Applied Ergonomics
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Lecture – 10

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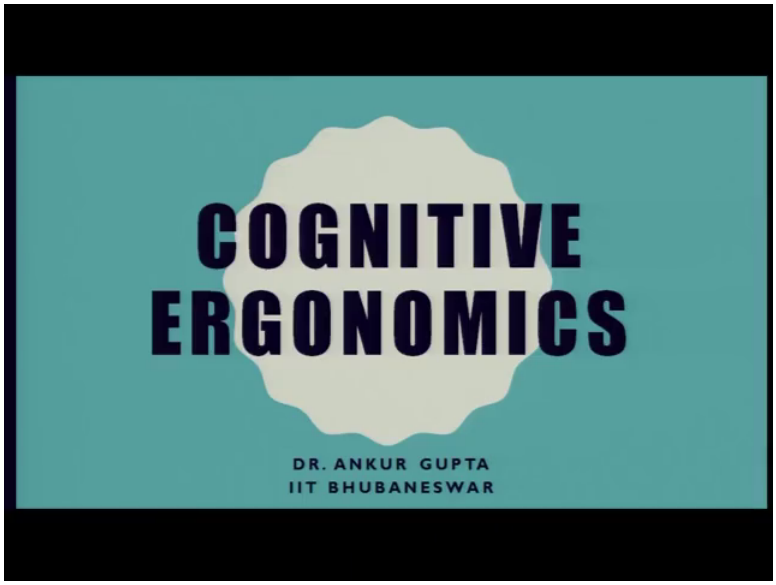

Welcome to the lecture series of the course applied ergonomics. Today we are going to start one of the most important topic in this applied ergonomics course that is cognitive ergonomics. So, first of all we would like to learn that what this cognitive is all about and what is its relation to the ergonomics and other aspects also we will discuss and I hope you will find a lot of interest in this particular topic. So, first of all we need to understand that what this cognitive in terms of its meaning. So, this there are various cognitive activities basically which we have to make ourselves aware that cognitive activities includes thinking when you read something write something when you are in decision making and when you are going to solve something. So each and every activity which you performed with the help of brain, so that particular activity comes in the category of cognitive activity.

So, here we will go in detail and we will try to find out the various fundamental of this particular cognitive ergonomics as well as the reasons why the particular thing happens

and for what reason it is happening. So, each and every thing that is related to your response and detection when we will study here.

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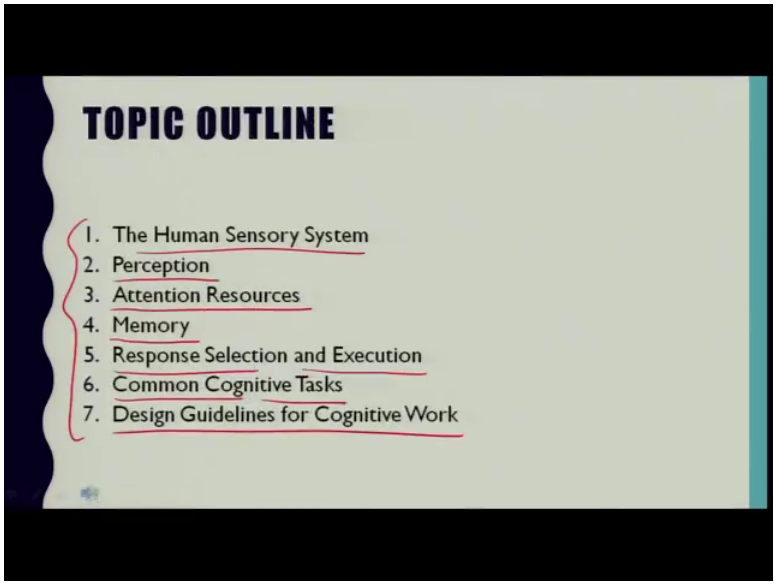

So, first of all as far as introduction of cognitive ergonomic growths so we will be covering in this particular topic about the human sensory system, perception, attention resources, about the memory, about the response selection and execution, various common cognitive task and at the last design guidelines for cognitive work. So, these are the few topics that largely essential to develop our understanding towards cognitive ergonomics.

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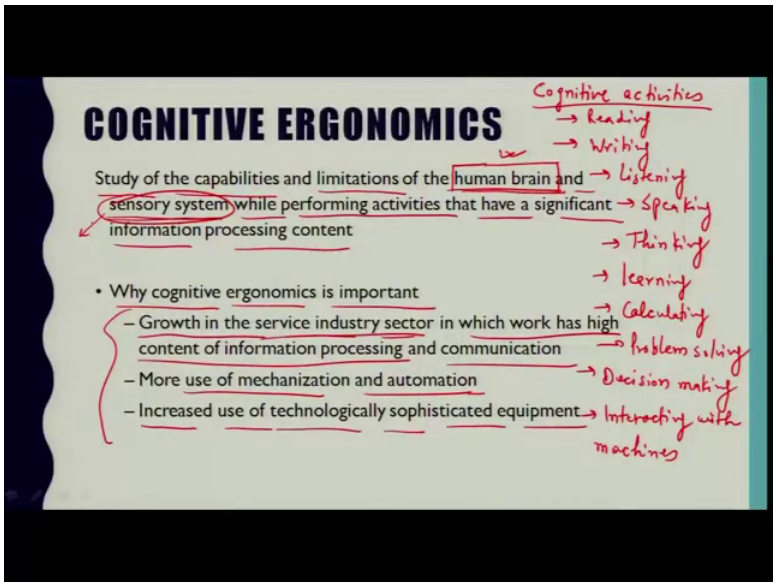

And now we need to understand that what this particular cognitive is all about. So, the cognitive ergonomics is the study of the capabilities and limitations of the human brain and sensory systems while performing any activities that have a significant information processing content. So, basically this cognitive activities may include reading something, writing, listening, even speaking, thinking, learning, even if you are performing any calculation, problem solving, decision making or interacting with machines. So, these are some of the examples that I have put in front of you so that you can have a better understanding towards this particular cognitive activity.

So, cognitive activity includes all sort of activity which uses your brain, so brain as well as sensory system. So, why cognitive ergonomics is important because this growth in the service industry sector in which the work has high content of information processing and communication. Since more use of mechanization and automation because of which we need to be aware of the control processes that were previously performed manually. Increased use of technologically sophisticated equipments that is cognitively more challenging to operate maintain and repair. So, for those reasons we have to be cognitively fit as so as to perform a particular task in a more efficient manner.

So, as for as the service industry sector goes or day-to-day activities or your personal act is concerned, so you have to be ergonomically perfect; and for in order to be perfect in terms of cognitive abilities, you should have a proper brain functioning as well as your

sensory system should be work properly. So, we will go in detail about various sensory systems that are present in our human body as well as other cognitive factors that directly or indirectly affect the performance a human being.

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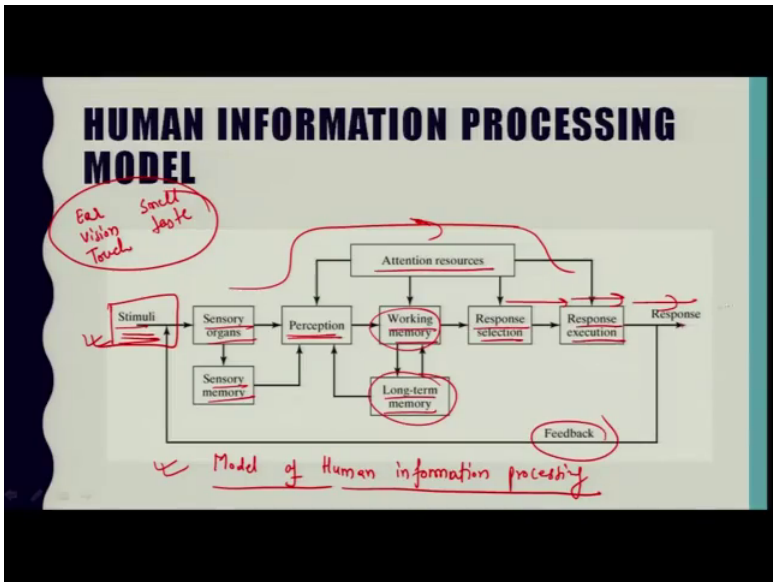

So, this is the particular model for information processing. So, we need to understand the human information processing system also, in order to have a better understanding of this particular topic cognitive ergonomics. So, cognitive ergonomics considers how the human and in fact how the human mind perceives its environment and processes information. So, any kind of cognitive activity which may be speaking, thinking, learning, calculating, problem solving, while making decisions, so that the whole that particular task has been performed within this model of information processing.

So, this particular figure presents a very useful model that reveals how these cognitive functions are performed. So, it is a basically sequential model in which external stimuli is received by the human sensory system human sensory system in detail we will we will understand those with human sensor system that maybe your ear, your vision, your eye, even touch smell or taste. So, these five are your stimulus, so through which you get some signals those signals. So, this basically external stimulus is received by human sensory system and then mind perceive the stimulus and response to it using attention resources interacting with working memory, long term memory, short term memory and

then your response is decided and then response execution is decided and then you perform the action.

So, this whole modern we will be using as a framework for our discussion for cognitive ergonomics in the latter stages of our discussion for this particular topic. So, here and in a brief this stimuli sensory organs, sensory memory, perception, attention resources, working memory, long term memory, response selection, response execution and then feedback and then you responses performed so in the form of some action. So, these all things we will discuss in detail in the coming slides.

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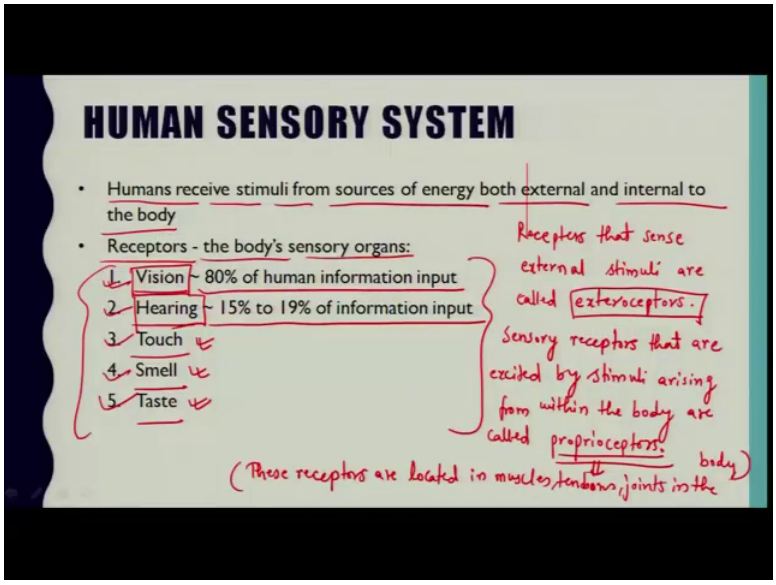

So, first of all we will discuss about the human sensory system. Since humans receives stimuli from sources of energy both external and internal to the body. Some of these stimuli is assessed by the receptors, these are the bodies sensor organs. So, receptors that sense external stimuli are called exteroceptors and that are associated with these five human senses. So, receptors that sense external stimuli are called exteroceptors and this exteroceptors are associated with these five human senses. So, those five human senses are through which you get information and then you decide your course of action. So, those five senses are vision, hearing, touch, smell and taste.

So, two important exteroceptors are vision and hearing, because this particular vision gives you about 80 percent of the human information that you get as an input. And as far as hearing is concerned, so 15 to 19 percent of the information input is obtained by

hearing. So, it is roughly estimation and remaining information you get with the help of touch, smell and taste. So, there is one more definition that you can remember, there you can have that sensory receptors that are excited by stimuli arising from within the body are called proprioceptors.

So, these receptors are located in muscles tendons and joints in the body. So, this proprioceptors are located, so this particular receptors are located in muscles, tendons, joints in the body, but our principle focus is here is on the exteroceptors sensory organs. So, exteroceptors are those five aspects that we will fairly discuss in forth coming slides. So, first of all we will take this vision as a matter of detailed analysis.

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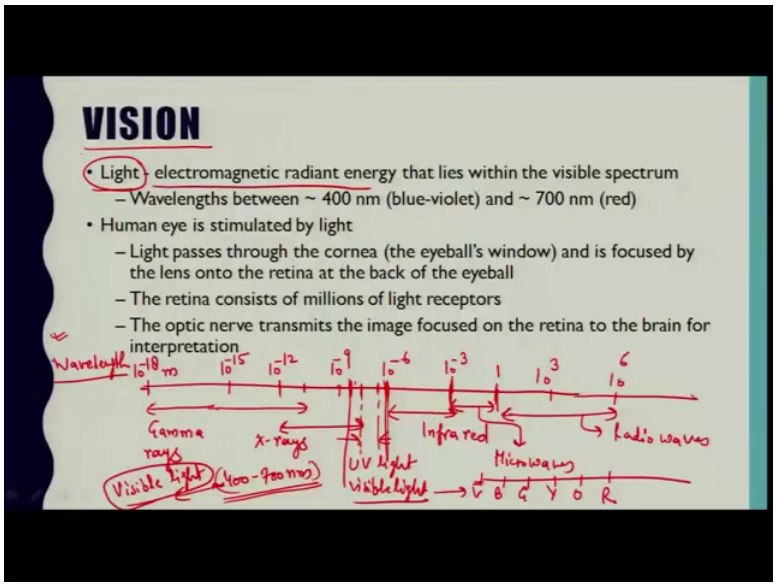

So, we will be now going to start this vision. So, vision is one of the most important of the five basic senses. So, here what you what you see is only the small portion of the electromagnetic radiations that are available in the mother nature. So, the mother nature all kinds of radiations or energy that is exhausting is summarized in the electromagnetic radiation spectrum. So, in the electromagnetic spectrum that the light or the wavelength that particular portion of the wavelength that is visible is very small. So, if you could understand this electromagnetic radiation and out of that what is the particular portion that we as a human beings can catch. So, it will be easy for us to differentiate between other radiations that are present around us.

So, if you can make the chart of electromagnetic radiations, if let say if you start with the 10 to the power minus 18 meter, and this particular electromagnetic spectrum is discriminated with the help the wavelength range. So, other the ways that are available are discriminated with the help of help of this wavelength. So, let us say 10 to the power minus 18, 10 to the power minus 15, ten to the power minus 12, 10 to the power minus 9, you take minus 6, 10 to the power minus 3, 1, 10 to the power 3, 10 to the power 6.

So, what I am doing here I am going to have overview of the electromagnetic spectrum through which we can have the idea of available radiations and the portion of the radiation that is visible to our naked eye with naked eye. So, as far as other radiations are concerned, so the range that you can take the first kind of range that is of gamma rays that is ranging from let us say from 10 to the power minus 18 meter to approximately 10 to the power minus 10. And the other kind of ray is x ray that can be characterized by the wavelength this particular 10 to the power minus 12 to 10 to the power let say minus 7. So, this is the range of x rays.

And then this UV light they gets your out 10 to the power minus let us say 8 to 7. So, so this is UV light and visible light is somewhere in the region of 10 to the power minus 6 this is the combination of UV light plus visible in fact. And in nanometer range you can that is described as a of visible light is 400 to 700 nanometer range that is of wavelength of visible light that is of our concern and that is only the portion that is visible to our eyes. So, then you can think of the 10 to the power let say minus 6 to 10 to the power minus 8, this the UV visible light range. And apart from that 10 to the power minus 6 to 19 to the power minus 3 this range is about infrared radiations; and apart from that this infrared there are radar waves or microwaves. So, this particular portion is of microwaves and in long term so let us see up to 1 to 10 to the power 6, those are a five wavelength range these are of radio waves.

So, these are the possible and. In fact, this visible light if you are I am saying which is lying from the 400 nanometer to approximate 400 nanometer, 700 nanometer this range is will be giving you various lights also like violet, blue, green, yellow, orange and red. So, these colors I have also having some wavelength. So, this particular range of wavelength is only visible to our normal eyes. So, these are this is complete electromagnetic spectrum and in which I have tried to represent all possible radiations

that are available, but only that portion of visible light is that we can crack or we can record we can visualize with the help of naked eye.

So, now coming back to our discussion to vision that vision is the one of the most important of the human senses, and the wavelength range is between 400 nanometer to 700 nanometer, and here the human eye is stimulated by light. So, about basic principle is this the light passes through the cornea, which is the eyeball's window and is focused by the lens on to the retina at the back of the eyeball. This retina consists of millions of millions of light receptors. The optic nerve transmits the image focused on the retina to the brain for interpretation. So, this is the theory of basically the fundamental of how eye can as operating within the body. And let us have a figure, so that you could have a better understanding of anatomy of eye.

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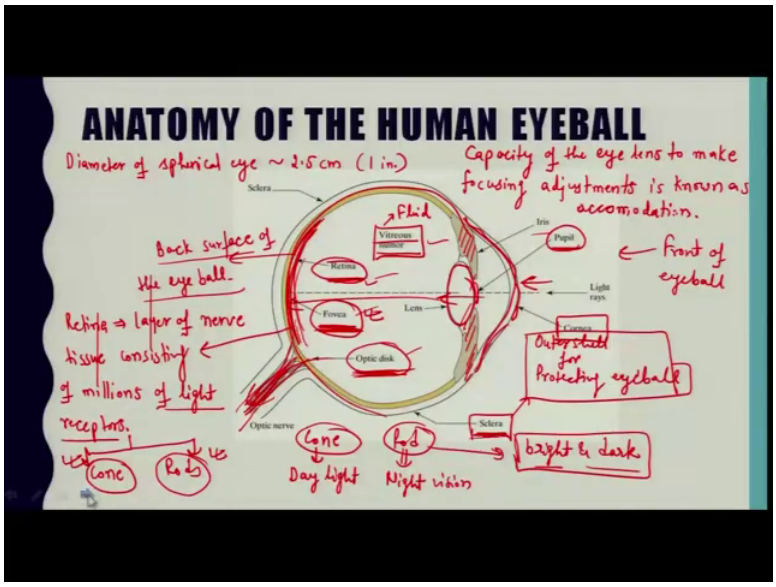

So, this is the anatomy of the human eyeball. So, here we can see from this figure that eye is approximately spherical. Here you can see with the help of this figure and basically this particular spherical diameter will be about diameter of a spherical eye is measured as an approximate 2.5 centimeter that is 1 inch. So, this particular eyeball is protected by a tough outer shell; this particular as you can see this sclera is the outer shell. So, this is the outer shell is known as sclera, so that particular eyeball is protected by this is the protective in fact, this is outer shell for protecting eyeball.

So, now, and it is filled with transparent jelly light fluid that maintains the eyeballs spherical shape. So, this particular vitreous humor is the fluid that is present inside this sclera and which is helping in maintaining the eyeballs a spherical shape. This particular is sclera, this particular is sclera is including modified reason this is the modified region and this is at the front of the eyeball. So, this is the front of eyeball. And here you can see the modified region that particular modified region is known as cornea. This is cornea. So, this particular modified region is known as cornea.

The cornea is a transparent and protective covering, and it is the eyeball window as well. And as well as this particular as you can see from the figure this particular cornea is more curved than the rest of the part of the eyeball. Light rays forming an image enter the eyeball through the cornea. Light passes through the pupil, this is the pupil which is contactable aperture in the iris, the pupil regulates the amount of light passing into the lens, this is the lens, and it dialects in low light and constructs in bright light. Light passes through the lens which adjusts its shape to focus the image on the retina. So, this portion is known as retina and this particular retina is at the back surface of the eyeball.

So, for distance vision the lens becomes flatter to increase its focal length and for close up vision the lens become rounder and thicker to reduce its focal length. So, this particular capacity of lens to make this focusing adjustment is known as accommodation. So, like if you can as write it as a definition that capacity of the eye lens to make focusing adjustment is known as accommodation. Now, after that this retina, we were discussing about this retina which is the back surface of the eyeball is basically the layer of nerve issue which consisting of millions of light receptors. So, this particular retina is the layer of nerve tissue consisting of millions of light receptors.

And these photosensitive cells are of two types basically, these light receptors are photosensitive cells which are of two types we can be categorized as a cone and rods because of their respective shapes under a higher power microscope. So, this light receptors are maybe of the shape of cold or maybe of rod. So, the cones are highly sensitive to bright light and are used for daily light vision like sunlight etcetera, but the roads are sensitive in low levels of illumination and are used for night vision. So, this particular cone is helpful in daylight and rod is used for night vision, where the low level of illumination is there. Now, the combination of rod and cone photoreceptors are used

for lightly well between bright and dark. So, if the combination of this cone and rod photoreceptors are used for leveling the light, which is in between bright and dark.

So, now coming back to the eyeball anatomy, retina has two regions. As you can see fovea and second is optic disc. So, this fovea and optic disc so much of the image is focused on this fovea region. So, it is clear from the figure itself although it is bit missing, I have written a lot of things in this, but it is obvious it can be easily seen that a retina is consisting of two region fovea and optic disc. So, much of the image is focused on the on this fovea region of the retina; and fovea has a high concentration of course, and is therefore, the region of greatest visual sharpness under good lighting conditions. So, by comparison the density of rods is low in fovea region, but much higher around the 20 degrees away from the fovea, so that is why human can see a given object in a night time better when the look slightly away from the location of the object. So, this causes the image of the object to project onto the rod receptors which are more sensitive under low lighting conditions.

Second is optic disc it is the region of the retina where the optic nerve is located these are the optic nerves. So, this optic nerves transmit the image focused on the retina to visual centers of the brain for further interpretation. So, optic does itself is absent of photoreceptors and is therefore, a blind spot on the retina. So, in this way the retina gives then for is connected to the optic nerve and this optic nerves transmit the whole image to the brain for further interpretation. So, now this is about the whole anatomy of the human eyeball, I hope the things have been clarified the various parts existing within the human eyeball. So, in a brief the pupil the iris, vitreous, humor, retina, fovea, optic disc, cornea, sclera, so these are all the basic components of human eyeball.

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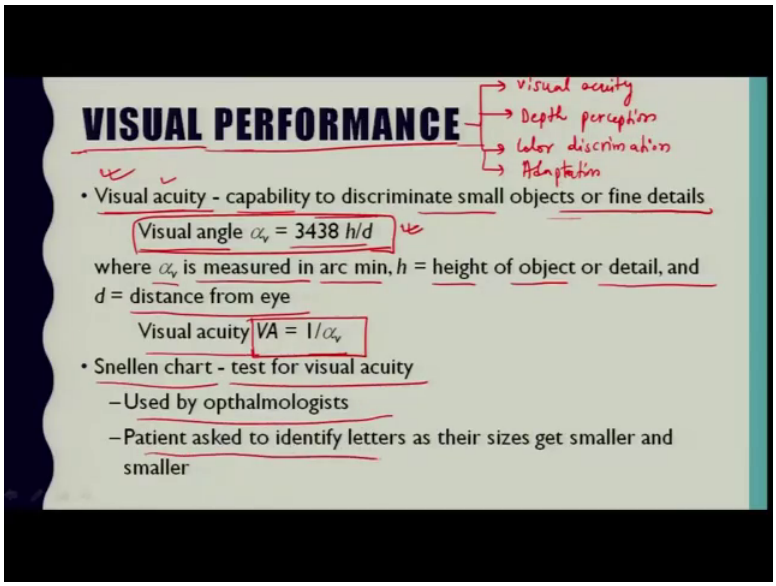

So, now we need to understand about the visual performance. There are basically several measures of human visual performance that we have to mention in our discussion of this understanding of eye. So, this performance measures affect and individual capacity effectively in many situations, so whether it be a job or in a daily life activities. So, we need to understand about the basic aspects of visual activities as well as visual performance and what are the possible remedies through which you can enhance your visual performance. So, because these performance measures affect and individual capacity to function efficiently.

So, we here in this particular article we are going to understand about the visual acuity, depth perception, because the visual performance is based on the how much conveniently you are visualizing any object which is placed in front of your eyes, so that is visual acuity. And depth perception you need to understand some sort of color discrimination we will slightly discuss these aspects and adaptation. So, here first we need to understand this visual acuity. What is that, it is the capability to discriminate is small objects or find details. So, it depends mainly on the accommodation of eyes. So, the common measure of this visual acuities minimum separable acuity which refers to the smallest feature that eye can detect. So, this is usually defined in terms of this visual angle which is subtended at the eye by the smallest distinguishable detail.

So, there is a figure in the next slide that I am going to show you through which it will be clear that how we can develop this particular formula that alpha v is equal to 3438 into h by d. So, first of all you need to take care of this formula. So, in that alpha v equals to 3438 h upon d. Where alpha v is the measured angle in arc minute, h is the height of the object or detail, and d is the distance from the eye. And we calculate visual acuity, which is the capability to discriminate a small objects, so that is the ratio of reciprocal of the visual angle. So, with the help of 1 upon alpha v, we can calculate the visual acuity. And there are other things also which we used to test for visual acuity that is a Snellen chart which is used by ophthalmologist. And the patient asked to identify letters as their sizes get smaller and smaller. So, we will discuss these things.

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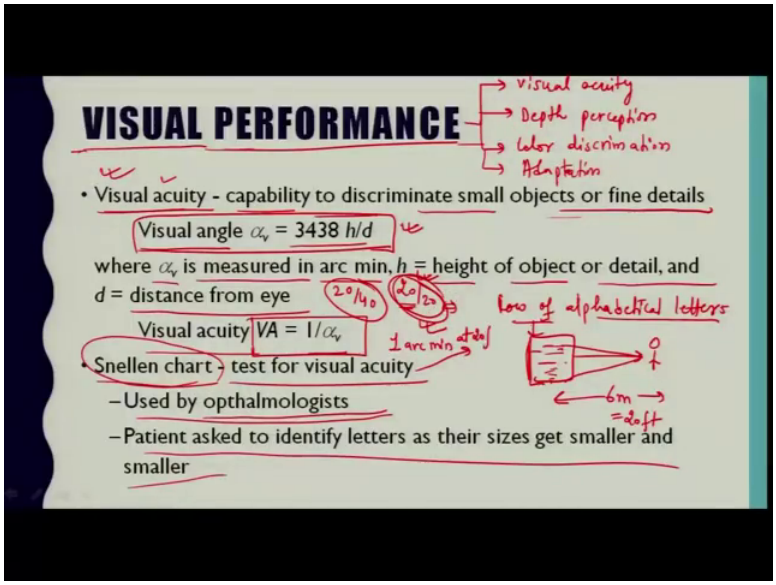

So, now we need to understand that this is the eye and this is the object. So, the height of the object is h and the total angle that a particular eye is making to this object is alpha v and the distance from the eye to the object is small d. So, generally alpha v is expressed in radius of arc. So, this is usually converted into arc minutes. So, here some of the techniques that we use here in order to estimate this visual angle is like this is usually converted into arc minute. So, 1 arc minute equals to 1 by 60 degree. So, from this particular figure, we can take as alpha v is equal to 60 into 360 upon 2 pi into h by d, this is 3438 h by d. So, here alpha v is measured in which is visual angle basically measured in arc minute, and h is the height of the object which can be expressed in centimeter or inch, and d is the distance from the eye that may be in inches or so.

So, in this way this has been defined and you can easily evaluate this particular value from where it has come, so that I have explained here that from this particular conversion of units we have gone to this value. So, in this way this visual angle has been calculated and visual acuity is defined as is the reciprocal of visual angle and that is expressed in the arc minute. So, in equation form, you can take it as a VA. So, for a person with normal visual acuity like if VA equals to 1.0, it means 1, which means that the person can see an object with substance and angle this is the condition for normal vision.

So, it means that alpha v equals to 1 arc minute. If an individual can only (Refer Time: 39:50) a feature that substance and visual angle of 2 arc minute, so it means its visual acuity will be 0.5 which is less than the normal. So, values greater than 1 mean better than normal visual acuity; if VA is greater than 1, it will be indicating that the vision is better than normal visual acuity. And there are various standard methods to test the eyes in that common method used by ophthalmologists is to test eyes with the help of a Snellen chart.

So, this Snellen chart is basically consisting of rows of alphabetical orders as it is been tested. So, rows of alphabetical orders in fact alphabetical letters sorry against a bright white background located at a certain distance away from the patient and the usual distance is 6 meter. So, there is a one particular chart which contains a row of alphabetical letters and the person is used to sit at somewhat 6 meter of distance away from the chart, and the patient is asked to identify the letters as their sizes become increasingly small, and accordingly as the subtended angle made by them also become smaller. So, the row of letters on which the patient biggest too miss read the letters is used as a measure of acuity.

So, this particular is Snellen acuity is expressed as a ratio so like if for example, if it is 20 by 40, so it has some meaning, if it is 20 by 20, it has some meaning. So, this particular 20 by 20, if it is coming, so it means that it indicate the normal vision which corresponds to the visual angle of 1 arc minute at 20 feet. And basically this particular 6 meter is the 20 feet that is why it is 20 is arising here. And it means that basically this 20 feet that normal vision is this 20 by 20 which corresponds to have visual angle of 1 arc minute at 20 feet and visual acuity value of 1. And individual with 20 by 40 vision has below normal vision and can just read letters at 20 feet that a person with normal vision can read at 40 feet.

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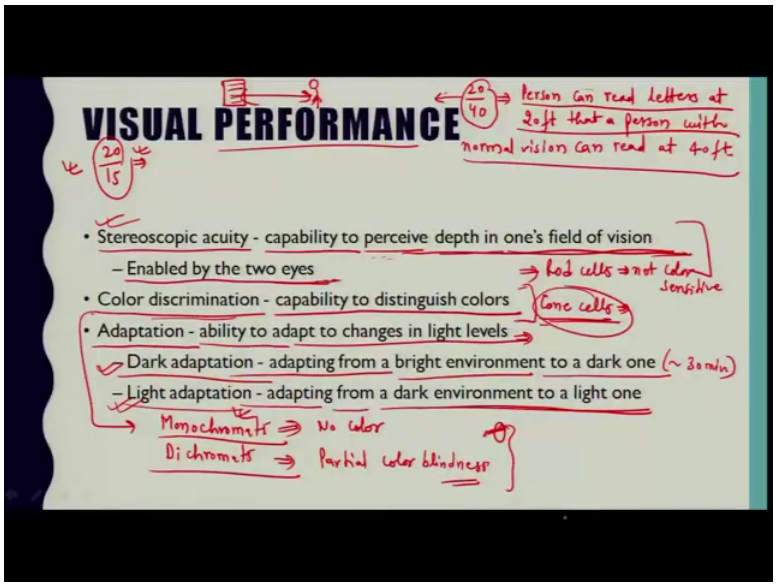

So, we can also understand the meaning of that particular thing that what do you mean by 20 by 20, and 20 by 40. So, 20 by 20 thing is clear with the normal vision. By if it is coming as a 20 by 40 it means that a person can read letters at 20 feet that a person with normal vision can read at 40 feet. So, now, things are clear that how do we calculate this particular vision performance, so that a Snellen chart is put at some sort of 20 feet to the person whose eyes are to be tested. And then it has been asked to read a letters which are written in the Snellen chart and then this particular ratio is decided and accordingly his vision is decided. So, in the similar way if like 20 by 15 is coming, so it is better than the normal vision. It means that an individual can read letters at 20 feet than a normal person can read at 15 feet. So, the same thing happened here which I have returned as a sentence. So, the same kind of principal lies here for the 20 by 15 as an explanation.

So, now, another thing that we need to understand about the other visual performance parameters, so depth perception is a form of visual acuity which is called as a stereoscopic acuity. So, it is defined as the capability to perceive depth in one's field of vision and it is enabled by the two eyes. So, this is may possible by the fact that person sees an object with two eyes that are separated by few inches, so that is each eye sees a slightly different view of object. The brain integrates and interprets the two images to estimate the approximate distance of the object related to its surrounding in the view field.

The image projected on the two retinas differ the most for objects that are close and the images are virtually the same for objects at great with distances. So, thus estimating the distance of near object is much more accurate than for far away objects. So, the ability to perceive depth in one's field of vision is especially important in task like driving a truck or operating a crane or firing artillery shells at a distance and any position and so on and so forth. So, this is a current of stereoscopic acuity.

And the next is colored discrimination. So, the person is having difficulty in discriminating those colors. So, this is the capability to distinguish colors and it is enabled by the course in the retina which are nothing but the photoreceptor cells that are obviously sensitive towards light. So, rod type sense are not color sensitive as we have discussed in the previous slide that there are two types of photoreceptor cells first is rod and second is cone. So, those rod cells are not colored sensitive. So, those in fact we can write it as here that rod cells are not color sensitive and that is why people cannot distinguish color at very low illumination level.

And cone receptors basically are of three types, differentiated by the presence of one of the three type of color discrimination, certain cones are sensitive to red colors, others to green and remaining once to blue. So, the red object would stimulate, the red receptors and but not the blue and green receptors; colors other than red blue and green would stimulate come combination of so the greens would stimulate combination of receptors in relative strength, so that combined sensation could be interpreted by the brain to identify the color. So, those are the things that we need to understand regarding these color discrimination. And in good lighting a person with normal color vision can discriminate among hundreds of different colors, but there are still other defects also which we treat as a defects those are monochromats, dichromats.

So, what are those about like the instances of complete color blindness like colorblindness if means the people who can only see the various shades of grey, but not colors. So, no color is identifying is monochromats. Dichromats are those within condition where the partial color blindness is there, in fact they are sensitive to only two colors the condition is dichromatism. So, in everyday living this color discrimination is very important and in many work activities this particular color discrimination is required. So, color perception adds to the pleasure of visualizing the nature, and there are various colors around us. If you are not able to judge particular color in its own a

nescient form, so it is very difficult to visualize the nature as well as to perform any task in any job or in any day-to-day activities.

Suppose, what are the common conditions where you can face difficulties like a when you are driving a car and the signal is there. So, you will not be able to recognize which kind of signal is coming red, green or yellow, so in that in that way you are driving will not be perfect and the chances of accident may happen. So, in this way this ergonomic conditions are not going to be fulfilled if you are facing the defect of color discrimination. So, in that way the inability to correctly interpret the color in any case for example, in the traffic light, so that may give you some troublesome situations.

Another thing is in vision terms adaptation. So, adaptation is the ability to adopt to changes in light levels. So, basically there are two situations here first is dark adaptation, second is light adaptation. So, in that dark adaptation, it means that adopting from a brightly illuminated environment to a dark environment; and light adaptation is adopting from a dark environment to a light one. So, this light adaptation occurs relatively quickly with complete adaptation in about 1 minute and dark adaptation takes much longer about 30 minutes and involves a change over from the use of cones to rods followed by gradual adjustment in the rods to maximize their sensitivities to low illumination levels. So, that was all about our eyes fundamentals and its functioning.

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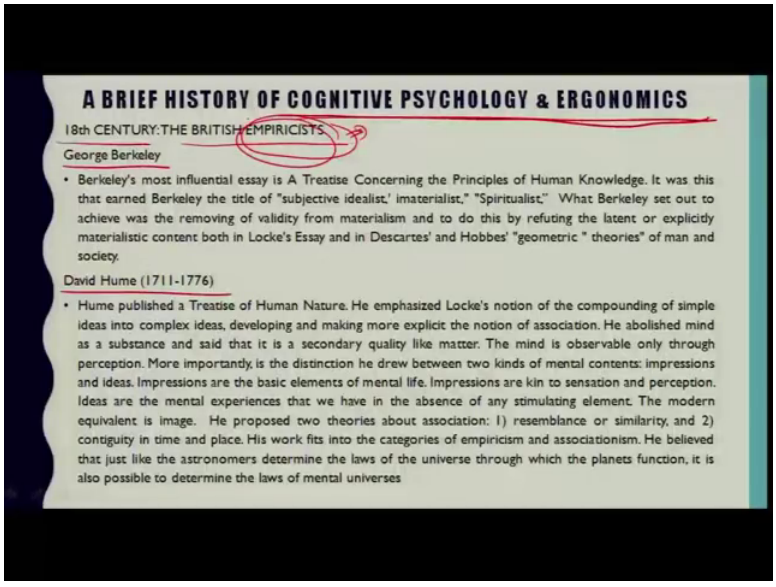

So, I am going to close this lecture, but before that let us have recall of the history that has been given by various researches and that is attribute to recall those findings of various scientist researchers that has given us a platform to initiate the thinking especially related to ergonomics. So, that ergonomics the basic components of ergonomics is the physical cognitive occupational and human central design. So, in that cognitive psychology is also playing a very important role.

So, in 18 century the British empiricists at this particular empiricists means that empiricists is a person who supports the theory that all kind of knowledge is based on the experience and that experience is derived from the senses. So, that human senses are vision, touch, hearing, smell and taste. So, based on those senses and its related observation those experiences are made, and this empiricists believe that that the theory behind that particular the statement that all knowledge is only based on the that we have achieved from the obtained from the human senses.

So, George Berkeley in 18th century the Berkeley's most influential essay is A Treatise Concerning the Principles of Human Knowledge. It was this that earned Berkeley the title of subjective idealist, imaterialist, spiritualist. What Berkeley set out to achieve was the removing of validity from materialism and to do this by refuting the latent and explicitly materialistic content both in Locke's essay and in Descartes and Hobbes geometric theories of man and society.

So, in the David Hume in 1711 and 1776his tenure was this. So, Hume what is the contribution of Hume he published a treatise of human nature. He emphasized Locke's notion of the compounding of simple ideas into complex ideas, developing and making more explicit the notion of association. He abolished to mind as a substance and said that it is a secondary quality like matter. The mind is observable only through perception. We will this particular word perception in the later slides. So, more importantly is the distinction he drew between two kinds of mental contents impression and ideas. Impressions are the basic elements of mental life, impressions are kin to sensation and perception. Ideas are the mental experiences that we have in the absence of any stimulating element. The modern equivalent is image.

He proposed two theories about association resemblance or similarity second is contiguity in time and place. His work fits into the category of empiricism and

associationism. He believed that just like the astronomers determine the laws of the universe through which the planets function, it is also possible to determine laws of mental universe. So, it is a theory that has been given in the 17th century.

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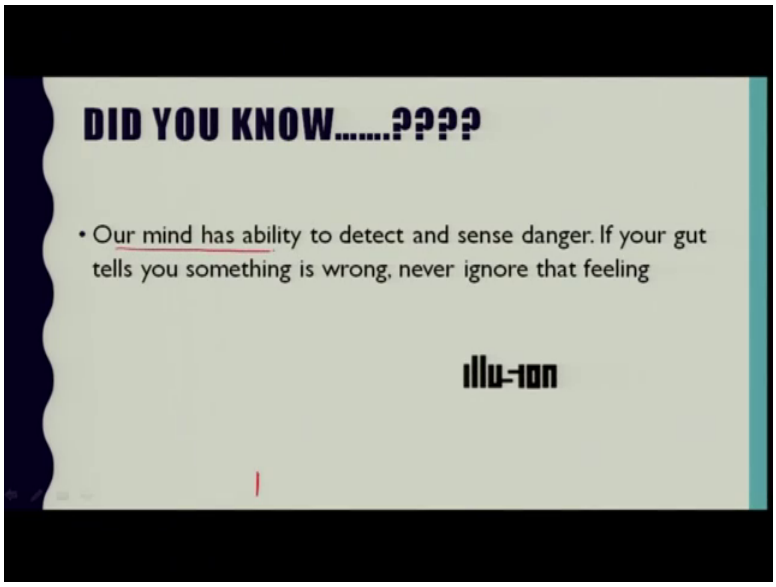

And as for the fact that did you know that our mind has ability to detect and sense danger. If your gut tells you something is wrong, never ignore that feeling.

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And gravity for this lecture you can see this cartoon which is taken from the Google. So, here is my proposal for making our department more productive. The proposal contains

my best cognitive distortions. So, with this I would like to close this lecture, and I hope you have gone through various aspect that we have discussed in this lecture so far.

Thank you.