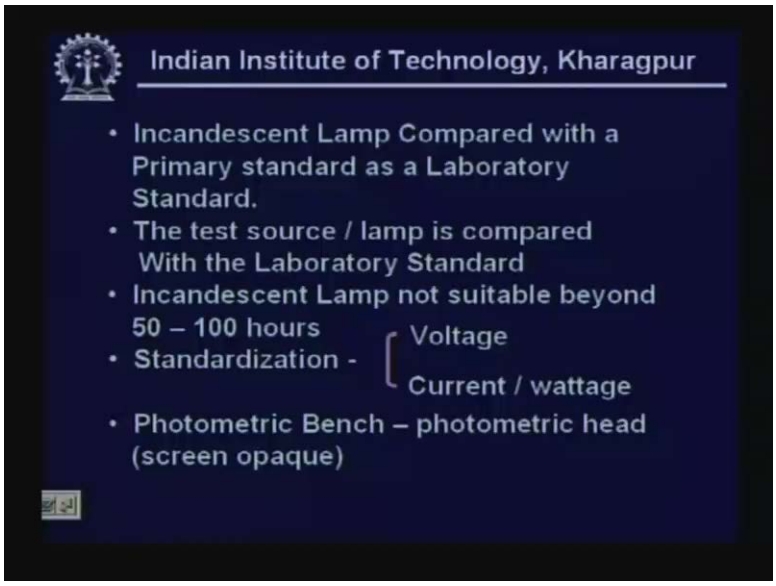

The test source is compared with the laboratory standard and this process of comparing and measuring is what we called as the photometric. In fact how do we define the light or radiation ability of a source, in terms of the luminous intensity. And it is categorized or the unit of luminous intensity is candela. So we do this and one has to keep in mind that this lamp which is compared with the primary standard, we have to take care by not to be used beyond 50 to 100 hours and second thing it should be borne in mind, it gives expected output only when it is maintained at the nominal rated voltage or allowed to draw the rated current. So this aspect has to be borne in mind, in fact we will see when we take up various sources how varying conditions affect the life of our lamp. Life of a lamp would mean one the, it continuing to give the radiation output without any deterioration.

And secondly some of these things, I mean it doesn't get, one simple thing is we are using an incandescent lamp. What is an incandescent lamp? It will get clear as we go along but as a first thing is it is an element working on the thermo luminance that means there is a filament which is heated. Now we want that this filament is not destroyed that is what I mean by maintaining itself. So the thing is done by having what we call a photometric bench and the test lamp along with the standard lamp or the laboratory standard lamp is compared and the radiation from these two sources what we call on an opaque screen called a photometric head is observed. This will become clear when we see the diagram. See then what do we do? There are various ways of doing, one the first and foremost simplest one is compare the test lamp with the standard lamp on the photometric bench. Simultaneously one could be vary the position of the comparison lamp okay or the other could be varying the position of the test lamp.

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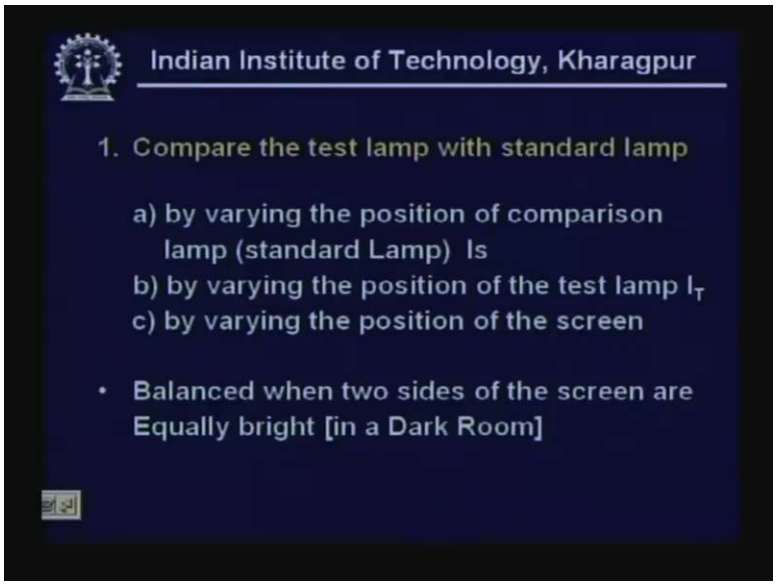

The third could be varying the position of the screen. Okay, we vary these, where we looking at. We are looking at that on the photometric head which is nothing but an opaque screen, the light radiation is of the same intensity, this is to be observed. So what we see? We look at the brightness of the two sides of the screen and we look for equal brightness on inside, okay. So what are we doing? We are taking a standard lamp, we take the test lamp and a photometric head and we keep the screen between the two lamps and we observe the brightness on the screen of the photometric head due to these two lamps. Now we can vary either standard lamp position or we can vary the position of the test lamp or the position of the screen for this condition and obviously all these needs to be in the dark room.

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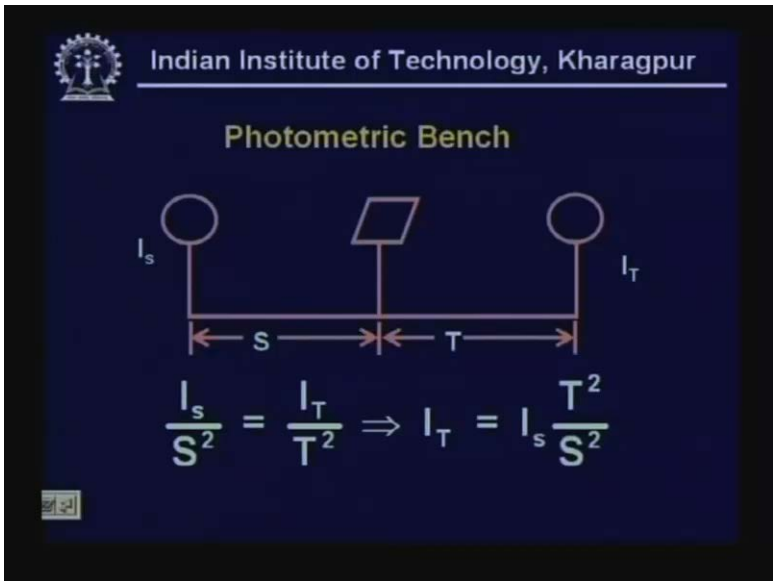

Of course some of us have done some of these experiments using photometric benches in school physics classes on light experiments. Here is the picture which shows the arrangement for photometric bench. So the first method which we said is on a single bench simultaneously both the lamps are located and the photometric head is placed in between them. Let the distance between the source, standard source and the photometric bench be S and that between the photometric head and the test lamp be T. Then one can say if the brightness is same on the screen at either end, on either side look the brightness on this can be expressed using which law, the inverse square law of illumination which says at any point x away from a source I, the illuminance is I by X square. Applying that we get I_S over X squared is equal to I_T over T squared. And hence one gets I_T is equal to I_S T squared by S squared. Needless to mention that photometric bench has a scale attached to it which enables us to clearly get the distance between the various, between the sources and the photometric heads.

So this is a very important issue. And what are the various (Refer Slide Time: 00:14:03) balance, one I keep the position of the head and the test lamp fixed, where is the position of stand lamp thereby I get the value. Alternatively I keep the position of the standard lamp and the photometric head fixed but vary the position of test lamp. The third way or yet another way of doing it could be keep the position of test lamp and the standard lamp fixed but move the photometric head and thereby get the value of S and T that will give us the thing. There is another way of measuring is instead of using the photometric head, we use what we call the Lux meter.

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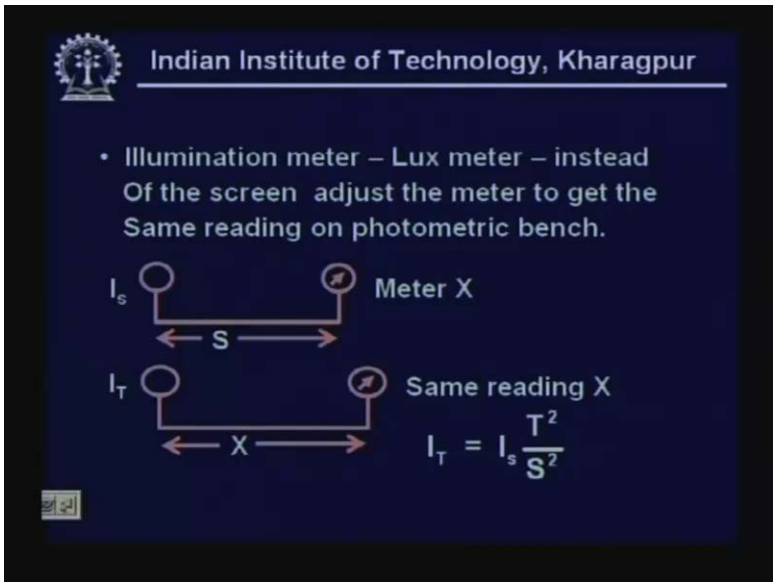

Remember when you are using a photometric heat ahead which is an opaque screen, it is somewhat subjective in the sense that it depends on the person who is involved in taking the brightness or in balancing. Once we use a meter which is being called illumination meter which is marked in terms of what, illuminance. Illuminance we recall was defined as the lumens per meter square or the light flux per unit area and is expressed in unit of lux, hence the lux meter. So what do we find? What do we do on a photometric bench? We locate the standard lamp and at

a certain distance S, we get say a reading on the lux meter of X. So what do we do? We take a photometric bench, we locate the meter at a distance S, observe the reading let it be X. Then the next stage what we do? We take the test lamp, we replaced standard lamp by test lamp and then move or vary the position of the lux meter to obtain the same reading of illuminance.

Here in the diagram, the distance marked X should have be capital T. So once we do that we have again knowing that illuminance is in terms of the, given in terms of the luminous intensity and distance by the help of inverse square law. In the first case we have I_S by S square equal to X and in the second case we have I_T by T square equal to X. Since we find the distance T between the test lamp and the meter for obtaining same illuminance X then we get the luminous intensity of the test lamp as I_S multiplied by T square over S squared. So to some extent the subjectivity of using a photometric head is eliminated, if we use a lux meter. The way to do is take the standard lamp, let's say it's placed on the photometric bench and the lux meter is positioned a distance S away from the standard lamp. For an end say its gives a reading X when we relocate or replace standard lamp by the test lamp and move the meter till such time we read the same reading. And we get a new reading, new position of the meter away from the test lamp or the source of T then going by the law of square, law, law, inverse square law of illumination one gets the illuminance I mean the illuminance intensity of the test lamp in terms of the standard lamp. This is the second way.

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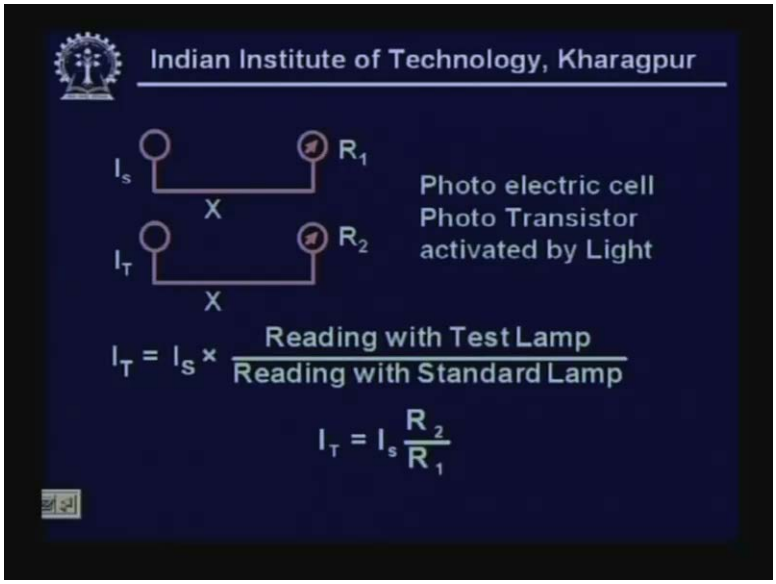

There is yet another way is here recall we just varied the distance. Instead of varying the distance, varying the distance for the same reading of the lux meter, if I use a lux meter and position it at a certain distance X of the photometric bench from say a standard lamp and get a reading R_1 and again on the same bench I replace the standard lamp by the test lamp and maintain the same distance X between the lamp and the meter, I get a new reading R_2 then what we get is that we can relate. In fact you remember that what are we reading in the lux meter? We are reading the illuminance; illuminance is proportional to your luminous intensity. Recall inverse square law, in the first case if the reading R_1 was there, R_1 is essentially I_S by X square.

The second case we got the reading R_2, R_2 is I_T by X square. So since X is same, what do we have? We can say I_T equal to I_S into reading with test lamp which is R_2 by reading with the standard lamp. So this is the way to go about making some measurements. This is fine as far as what goes as far as getting the luminous intensity. It is the first thing, once we have luminous intensity all other measurements or calculations become easy, in fact that is why the photometry is an important issue for measuring. And how do we do it? We can do it by comparing with the laboratory standard.

What is the laboratory standard? A laboratory standard is nothing but an incandescent lamp compared with a primary standard maintained in the standard laboratories and with the help of a photometric bench. We saw three ways of doing it; I mean two ways of doing it either using a photometric head or a lux meter. Now what you see is a way to create simple lux meter. What we observe? There are two circles; outer circle is an enclosed opaque sphere with a small opening and the smaller circle inside represents the source. There is a diffusing screen so that most of the light flux goes through the opening and is measured using a photo cell or illumination meter. We'll look into the illumination meter or a photo cell, how it works a little later.

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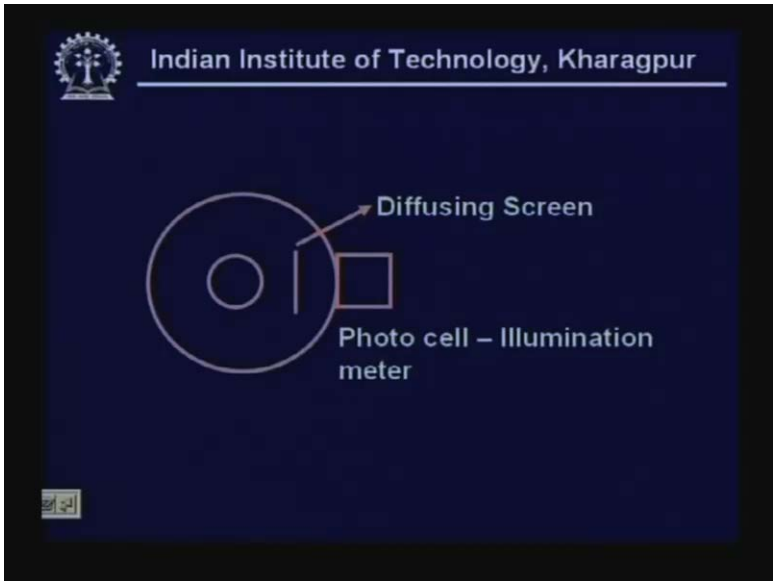

In a simple sense it is a photoelectric device which sends an electric current on exposure to light and this electric current measured is an index of the luminous intensity or illuminance, I mean at the point where it is maintained. So this is how one could do? So this is another way, yet another way of measuring. So this is not using a photometric bench. We talked about measuring the illuminance from a standard lamp comparing and again maintaining the same distance on a photometric bench for a test lamp taking the ratio of the two readings. So you can, this particular arrangement is what we call photocell arrangement. So what you do? Initially we keep a standard lamp at the center representing the smaller circle, observe the reading on the photo cell then replace it by the test lamp, repeat and then you know you have the reading, the luminous intensity of the test lamp would essentially be the luminous intensity of the standard lamp multiplied by R_2 over R_1. So this is how a photo cell looks.

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So, once again recapping the standard units which we employed in the illumination thing. One of the fundamental things is the radiation ability which we defined as luminous intensity which is standardized as candela or abbreviated as cd. The next most important thing is total light output is the luminous flux lumen. In fact we look at some other things which are called as the light flux diagrams because depending on the overall lamped system, although a lamp may be able to radiate uniform flux in all directions depending on the, what we called lamp shade or in other words technically known as luminaire, it may direct the light and therefore it may change the light characteristics in the environment. So it becomes necessary to know the luminous flux at lumen.

Illuminance of course is abbreviated as lux, lx is known as the lux is the luminous intensity at a point that is lumens per meter square. Now there is an another term called brightness which we have also encountered earlier in talking about the functioning of the I is standardized as lamberts. The difference between brightness and illuminance though they look to be the same is this. Brightness is sort of the cause, illuminance is the effect. That is if a light falls on a source, the effect of this light on that test object is what we call illuminance whereas the light output available at a particular point that is what we call the brightness.

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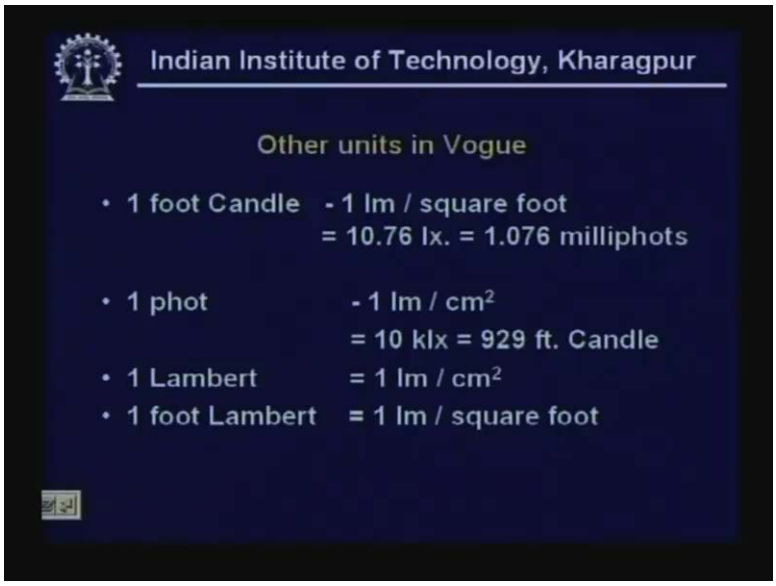

So this and here it becomes necessary for us to know some other units which have been invoked because though they are not currently used but for the sake of completeness, it must be taken care there in the FPS system, one may encounter when read in the literature. And in fact even we have encountered, one of them is foot canal which is nothing but one lumen per square foot which is essentially nothing but 10.76 lx or we do have another unit which is called phot. See in fact, the lux is a very large unit, so you talk in terms of phots which is one lumen per cm square. Let's look it at this way, we are looking at the effect of a light over a certain unit area and one meter square is a very large area. So if you look at as a point effect variation may be sometimes if the variation is large over a certain region, it may be necessary for us to look over smaller areas that's where phot becomes useful. It's one lumen per cm square or which is nothing but 10 kilo lux.

And then you have Lambert, I told you Lambert is nothing but again the brightness is talked about in terms of Lambert, it is one lumen per cm square. If it is the illuminance we would use the term phot and for brightness we would use Lambert. One foot Lambert is nothing but one lumen per square foot. So the foot candle would be the cause or the response due to a certain source, foot Lambert would talk about the brightness of the thing. See there are two things, sometimes the walls have some brightness based on the natural light that is expressed in terms of this. So going a little more into brightness because brightness and illuminance confuses often times and it is necessary for us to know the difference.

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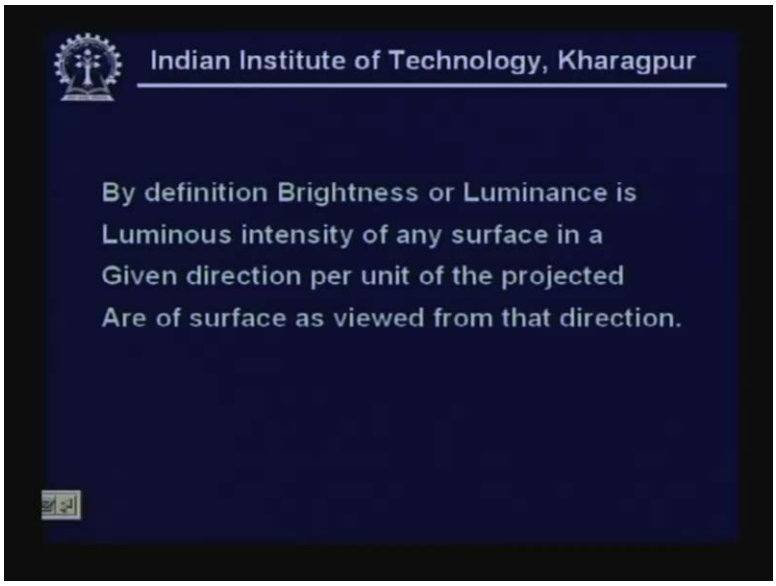

By definition brightness or in fact brightness is also known as luminance whereas the effect we call in terms of illuminance, luminous intensity of any surface in a given direction per unit of the projected area of the surface as viewed from that direction. This is very important in interpreting the light flux diagram in these sources.

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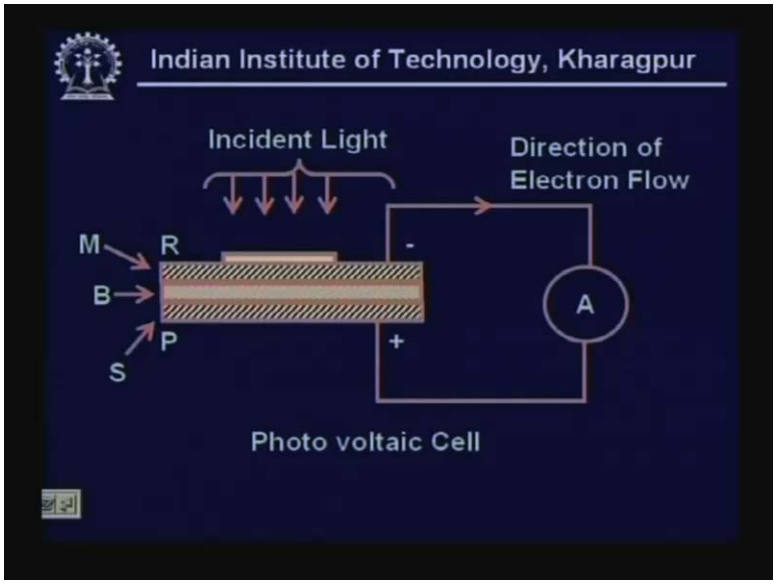

Now it is time to look at the photo voltaic cell. I talked you about that there is a photo voltaic cell. We have what is it called the, it uses the photo electric effect. As can be seen there are three layers, it appears to the three layers but it essentially there is a small thin semi conducting layer S, a small gap on top of which a transparent thin metallic layer M is placed. This gap is talked

about as the barrier and this transparent layer on which light is incident. And as can be seen the region marked R which is nothing but the covered thing that is only it is coated with some metallic thing. Now what do we do? Suppose if this is transparent, on exposure to light this semiconductor gives rise to certain electrons and there is a current flow between the two layers. Now this current is collected and read on this ammeter shown. So this acts as a photo voltaic cell or the lux meter, this is the principle of the lux meter. Now how the ring is located will become clear as we go along.

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So the first thing is the sensitive element which is a semiconductor which gives rise to electrons or goes into conduction mode on exposure to light. The two materials that have been found suitable for this particular application have been selenium and cuprous oxide, these are the semi-conductor materials.

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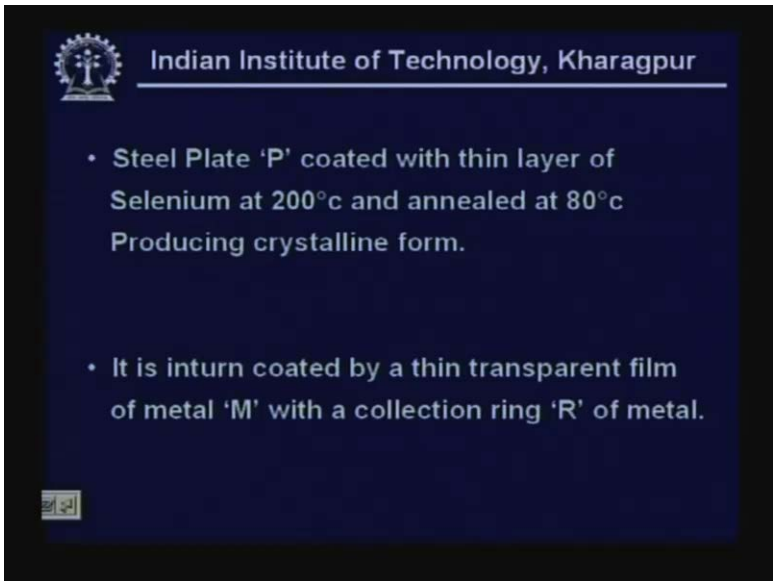

There is a small that means what is done? Look at the diagram once again. We have a small steel plate; in fact if you want to collect this current which is generated, you need to have electrodes. That is why that on a small steel plate you thin layer of selenium, let say the selenium and cuprous oxide both are possible, let's call it we are using selenium and it is placed. Then in turn we coat it with a thin film of metal and there is a collection ring of metal. See the first coating M is transparent where as the outer ring is not transparent.

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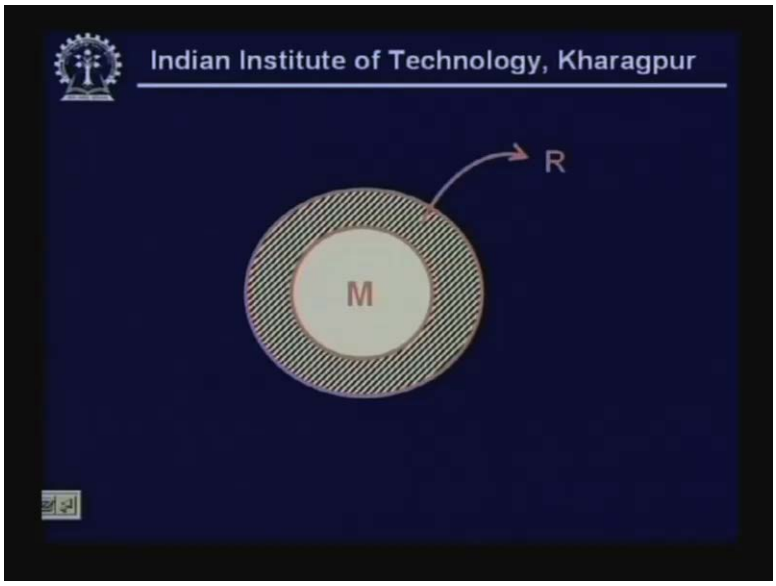

This is how it looks. One could see the top view; the R is opaque whereas M is transparent. These are top view and that is how the current is collected between B and R.

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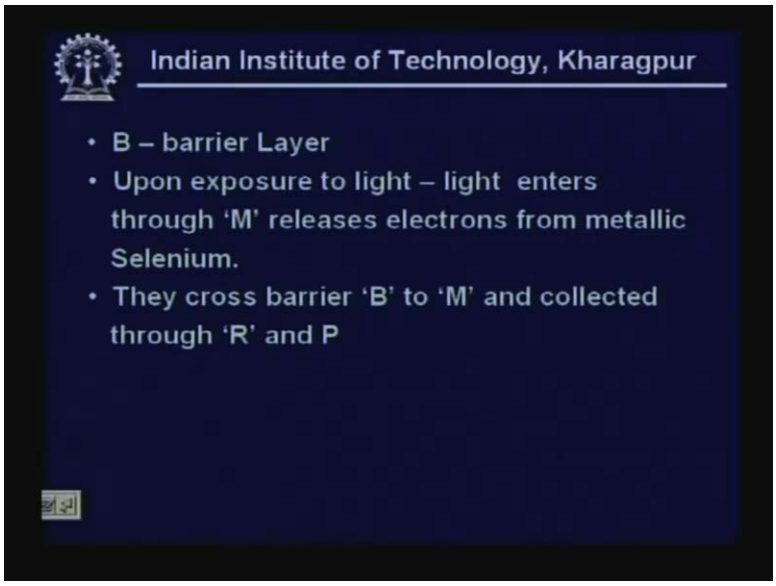

B is the barrier, on exposure to light- light enters through M releases electrons from selenium. They cross the barrier B to M and are collected through R and P. Now once the current is allowed to flow, this current is indicated in the ammeter which could be a micro ammeter and this gives the calibrated in lumens or lux. So that is the principle behind the photo electric cell, this is very important.

Now from the measurement point of view or use point of view, one other thing which becomes necessary is the light flux distribution curves that are provided by the manufactures and they are often guided by the accessories that are used with the lamps. As we study the sources we will get clear like incandescent lamp is placed in a glass envelope which is called the bulb. We know it as bulb the glass envelope is that.

Now we have seen lamps which are coated inside the top, so that most of the light flux is radiated downwards. So that is in a simple sense a mechanism to direct the light or control the light. Now, the whole that could be one way of directing the light, the other thing that happens is often we place these lights in what are called lamp shades which are again coated with reflecting material which reflects bulk of the light going there. And therefore these accessories which control or direct the light are called luminaires and we have also talked about one phenomena that happens with the sources as far as the eyes go is the phenomena of glare. Whenever eyes are in the straight line with the intense light coming from a source, there is a phenomena of glare. To avoid this it's often times light is diffused. So the whole thing scheme of reflecting, controlling the light to be directed in a particular direction and diffusing are called luminaires.

So let us see what luminaires are, how their distribution curves are and how do we make the estimates. In fact this also forms a part of photometric, though it may not be exact measurement but it is necessary to understand how to, okay.

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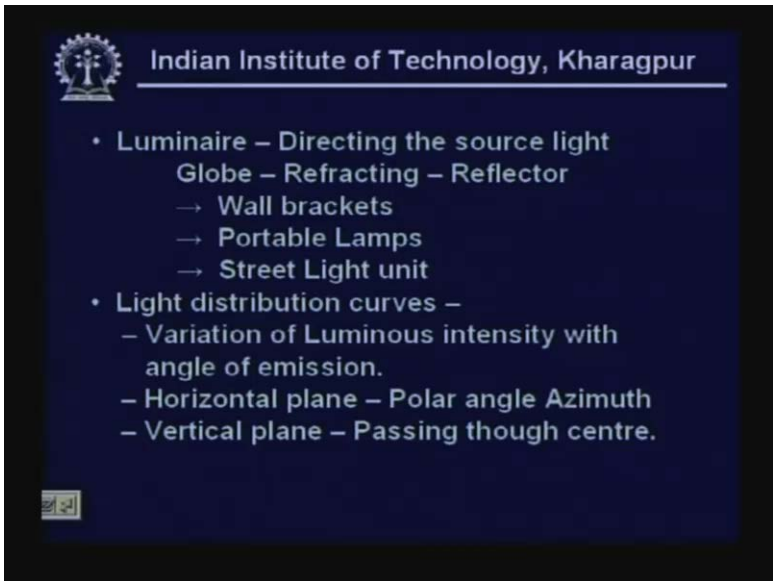

So you have luminaires which are basically directing the light from the source. Now as I told you to avoid glare you may be using diffuses and this could be in terms of one common thing which we have seen for ornamental lighting is to use spherical diffuses which are also called because it resembles the mother earth as globe, they could be refracting reflectors. Now depending on type of application you could have wall brackets and street lights we have seen they are so positioned that the street users or the vehicle or traffic is able to use. So therefore all these have what are called light distribution curve in the various planes which is nothing but the luminous intensity the service angle of emission. We have both horizontal plane and the vertical plane passing though the center, okay.

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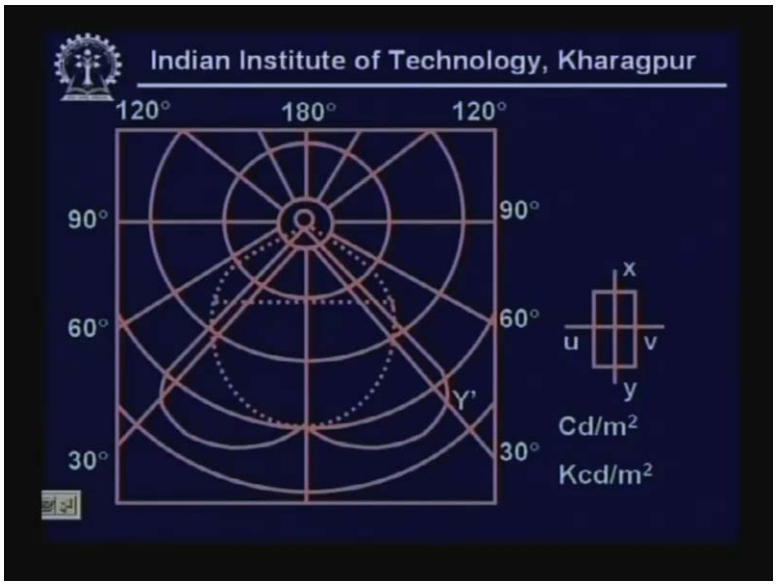

So now this is a typical light distribution curve what we have is it's a, you could call it as a vertical. Assume that there is a lamp along with its luminaire that is if the lamp is already pre-coated inside that itself would be reflecting. So considering all that at various angles how the light flux distribution is it starts in terms of luminous intensity per unit area. So we have such curves given. So whenever we buy a complete lamp system, we are provided with such curves. Now for me to be able to access the requirement of lighting in a particular room, I may need to use this curves together and be able to arrive at the luminous intensity or illuminance on the work table depending on the nature of the work.

Work table when I mean, it not necessarily table. Work plane is what I mean here. So in fact there is one particular way we have talked about points and talk about point source, we said the total flux is talked in terms of mean spherical luminous intensity called lumens; one has to arrive at that. When normal nickel lamp, it is nothing but if ICD is located at the center one get I by 4 pi as the MSLI because it is uniformly distributed in all directions but observe when it is given in this kind of a direction, the light intensity is not same in all directions and that is taken care by considering the polar curve provided like here we have a polar curve given for a lamp marked curve A.

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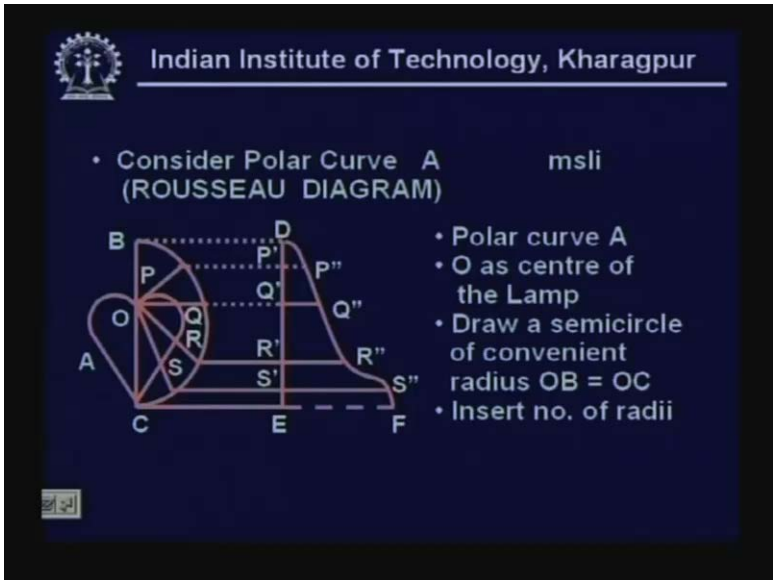

Incidentally the lamp is placed at the point O and the curve takes the shape of a heart. So now in order to get the mean spherical luminous intensity, what we do is we construct what is called as a Rousseau diagram. How do we go about? We start take the polar curve A given, take O as the center of the lamp then take any convenient radius and here the most convenient radius would be my polar curve is extending upto OC. So I take that as a radius, draw a semicircle and then from O at several points I keep drawing the radial segments to the polar curve which meets, initially when I go upwards originating at O it meets at O itself then I relate. That is the intensity value, I relate that, take the projection on to another vertical line marked DE. Let's say I take radial going upwards at O whose length is 0 and then I project it as from B onto D of zero length horizontal that is the intensity.

Now let's say the second radial meets at P and which is marked as at P prime on the line DE of length P prime P double prime that is the radial distance from O to P on the polar curve. Similarly at another radial we have seen cuts, the polar curve at Q. This maps say at Q prime on the line DE, Q prime Q double prime gives the luminous intensity corresponding to that angle. So this is how supposing we are positioned there, this is the luminous intensity in the direction. So basically by having a luminaire and a director, selectively you are adjusting the luminous intensity in various directions whereas in a normal simple source, it's same in all directions.

Now we see the radial which cuts at R maps at R prime R double prime and similarly S prime S double prime. So we get the number of this thing. The average of these horizontal lines like EF S prime S double prime R prime R double prime Q prime Q double prime P prime P double prime would be your the mean spherical luminous intensity or in other words the area of this curve is the index of mean spherical luminous intensity. The construction of this diagram from the polar curve is what we called Rousseau diagram. So for any given lamp with the or the lighting system, we have a polar curve given in a particular plane depending on the plane of interest. If you are looking at a work table, you need to know the horizontal polar curve to be able to get but if you are looking at a lamp for application on the streets, you need a vertical plane so that is how it is done.

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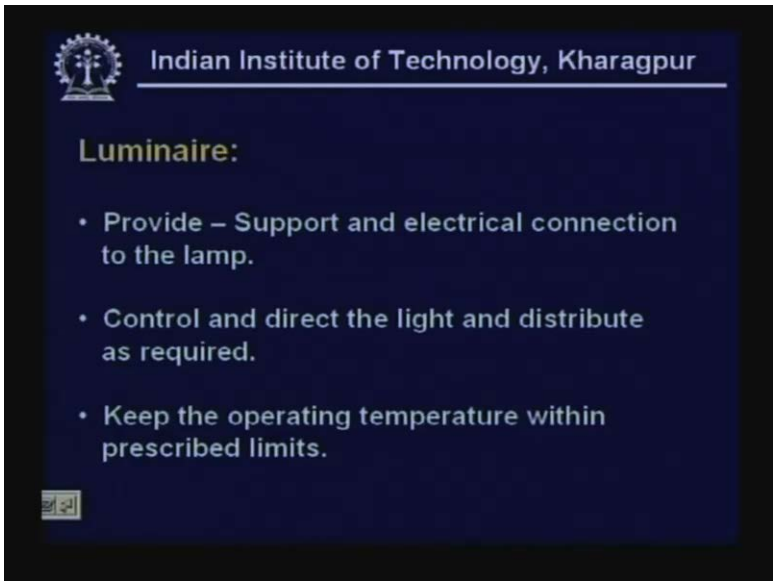

So the luminaire is the one which distributes or creates this polar curves which can be whose effect can be taken care through Rousseau diagram. And what do the luminous do? They support and also bring electrical connections to the lamp. Remember all sources are being fed by electrical energy. They in fact control direct the light and distribute as required. And there is an additional responsibility in the whole system that you have to keep the temperature within the prescribed limits. See if our illumination system tries to go raise the temperature, it's going to be a burden on the air conditioning system especially in the interior lighting.

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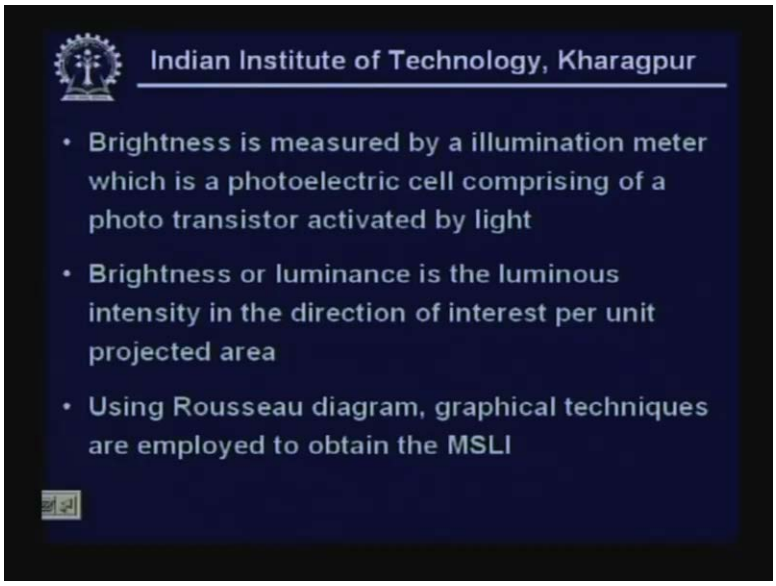

Now we already said brightness could be measured using an illumination meter which is activated by a photo electric cell and we have seen how a photoelectric cell is nothing but a layer of semi conducting layer and a conducting transparent layer which generates electric current upon exposure to light. Now brightness or luminance is the luminous intensity in the direction of interest but for the unit projected area, this is very important and we have already said we use the Rousseau diagram to get the mean spherical luminous intensity. This becomes very important because unless you have an idea of this, it may not be possible for you to arrive at the number of sources, location of the sources etc.

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So this apart, one looks that the luminous should be very easy to install and maintain. At the same time you have to have a pleasing appearance. We said right in the beginning of this course that illumination engineer has to have aesthetic sense just as an architect, in fact light is or illumination is provided so that object of interest is visible or perceivable but not the source itself unless it is the ornament of observation and it should have a very pleasing appearance and be very cost effective.

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Requirements for good luminaires can be therefore listed as they should provide good support and electrical connection to the lamp, of course depending on the voltage operation. And in fact though I say it should control direct and distribute as required, it's an order to say that these days there are electrical controls available which are part of the luminaire and keeping the temperatures within the prescribed limit.

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They should be easy to install and maintain. Maintenance is one important aspect that takes away lot of our this thing time and money. Then in order to focus or get the required kind of a radiation and direction, lenses and prisms are often used.

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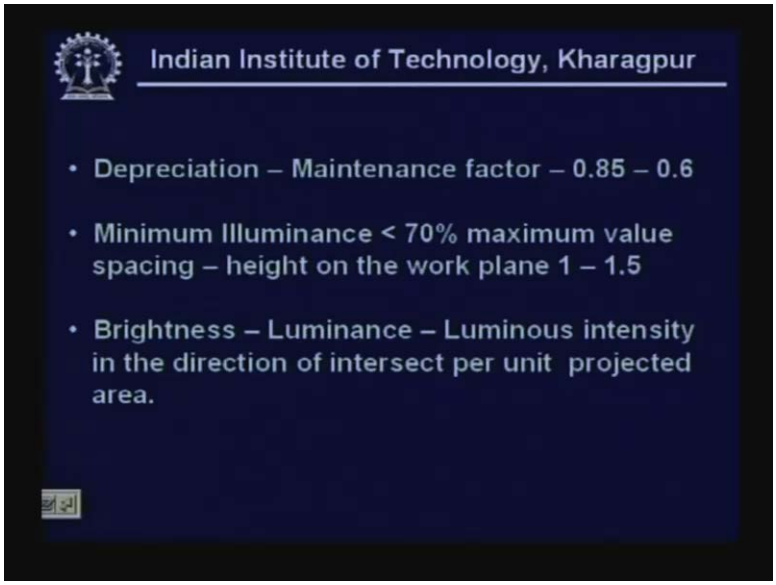

The some factors which are necessary in order to evaluate, there are one major factor is what we called depreciation or known as maintenance factor. In fact depending on the type of maintenance possible or carried out, we can say that if the virgin lamp has a certain light flux radiation capability, it reduces the time and this even for the best of the lamps is around 0.85 which can be as low as 0.6. Then the other thing which is often kept in mind is minimum

illuminance should never be less than 70% of the maximum value. In fact if you see the guidelines which are one of the good source, forgetting guidelines is illumination engineering society books which talk of average level but we need to have reasonably uniform illuminance, it cannot be abruptly changing that will cause fatigue on our eyes. Therefore it should be assured that you have the, nowhere in the work area is less than 70% and this in fact has been found that it is achievable if you have multiple lamps by keeping a 1 to 1.5 ratio between spacing to height on the work plane, when you have to use multiple. And this applies for point sources not for line sources. Then of course brightness, luminous we know we have already defined is the luminance.

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Now this apart, there is yet another factor called utilization factor. Depending on the type of the lamp we have there are different kinds of utilization factor which means how do the total light that's available how much of it is getting used. See there are these days you have luminous available where 0.9 to 0.95 of the light is directed but the conventional open lamp shades only about .04 comes down on to the object. And there are certain open pendant things where very little light comes out. In fact in trying to avoid glare, I said we use diffuses and that's where some amount of light is always lost, these have to be, okay...

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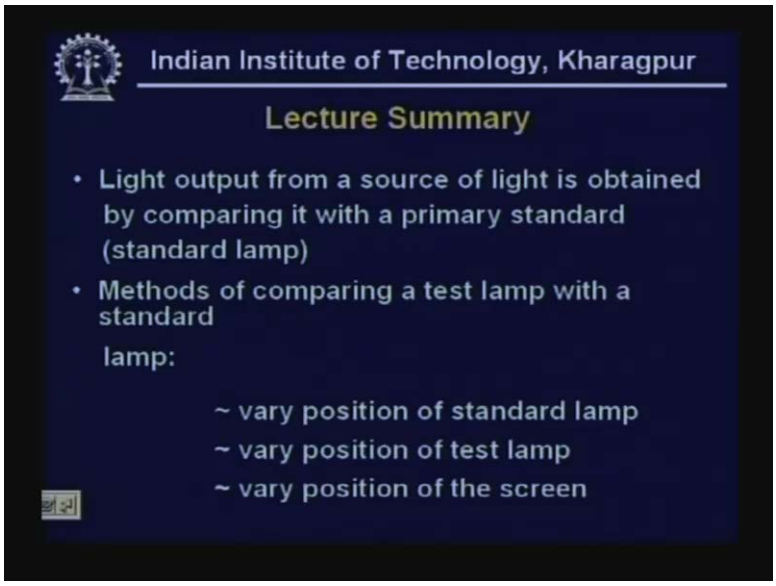

So the lecture summary therefore could be light output from a source of light is obtained by comparing with a primary standard or a standard lamp. Now how do we do that? I said it is using by comparing with a laboratory standard on a photometric bench where a photo head is used. A photo head is nothing but an opaque screen and this type of measurement is subjective in nature. Methods of comparing a test lamp with a standard lamp: Vary the position of standard lamp number 1. So what you do, keep the photometric head and test lamp fixed. Second thing could be keep the standard lamp and the photometric head fixed, vary to the test lamp.

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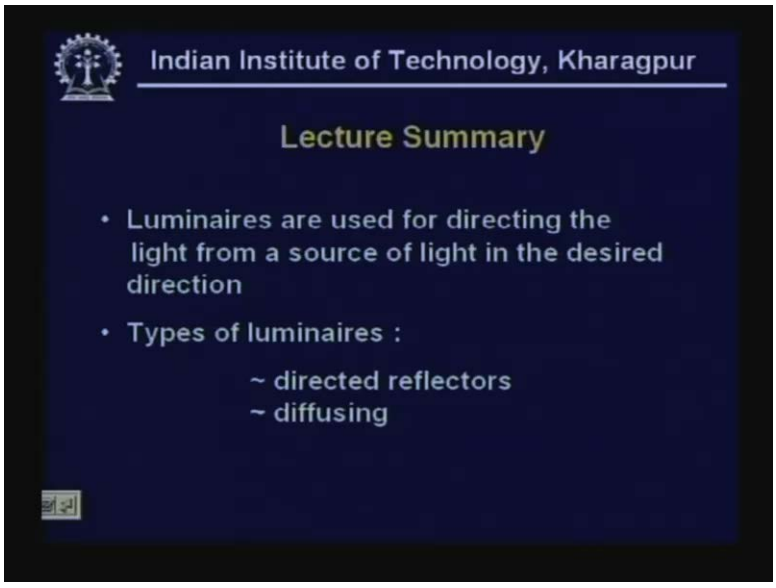

Now to avoid the subjectivity, we talk of using what we called the lux meters and wherein we could take the test lamp and the lux meter at a fixed distance and the standard lamp and lux meter at the fixed distance, get the two readings the ratio of the two reading gives the test lamp luminous intensity. Here again you could either fix the distance or fix the reading of the lux meter accordingly get. Now luminous are invariably employed in fact nowhere we use the lamp directly, any lamp we used is with its accessories. Luminaire is the term used for complete accessories that are used which will consist of your reflectors, control gear, other accessories and remembering that it's driven by the electrical energy the lead ins, lead outs all together and so they direct the light in the desired direction. They could be direct reflectors or diffusing, I said unless the light comes reflected from sealing say for an interior lighting. If the light rays are in the site of, in the line of vision they can cause glare when the intensity is high. This has to be avoided, this could be done easily using diffuses. Therefore you have luminaires which are directed reflectors diffusing and they could be using prisms or various kinds of things.

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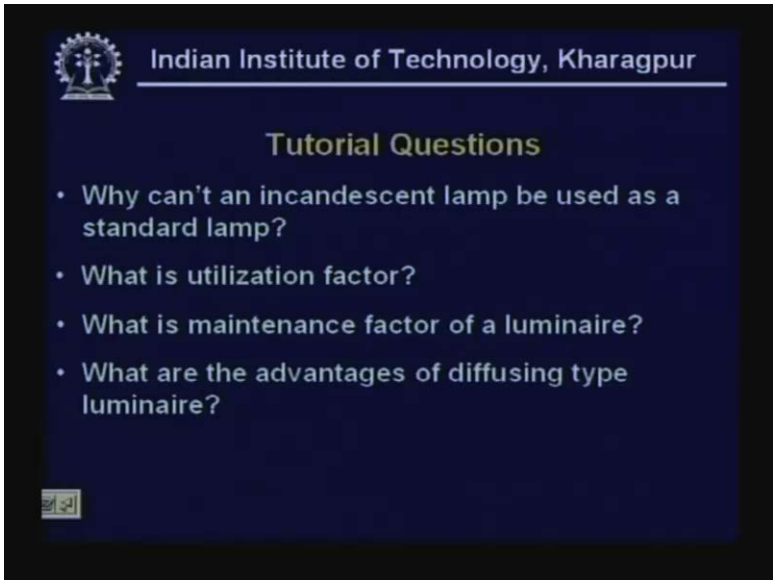

So we could have some questions based on this lecture. Why can't an incandescent lamp be used as a standard lamp? However I said incandescent lamp is used for comparison methods in the laboratory on the comparison that thing, keeping in mind that we maintain the voltage and wattage. What is the utilization factor, what is maintenance factor of a luminaire, what are the advantages of diffusing type of a luminaire?

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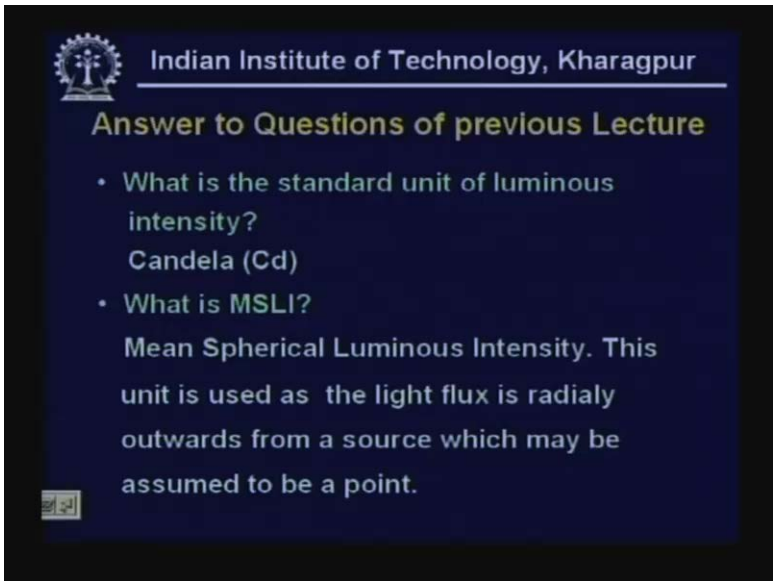

Now, some of the answers to questions in the previous lecture, they are what is the standard unit of luminous intensity. The answer is candela. Remember the standard unit of luminous intensity has been adopted based on the origin of primary standard. In fact primary standard has originated through several levels began with the first and foremost standard was wax candle. Then what is MSLI. MSLI is the mean spherical luminous intensity, as the light flux is radially outward from a source which may be assumed to be a point. In fact that is why when we are dealing with the lamps; we look at the light distribution curve we saw that and how one gets the mean spherical luminous intensity through a process of constructing the Rousseau diagram. What is the standard procedure to measure luminosity? The luminosity can be measured by the standard procedure of photometry that's what we saw in today's lecture. Thank you.