Applied Ergonomics

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Lecture – 26

So, good morning and welcome to this lecture, in this lecture what we have, what we are going to cover is that since we have covered sufficient theory of physical and cognitive ergonomics. Now we will try to solve some of the questions related to physical ergonomics today so that the understanding towards the theory and related applications could be well understood.

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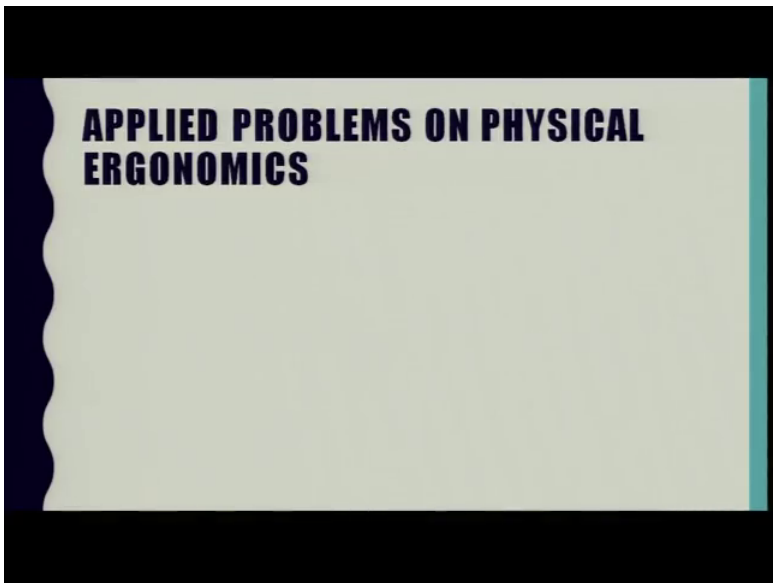

So, in series with that I am going to continue with the, I am going to start with applied problems in fiscal ergonomics.

So, let us have a first question that is in the slide itself and that is based on the calculation of calorie content in the foods.

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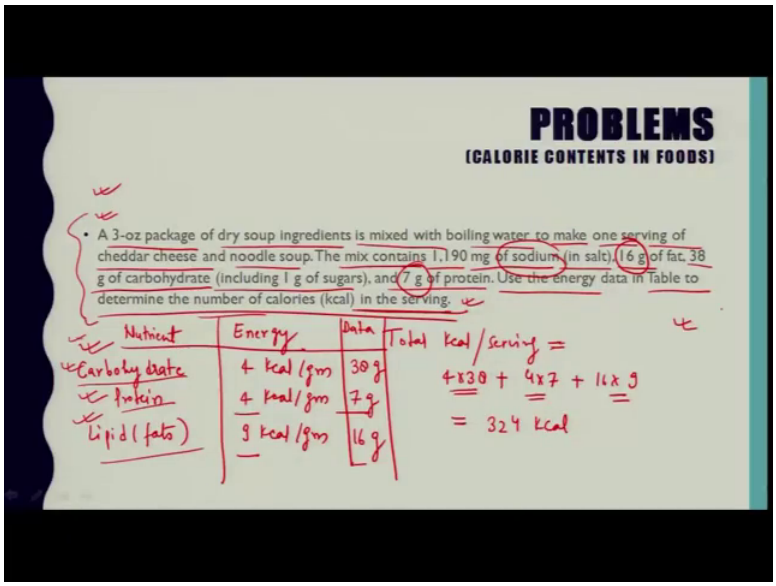

So, this 3 oz package of dry soup ingredients is mixed with boiling water to make one serving of cheddar cheese and noodle soup the mix this particular mixture contains the 1190 milligram of sodium that is in salt and 16 gram of fat and 38 gram of carbohydrate including 1 gram of sugars and 7 gram of protein. So, use the energy data in the table to determine the number of calories in the serving.

So, here how will you calculate the number of calories, since why these things are essential because all of the all kinds of work activities required physical efforts and for doing those physical work we need some energy and energy is only obtained by the food you will take intake. So, if you will be aware of the calorie content in that particular food. So, it will be easy for you to estimate in fact, rough estimation of what you are taking on daily basis and what and how much effort physically you are applying to get your work done. So, this knowledge is essential and in this way you will be a physically fit and that is why the ergonomic purpose will be solved.

So, how will we attempt this question, so since if you recall the past theory that we have understood while tackling this physical ergonomic topic. So, there was basic chart, I am revising the chart also. So, that chart was based on the basic nutrients along with the calorie content in which there are 3 basic nutrients that we described. So, carbohydrates containing 4 kilo calorie per gram and protein is containing 4 kilo calorie per gram as well as this lipid or named as fat it is kilo calorie per gram.

So, now the question becomes simpler and so the total kilocalorie since it has to be calculated per serving. So, total kilo calorie per serving will be calculated as since here the data is giving you so according to the data available in the numerical. So, the carbohydrate that is given as 38 of carbohydrate it means 38 gram of carbohydrate protein is given as 7 gram and this fat is, the value of fat is this particular 16 gram of fat.

So, as a calculation of number of calories these nutrients are only the involving factors in that particular energy calculation. So, only carbohydrates protein and fat will be in consideration and we will not contain, we will not calculate we will not consider this amount of sodium in our calculation. So, the total kilo calorie per serving will be equal to the number of calories provided by carbohydrate plus number of calories provided by protein and number of calories in fat.

So, now total kilo calorie per serving will be as, since if you start with let say this carbohydrate so 4 into 38 plus this times this, so 4 into 7 plus this into this so 16 into 9. So, as a whole if you will you just multiply this factors this 3 factors and make a sum of that. So, you will find out the value as 324 kilo calorie. So, in this way you can calculate the number of calories per serving whether it be a soup or any food.

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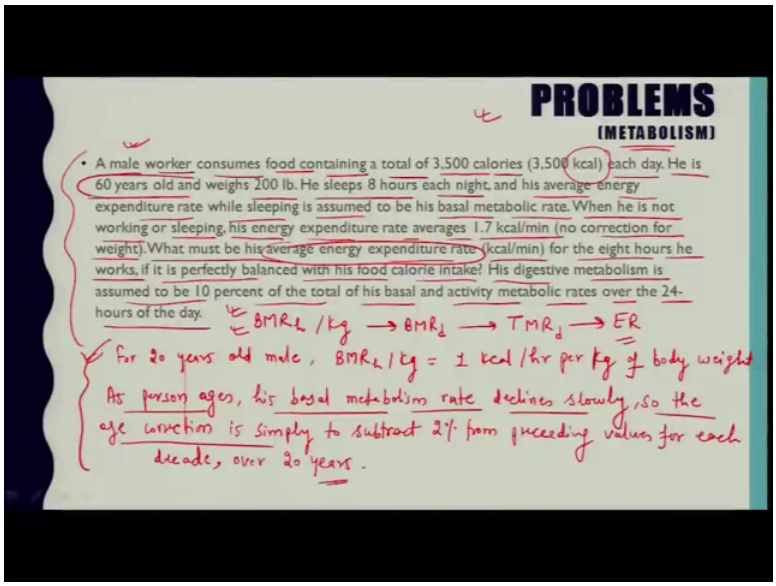

So, here there is an other example which is based on your metabolize. So, the question I have put is saying that a male worker consumes food containing a total of 3500 calories that is expressed in a kilo calorie and each day he is 60 years old and weighs 200 pound,

he is sleeps 8 hours each night and his average energy expenditure rate is while sleeping is assume to be his basal metabolic rate. So, when he is not working or sleeping his energy expenditure is averages 1.7 kilo calorie per minute no correction for weight what must be his average energy expenditure rate that can be expressed in kilo calorie per minute for the 8 hours he works if it is perfectly balance with his food calories intake his digestive metabolism is assumed to be ten percent of the total of his basal and activity metabolic rates over the 20 4 hours of the day.

So, here you have to recall the theory which we studied in metabolism in fact, in physical ergonomics a metabolism and the energy expenditure rate. So, here what you need to calculate you have to calculate the BMR h per kilogram. Firstly, you have to calculate this and then you have to calculate this particular BMR on the daily basis followed by total metabolic rate on the daily basis and then followed by average energy expenditure rate. So, this is the rough steps you have to follow in order to calculate this average energy expenditure rate.

So, now first we need to calculate this basal metabolic rate per hour per kilogram. So, as you may recall that for 20 years old male. So, BMR per kilogram is 1 kilo calorie per hour per kilogram of the body weight and as person ages his basal metabolic rate declines slowly. So, the age correction is simply to subtract. So, basically as person advances in terms of his age his basal metabolism rate declines slowly. So, that so the age correction can be calculated as by subtracting 2 person from preceding values for each decade.

So, in this way and that is each decade after 20 years so as per the rule for calculating this basal metabolic rate. So, as person ages his basal metabolism rate declines slowly. So, the age correction is simply to subtract 2 percent from proceeding values for each decade over 20 years. So, as the age passes you have to accordingly calculate the age correction factor. So, now, how we will we calculate this particular age factor. So, since as per the problem this particular male person is 60 years old. So, since he is 60 year old.

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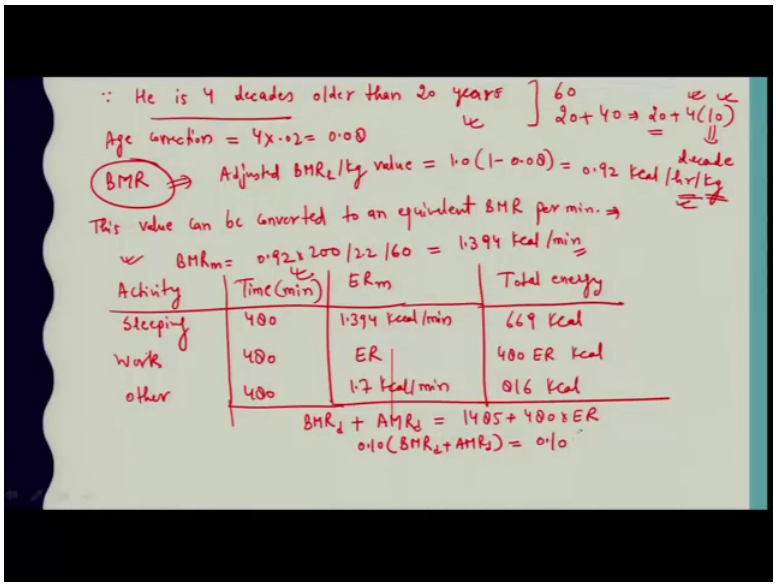

So, we can write it as he is let say 4 decades older than 20 years I hope you have understood this fact, it is like that the 60 will be how much? 20 plus 40 and 1 decade consists of 10 years. So, this can be as 20 plus 4 times 10. So, we can say that this particular person is 4 decade so 10 is a decade. So, 4 decades older than 20 years. So, in this way the age correction will be 4 0.08 that will be equal to 0.08.

So, as you may recall the fact that this, what is metabolism and what is basal metabolic rate. So, in that this particular basal metabolism is what that minimum amount of energy used by the human body when it is in resting when it is at rest condition when there is no as such digestive action is occurring inside the body. So, that particular minimum amount of energy is known as basal metabolism. So, taking care of these fundamentals in mind, so basically the energy used only to sustain the vital circulatory and respiratory functions is measured as a basal metabolism rate.

So, in this way so adjusted BMR per kilogram value will be 1 minus 0.08 that will be equal to 0.92 kilo calorie per hour per kilogram. So, in this way this particular value is calculated and so this particular value can be converted, this value can be converted to an like equivalent BMR value per minute by just dividing the number of minutes in a 24 hours period. So, how we will calculate this as like BMR m equals to 0.92. So, this particular weight is 200 pound. So, here we have to eliminate this per kilogram and per

hour. So, how we will do that? So, into 200 upon 2.2 upon 60, so that will be something like 1.394 kilo calorie per minute.

So, now since this particular BMR value per minute has been calculated. So, now, that all the time is to calculate each energy expenditure rate for all the activities that he is performing. So, what he is performing he is performing sleeping he is doing some work for 8 hours and other work also. So, we can make a table for listing all his activity and time he is devoting to perform a particular activity as well as energy expenditure and lastly the total energy. So, first kind of activity is sleeping so sleeping how much time it is taking. So, he is sleeping for 8 hours.

So, 8 if we calculating in minute. So, 8 into 60 is equal to 480 minutes relate corresponding energy expenditure will be 1.394 kilo calorie per minute and if you talk about the total energy. So, you will have to multiply this. So, some sort of this 669 kilo calorie will come out as per as work is concerned. So, again how much work he is doing he is work doing work for 8 hours. So, again 8 in if you convert it into minute. So, 8 into 60 equals to 480 and this energy expenditure rate will be unknown is unknown and so 480 times ER will be in kilo calorie and as far as other work is concerned. So, it is also he is doing for other work we have to consider as a 480 minute and that is 1 7 1.77 kilo calorie per minute and that if you multiply it will be 1816 kilo calorie.

So, now we need to calculate. So, if you if you could some. So, BMR per day plus this activity daily activity metabolic rate AMR d will be equal to 1485 plus 480 into energy expenditure rate. So, says what the question is saying that his digestive metabolism is assumed to be 10 percent of the total of his basal metabolic rate were the 24 hours of the day. So, we have to calculate this digestive metabolic rate as 0.10 times BMR d plus AMR d that will be equal to 0.10 times 1 4 8 5 plus 480 times er.

So, if you add these 1 and 2. So, you will get as a total metabolic rate which is the sum of the 3 types BMR plus EMR plus this DMR. So, we will sum up as 1.10 times 1 4 8 5 plus 4 8 0 energy expenditure rate. So, this we have added 1 plus 2, 1 plus 2 we have added this is daily total daily metabolic rate which is expressed in kilo calorie per day and this 1.10 times 1485 plus 480 times ER. So, here we can write it as a 1634 plus 528 times ER.

So, now we have as a food calories. So, he consumes food containing total of 3500 calorie, so now, as a total food calories what we have.

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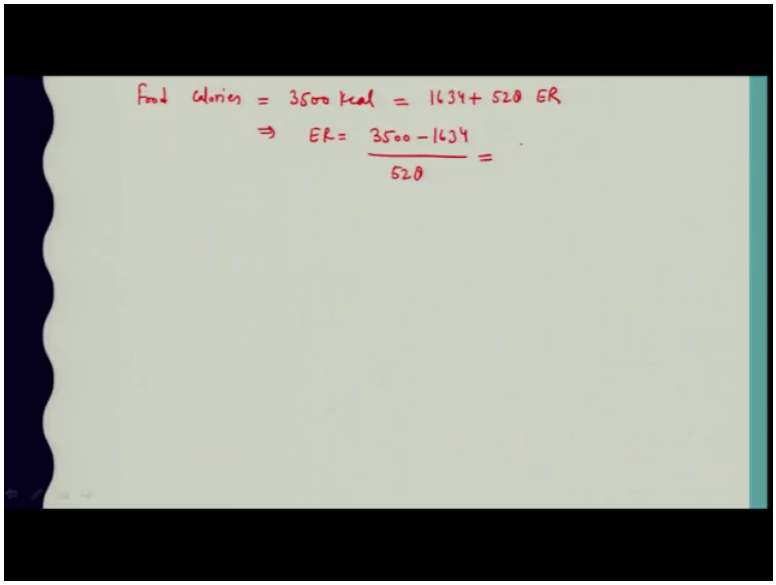

We have 3500 kilo calories. So, answer total metabolic rate on the daily basis we have calculated as 1 6 3 4 plus 528 ER. So, in this way we can calculate as ER equals to 3 5 0 0 minus one 6 3 4 upon 528. So, this will be after evaluation come out as a 3.53 kilo calorie per minute. So, in this way you can calculate this particular energy expenditure rate with the help of the formula that we have learnt in the theory class.

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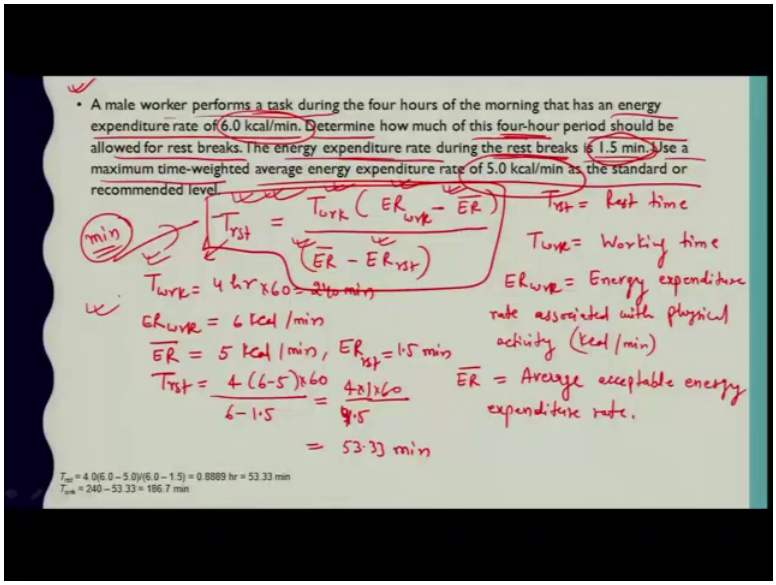

So, another question that is for you to solve and that is a male worker performs a task during the 4 hours of the morning and that has an energy expenditure rate of 6 kilo calorie per minute, determine how much of a this 4 hour period should be allowed for rest breaks and the energy expenditure rate during the rest breaks is 1.5 minute use a maximum time weighted average energy expenditure rate of our of 5 kilo calorie per minute as a standard or recommended level. So, as you may recall we have learned the formula to calculate this rest period.

So, that the formula I am writing here it is nothing, but the total energy conservation concept. So, total time you can write as a basically the rest time you can write as a wrk ER wrk minus energy expenditure. So, this is the energy expenditure rate minus ER rst where this Trst is a rest time. In fact, I am writing here. So, Trst equals to rest time is the working time and ER wrk equals to energy expenditure rate associated with physical activity that is expressed in kilo calorie per minute and this particular ER bar is average acceptable energy expenditure rate.

So, these are the given explanation of the particular terminologies that we have used in the formula and now we have to read the question again and pick up the given things. So, here working time is given as is 4 hour period. So, Twrk is equal to 4 hours, as well as energy expenditure rate is concerned. So, ER work the energy expenditure rate associated with physical activity is energy expenditure rate of 6 kilo calorie per minute. So, this is 6 kilo calorie per minute and as per as average acceptable energy expenditure rate is concerned.

So, it is given as a 5 kilo calorie per minute. So, we will use as ER bar equals to 5 kilo calorie per minute and this particular energy expenditure rate during the rest breaks is 1.5 minute. So, T rest is given as basically before that this particular thing is given as ER rest equals 1.5 minute. So, in this formula if you see this particular wrk is given as a 4 hour ER work is given as 6 calorie per minute and ER bar is 5 kilo calorie per minute this is given and energy expenditure rate associated with rest break is given.

So, now everything is given on the right hand side, now you have to calculate the left hand side that will be Trst equals to 4, 6 minus 5 upon 6 minus 1.5 if you will calculate at 4 into 1 upon 4 point 5 this will be particularly. So, say T work is given in hour so we

have to convert it in minute. So, into 60 we have to do 240 minutes. So, here we need to multiply with 60 into 60. So, something will come out like 53.33 minute.

So, all things you have to convert in 1 unit that is in minute and then you have to apply to this formula and get the result in a positive way. So, this is all about calculate in the rest period and rest period, rest period taking rest is very important when you are performing any work for a longer period of time. So, it is helpful for your all your metabolism and all the organs related to your functioning of human body. So, in order to have proper functioning for longer time you need you require a rest period and that rest period you can calculate with the help of these theories that we covered in the physical ergonomic part.

So, another question that we will solved and that is very much important as far as our body proportion is concerned because your weight should be proportionate towards your height as far as your proper efficiency is concerned. So, we will solve this particular question as well as we will try to understand the theory behind this body mass index, index and how you can roughly estimate whether your body is perfect or not with the help of this body mass index.

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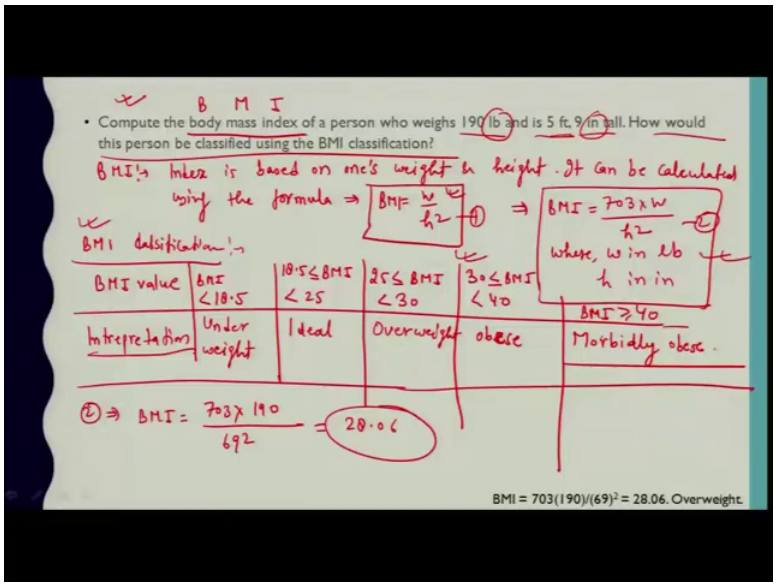

So, body mass index is nothing, but that is expressed in this body mass index. In fact, first we will read this particular question and then we will understand the theory behind that.

So, what we need to calculate is compute the body mass index of a person who weighs 190 pound and is 55 feet 9 inch tall and how would you, how would this person be classified using BMI classification. So, this basically this b for body m for mass and I for index. So, this BMI this particular index is based on ones weight and height and it can be calculated using the formula BMI equals to w upon h square if w is weighting kilogram and h is a height is in meter if you want to convert it into this unit that is pound per inch. So, some additional factor will be coming as BMI equals to 7 0 3 into w upon this h square where w is a body weight in pound and h is the standing height in inch. So, this is a formula you have to keep in mind in order to calculate body mass index.

So, there is a BMI classification and giving here. So, here I am giving you BMI value and its interpretation. So, if BMI is less than 18.5, if 18.5 if BMI is in between 18.5 to 25, if BMI is in between 25 and 30 and if BMI is in is between 30 and 40. So, what could be the interpretation? So, if it is less than 18.5. So, your body will be under weight and if it is in between 18.5 to 25 it is ideal if it is between 25 to 30. So, you will be said as an overweight and if you are in between 30 to 40 you will be having some about obese, obesity you will be having and if it is if BMI is greater than 40. So, you are suffering from morbidly obesity. So, morbidly obese is the extreme condition.

So, now coming back to the, this is obese o b e s e, now coming back to our question that what is being asked that how would you how would this person be classified using BMI classification. So, here is the classification. So, now, using the formula since it is given in pound and inch so you will, we will equation use equation 2. So, in that BMI equals to 7 0 3 into w is 190 upon 690 square. So, there if you calculate this thing you will get 28.06. So, this particular 28.06 now we have to see in which category it is lying in BMI classification.

So, this 20.6 is lying in this category. So, it means that the person is overweight. So, in the similar way you can calculate your own body mass index and this is the classification is given in this table. So, you just calculate and become aware your body mass index whether you are underweight or you are an ideal body or you are overweight or obese or morbidly obese. So, in this way you can calculate your body mass index.

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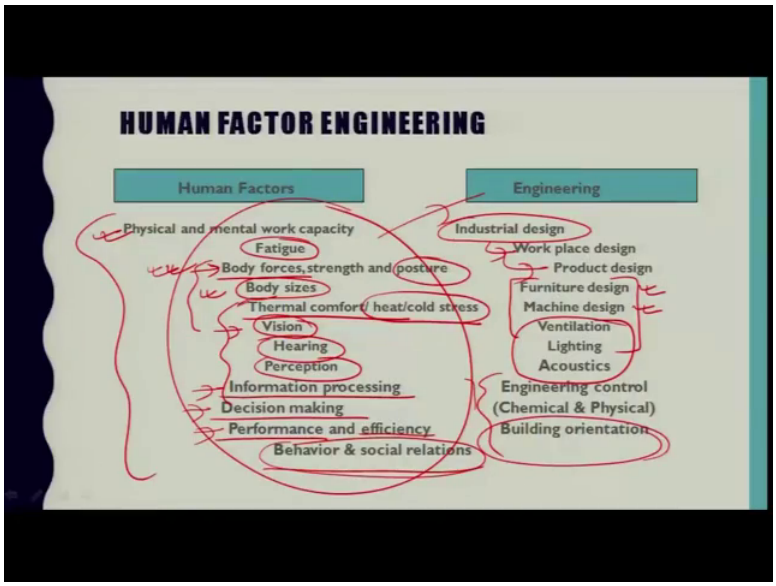

Now, there is the one questions we attempted and we recalled our theory also. So, this particular ergonomics is very much interesting topic in order to because it in order to understand the facts that are responsible for your performance and since it is mostly revolved around the human. So, human study is very much important here because it is the human that does the work. So, various aspects related to human whether it be a physical cognitive or social or psychological. So, all aspects we need to understand for developing and studying towards ergonomic topic. So, ergonomics is also known as human factors engineering. So, we need to understand what are the human factors and what kind of engineering is involved or what kind of discipline is required to do required to study to understand this human factor engineering are called as an ergonomic.

So, in that there are various human factors like physical and mental work capacity human also suffer from fatigue. So, human have strength and he changes posture time to time. So, and if you put some, if you let say if you do some manual task suppose you lift some object so the various joints and body part experience forces. So, the analysis of body forces, body size is also important and this because of this body size variability this ergonomic has become matter of study because a particular design whether it be a work system design or product design is not suitable for all kind of body because of the body size variability which we as a human being have. We also require thermal comfort and we also need to take care of heat and cold stresses we also have vision, hearing we perceive information and we also perform information processing, we also do decision

making, we also take care of the performance and efficiency and we also take care of behavior and social relations.

So, all the, these aspects are the human factors because of which we discretize all this complete syllabus of applied ergonomics in these aspects. So, physical and mental work capacity and fatigue we dealt in this physical ergonomic part, body forces we will be discussing in the biomechanics and as far as thermal comfort and vision, hearing, perception, information processing is concerned we covered this physical work environment part. And cognitive ergonomic part in which we learnt about the human information processing model, in which we discussed in which we covered the functioning of various human senses, sensory organs and its relation to the to our responses deduction and recognition that is in the form of information processing and decision making as well as performance and efficiency and some sort of cognitive psychology part we also dealt in the in the each slide of the very last slide we discussed of the historical part of the cognitive psychology in order to cover what have researchers done in the previous moment of time.

So, these are all the human related factors and which needs engineering analysis. So, if some sort of workspace design or product design is concerned. So, it comes in the industrial design where workplace design and product design comes into picture if as far as body force relaxation and posture comfortability is concerned. So, in that regime we take care of design whether it be furniture design, machine design or as far as thermal comfort concern we take care of ventilation lighting and acoustics and as far as other areas are concern we take care of engineering control whether it be a chemical or physical and building orientations where the building is basically space or a place where all workers used to perform their work. So, suitable ambient need to be produced in order to get the workers comfort ability, so that they could perform exceedingly well in whatever the task they have been assigned for.

So, in this way this human factors engineering is important in each and every aspect we can think of. So, in a nutshell the aim of ergonomic is to ensure that human needs for safe and efficient working met in the design of work system. So, aim of ergonomic is to design appliances technical systems and tasks in such a way so as to improve human safety health and comfort and performance .The ergonomic also improves the efficiency

in purposeful activity, it is helpful in achieving desired result without waste the minimum waste principle is also lying in the ergonomic area of a study.

So, error has to be minimized and we have to take care of the damage to the persons because human life is important and as well as if a sudden disasters or damage happens. So, we directly effects the person's life. So, that is also area of a study in ergonomic we have to develop the working situation in harmony with the activities of the worker.

So, because of dealing all the possible aspects related to human comfortability and human efficiency the benefits of ergonomics are this ergonomist focus to gain productivity, product quality it is responsibility to take care of the safety ensuring health reliability job satisfaction as well as personal development. So, that is solve for now in the next lecture we will do some numerical analysis and as per as, as well as some revision of cognitive ergonomic part till then.

Thank you.