Applied Ergonomics
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Lecture – 25

Welcome to this lecture. This lecture is based on our understanding for physical work environment, in which we will be covering the climate of work place, in that we will discuss about heat stress and cold stress.

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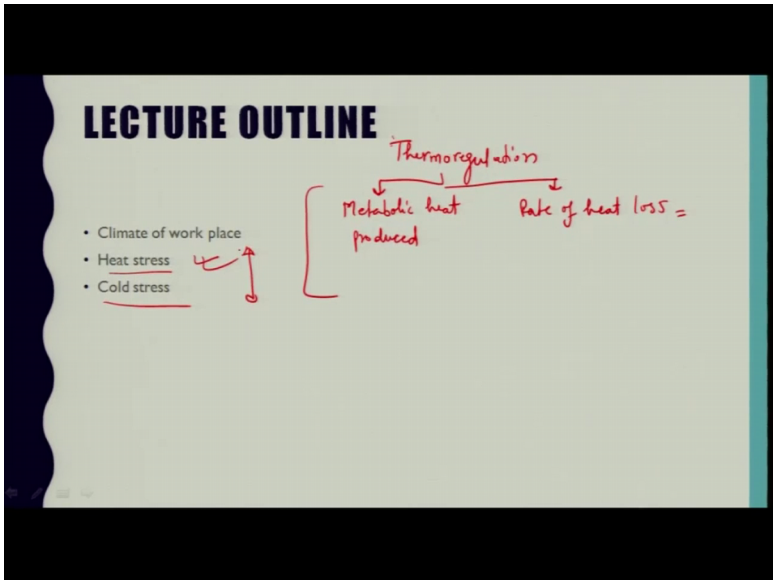

So, human have a remarkably well adopted ability to tolerate heat, compared with other prime climates. So, this applies equally to Eskimos as to tropically rain forest dwellers despite small differences. So, this is, because human are hear less, and have a large proportion of a high capacity, a sweat gland known as Akron glands on their bodies.

So, this particular, whatever be the environment, whether it is very hot or it is very cold. So, that thermoregulation is achieved by human body itself. So, that and itself achieved, by balancing the two main factors, which determine body temperature. So, first factor is, and in fact, that we have a studied in a physical ergonomics part. So, just to recall that part that thermoregulation can be achieved by balancing two main factors, which

determine the body temperature. So, it is maintained by metabolic heat produced and rate of heat loss.

So, this thermoregulatory goal, is to maintain the body temperature to about 36 to 37 degrees Celsius, and the cold temperature over 39.5 degree Celsius are disabling, and over 42 degree Celsius. They are usually fatal. So, in that case, further the drop in core temperature are extremely dangerous, and the temperature as low as 25 degrees Celsius inside the human body is fatal. So, in this case, we need to understand about the climatic conditions, in which we are working, and how much temperature in access or in reduced to a particular environment is containing. So, in that context, we will start first with climate of work place.

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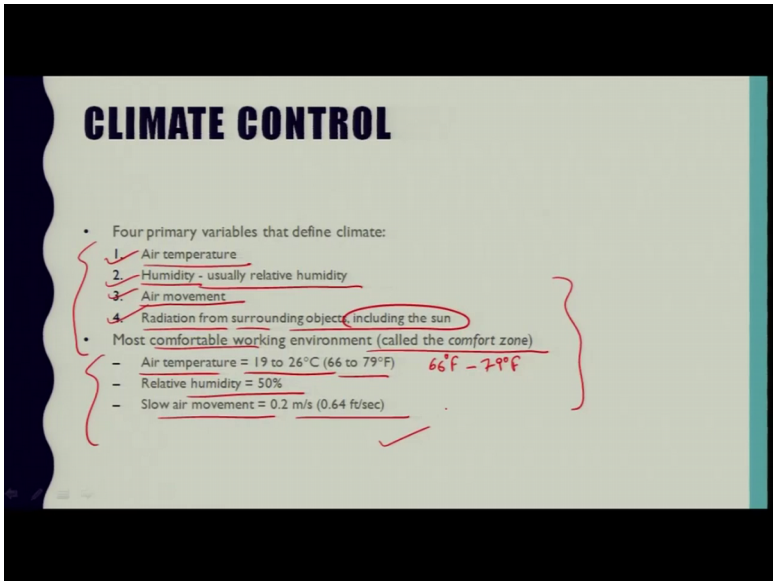

So, the climate in the work environment is very important factor in determining the physical comfort of worker in any organization, and their comfort effects job satisfaction and performance also. Although, the word climate usually refers to the outside weather condition, but here our goal is to make system appropriate towards workers that are working in that particular organization. So, here the word climate will be encountered in the workplace environment, whether it is a indoor or outdoor.

Basically, here we have, I have taken these four lists of variables; that is defining climate. So, they are four primary variables that define climate. So, first is air temperature, second is a humidity; usually taken as relative humidity air movement, and radiations

from surrounding objects including the sun. So, the most comfortable working environment which is sometimes called as comfort zone, seems to be in the temperature range between 90 degree Celsius to 26 degree Celsius in Fahrenheit, this is 66 degree Fahrenheit to 79 degree Fahrenheit, and at a relative humidity of 50 percent, and slow air movement of about 0.2 meter per second; that is 0.64 feet per second, if you convert from meter to feet.

So, here this four primary variable strongly affect, not only the comfort level of workers, but also their physical well being. So, the later, we will discuss about the heat. In fact, we have discussed about the heat balance and thermoregulation in physical ergonomic part, and the mechanism, which is there inside the body to control that particular temperature, and in order to avoid some fatal effects.

So, sometimes this fatal consequences that occur when body temperature deviates from a, from it is normal temperature. So, the normal value of the temperature at which human feels comfortable is 37 degree Celsius, which is, which should be maintain inside, not outside. So, in this particular topic, we will be discussing about the interventions that can be introduced to protect the workers from environmental conditions that might cause body temperatures to rise above or fall below normal. So, in that case, two things used to come; first is heat stress and second is cold stress. So, one by one we will take this topic, these topics and try to develop our understanding relevant to it. So, first we take this heat stress.

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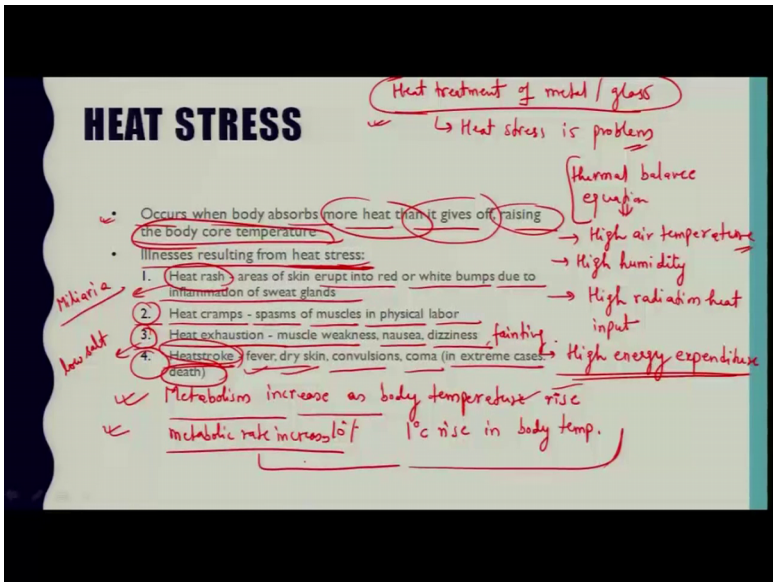

So, the hot working environment occurs naturally in many manual jobs if you take any manufacturing industry let us say in foundry. So, where metal casting occurs and in another case when if you say like in a power plant in any power plant you can say let us say thermal power plant where the boiler plays very important role. So, is in the boiler operation where steam and power generation takes place where the environment is.

Sufficiently hot another example we can take as an basic metal industries where this raw metal used to be a processed. So, in that also, while whether it be iron or steel making or aluminum production, and majorly the industries manufacturing industries, where hot working of metal takes place, or that hot working of metal operation is used to conduct. So, these kind of environment in which heat treatment of various materials, like metal glasses take place.

So, these are the examples that are most common job in which the ambient is more than the required, and more than the comfortability of a person goes. So, in that case, the heat is stress arises and it is a very much serious problem which human being faces, while working in those industries . So, now, as far as definition of this heat stress is concerned, heat stress occurs when the body absorbs more heat, then it gets of raising the body core temperature. So, here the heat stress occurs, when the body takes in, and or produces more heat than it gives off.

Thus, raising the body, the core body temperature according to the, like the thermal balance equation we have learnt in one physical ergonomic topic. So, in that there are several portion of component, which as a whole makes the thermal regulation equation. So, here so that particular thermal balance equation indicates that the body temperature can increase due to various combination of high air temperature, and which this high air temperature which reduces the conduction heat loss high humidity which reduces evaporation from sweating high radiation, high radiation heat input, high energy expenditure; that is just, because of, if a person is performing excessive physical work.

So, due to physical, due to high physical work load, this high energy expenditure are takes place, and so in fact, the metabolism increases as body temperature increases, because when the rise in temperature of the body take place. So, the function inside the body also takes place. So, biochemical reactions occur in a very faster way inside the body, in order to control the bodies temperature as well. So, the metabolic rate increases about 10 percent for every 1 degree Celsius rise in the body temperature.

. So, the increase in metabolic rate generates additional body heat, further raising the body temperature. So, the potential result is an out of control cycle that feeds on itself and can be certain. So, now, depending on this c b r t, this heat stress can result in the form of several illness. So, that illness is listed down here, the first kind of illness is heat rash. So, that heat rash which is also known as miliaria m I l I a r I a, in which areas of skin erupt into red or white bumps due to inflammation of sweat glands, the two second illness is heat cramps, which are spasm of muscles used in physical labor or in any manual activity.

The third illness may arise is heat exhaustion, which is also associated with the low salt, and whose symptoms include the muscle weakness, nausea, dizziness, fainting etcetera. The fourth kind of illness is, heat stroke, this particular heat stroke is a very serious failure of the bodies thermo regulation system, in which in extreme cases the death maker. So, heatstroke will be favored by fever dry skin conversions coma. So, there are various approaches, that can be used to reduce the incidence of heat stress in the work environment, it should, first we mentioned that the body is cardiovascular system, and sweat, this sweat glands operate to relieve heat stress.

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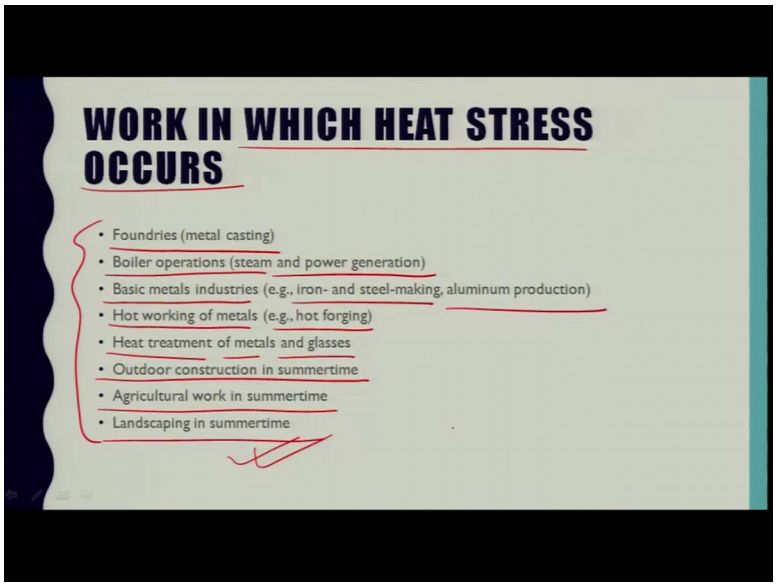

So, now the work in which heat stress occurs, there as an example I have listed in the previous slide, and here there is recall of that point, that the heat stress may occur in foundries, where metal casting work is performed, boiler operations, very steam and power generation is performed.

basic metals industries; like iron and steel making, aluminum production, hot working of metals; example hot forging heat treatment of metals and glasses, outdoor construction in summertime agriculture work in summer time, or landscaping in summer time. So, these are the part lively work in which heat stress surely occurs.

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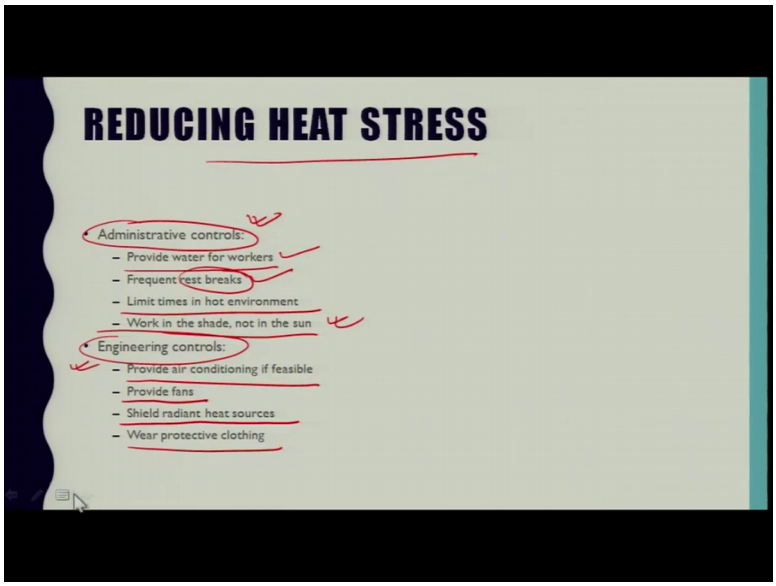

So, that was the point, where how to reduce this heat stress. So, there are basically administrative controls are there, and engineering controls are there. So, what does this administrator, administrative controlled. Now they provides water for workers, provides frequently rest breaks, the calculation of rest breaks we also learned in physical ergonomic part, limit times in hot environment and work in the shades, not in the sun.

So, these are the possible measures that can, and administration of organization can do, and here what could be the possible engineering controls. So, provide air conditions, if feasible in terms of cost and the workspace feasibility, it can provide fans for the workers, the shield radiant heat sources, and it also suggestible that worker should wear protective clothing.

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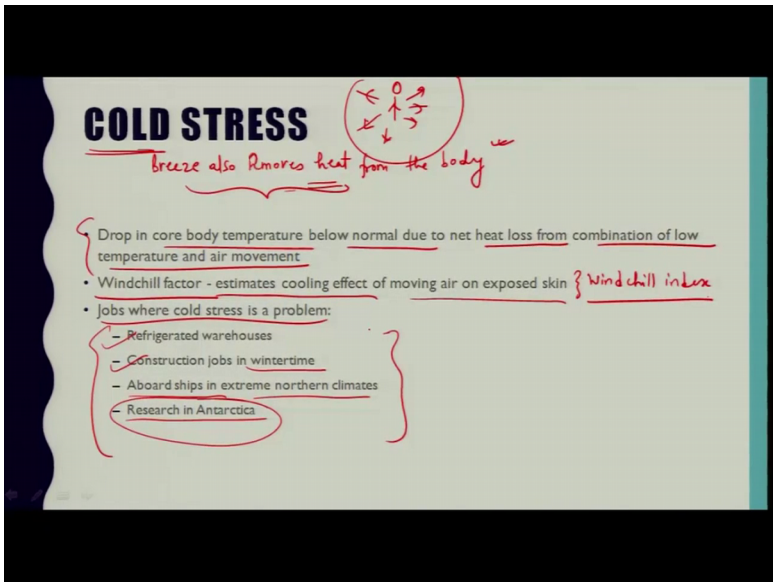

Now, we come to the next topic; that is cold stress. So, in a hot environment a breeze is blessing, because it removes heat from the body by evaporation of sweat, and possibly conduction. If the air temperature is cooler than a skin temperature, but in cold environment, breeze also removes heat from the body and that heat removal takes place mostly by convection and radiation. So, this particular heat removal well, because in a drop in body temperature to leave us that our physiologically harmful the combination air temperature, and air movement is captured in windchill factor; that is also called windchill index.

Basically, a drop in the core body temperature below normal due to net heat loss from combination of low temperature, and air movement windchill factor, which provides an estimate of cooling effect of moving air on exposed skin; say job where possibility of cold stress are refrigerated, warehouses, construction jobs in winter time, aboard ships in extreme northern climates, and research in Antarctica. So, these are the possible examples, where this cold stress arises, and because of which workers or the possible human being, where those are performing some sort of work are going to adversity effect with that, and possibly we facing some of the disorders or diseases.

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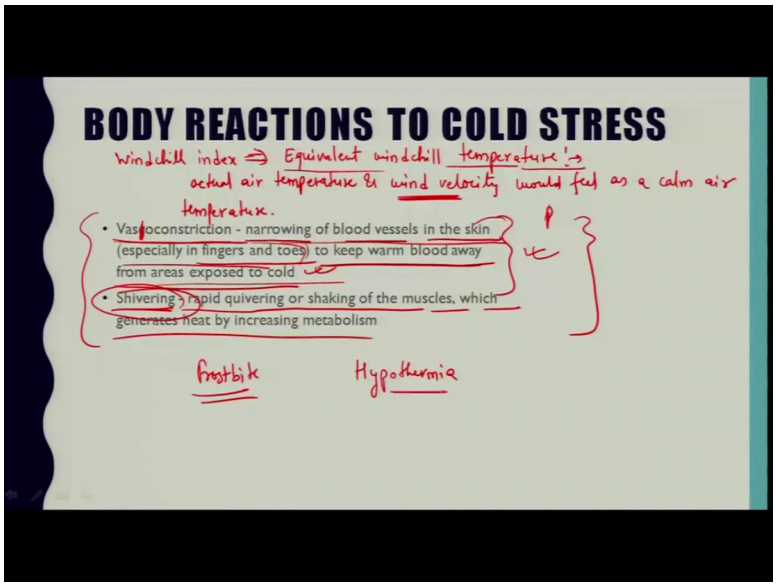

So, that particular windchill index is most commonly expressed as equivalent windchill temperature. So in fact, we can write here also that windchill index is mostly, most commonly expressed as equivalent windchill temperature, which basically indicates how given combination of actual air temperature and wind velocity. Wind velocity would feel has come here temperature, since as wind velocity increases at a given actual air temperature, the effect is that the equivalent windchill temperature gets colder and colder.

. So, in that condition the code work environment can be found out in poorly heated buildings, in a refrigerated warehouses, in like in cold storages and construction and other type of outdoor work in the winter time, where the commonly the job, in which the cold stress is a problem. So, here as far as body reaction to cold stress is concerned, the physiological responses to a reduced body temperature are basically vasco constrictions, and shivering. This is basically not vasco, this is Vaso, vaso constriction and shivering. So, this vaso constriction is the narrowing of blood vessels in the skin, especially in the fingers and toes, to keep warm blood away from areas exposed to cold.

So, this particular vaso constriction is the narrowing of blood vessels in the skin especially in fingers and toes to keep warm blood away from areas that are exposed to cold and the reduced blood flow increases the insulating capacity of the skin. So, the

extremities quickly loss heat to the surrounding air and becomes significantly colder than the core body temperature.

There is another kind of this response physiological response is the shivering. So, in that case, it basically consists of rapid quivering or shaking of the muscles, which generates heat by increasing metabolism, and in this way these physical responses are of limited values in extremely code environments, and the two conditions associated with several cold stresses are frostbite and hypothermia.

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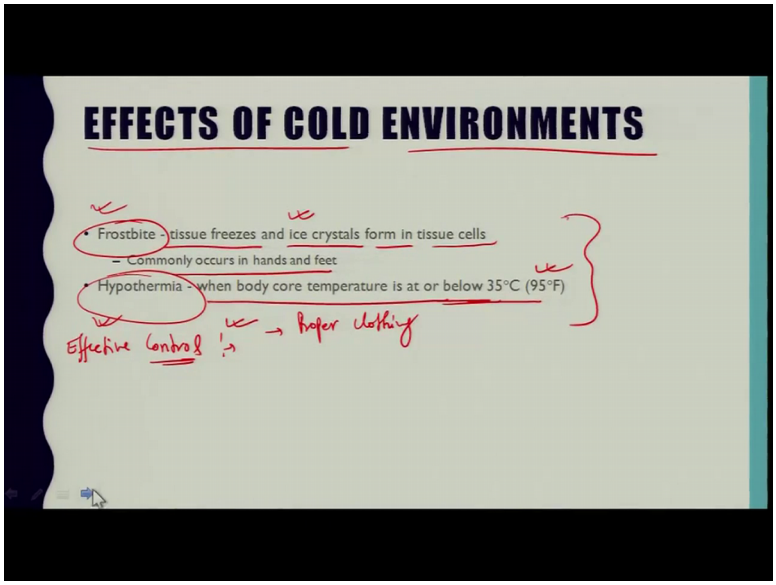

So, these particular conditions associated with severe cold stress. So, the effect of code environment as in the form of forced by term hypothermia. So, what those words are, what these words are. So, first bite occurs, when tissue freezes and ice crystals form in tissue cells. So, in most commonly, at most commonly occurs in hands and feet in the extreme frostbite, can lead to gangrene. In the affected extremities this particular hypothermia occurs, when the body core temperature is at or below 35 degree Celsius; that is 95 degrees Fahrenheit, which results in demonized physical and mental capacity.

So, here the body temperature decreases to about 35 degree Celsius and a combination of measure is available to help the body resist, forced by hypothermia and general physical discomfort, associated with the cold working environment. And one of the most effective control we can take for reducing our relieving this cold stress, is that should have proper clothing.

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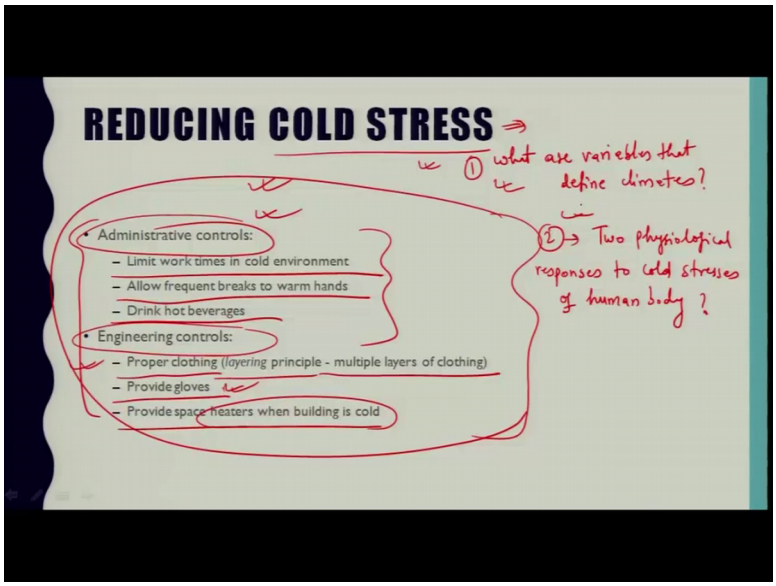

So in fact, we can understand with the help of these sentences written here. So, there can be administrative controls, and that can be engineering controls. So, as far as administration goes, it may limit work times in cold environment, it may allow frequent breaks to warm hands, it may allow to drink hot beverages. So, these are the possible; that means, one administration of any organization can implement in order to relief from cold stress, and as far as engineering control is concerned. So, proper clothing that is layering principal. So, multiple layers of clothing workers may be given glows, or they may wear gloves in order to protect from cold stress, and they provide space heaters when building is code.

So, this was all about relieving mechanism for reducing cold stress. And in order to make a proper ambient fit for work, and that kind of a study is a very important part of ergonomics. So, as far as applies ergonomics is concerned, the ambient should be appropriate, it should not be too high in temperature, and it should not be too low in temperature. So, those things are, those environment are not appropriate for human as well as machine performance, or machine in the sense any systems performance. So, those are the proper administrative and engineering controls. So, there are some questions for you, which you may think of that, that we have covered the questions, that we have covered that, and it all depends on you, how much, how many times do you recall those slides that I have given with this lecture.

So, you have to answer these questions by revising the previous slides that are, what are the variables, that define climate, you will find the answers of these questions in the slides itself. The second question is for you, that name any two physiological responses, two cold is stresses of the human body. So, these two questions you find out a in the previous slide. Try to answer those questions, and with this I am closing this lecture. So, like a question for you, you may think of as a project manager role.

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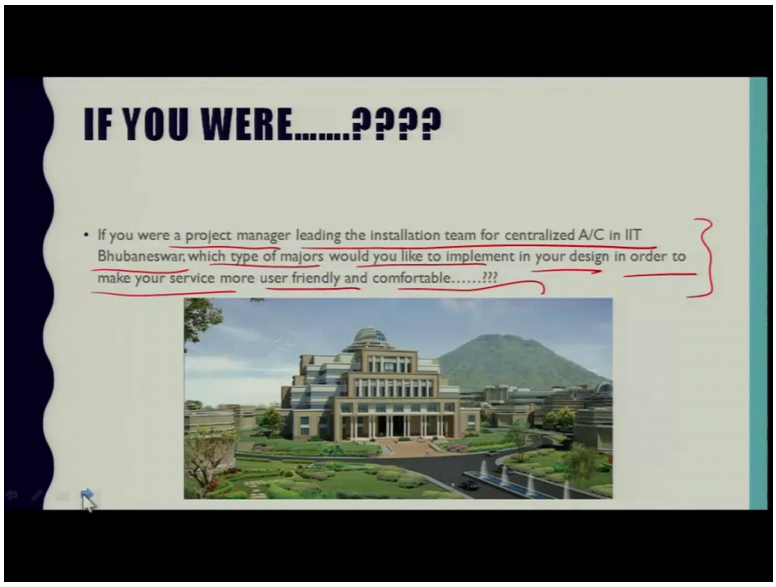

And if you were a project manager leading the installation team for centralized AC in an institute; like IIT Bhubaneswar, which type of measures would you like to implement in your design, in order to make your service more user friendly and comfortable.

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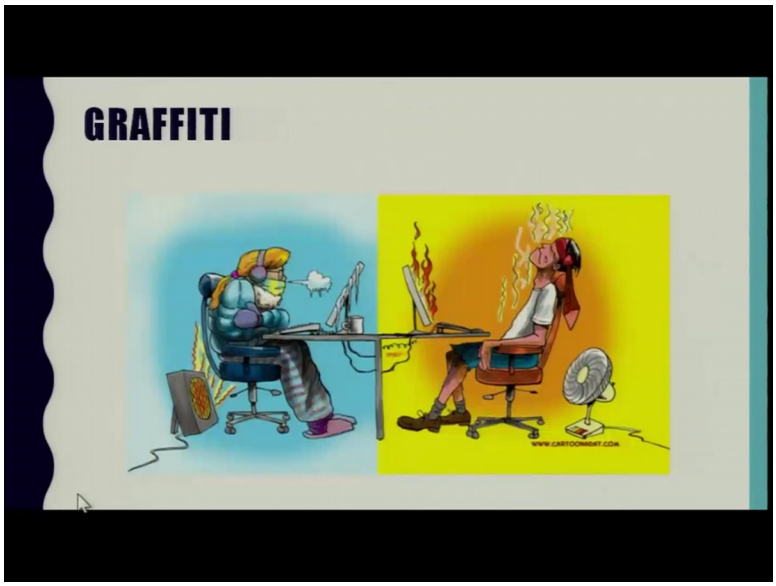

So, think of the situation, and try to provide solutions which could be ergonomically appropriate. So, the graffiti for you, enjoy this graffiti, and that is all for now. In this way, we are completed the theoretical part of the physical work environment.

And that is all for now.

Thank you very much.