Course on Integrated Waste Management for a Smart City
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Module 1
Lecture No 1
Introduction

Okay so this is a new course now on integrated waste management for a smart city so we have been we are offering this course for the 1st time at NPTEL and as well as I think it will be on (())(0:35) as well. So this is this course is focused on urban issues as you can say the main focus of this course will be on municipal solid waste in the short form we call it as MSW, is the waste that I and you produce in an urban environment. It is also it is a municipal waste it is a word as it suggests municipal waste means the waste which is produce in a municipality so that is the municipal waste.

We will also talk about construction under (())(1:05) waste which is another big area of the waste stream and even the new MSW management rules 2016 has identified CND waste as one of the major waste stream in terms of for its management so that is the CND waste will also be covered in this particular course and so as electronic waste management. So the way I have thought about this course is this is a 12 week course, so the 1st 8 weeks we will be focusing on municipal solid waste which is the biggest chunk of this course then 2 weeks you will spend on construction under (())(1:39) waste and 2 weeks on electronic waste.

So that is what I have been talking about I would like my plan is as you know if you have if we have taken NPTEL course before or if you are taking it for the 1st time, usually we will have a discussion board running and so which will be there so there would be a discussion board which you can participate. I will encourage you to participate in fact I will encourage each of one you to introduce yourself in the discussion board and then why you are taking this course so that we know your interest so that if there are certain things which we need to include in the course content we will try to do that and but it has to be relevant to the course of course.

So introduce yourself in the discussion board whatever queries you have ask in the discussion board, we will have people looking at discussion board almost every day and try to respond you query on a daily day-to-day basis and so welcome to this course again and let us get started. Myself is I am Brijesh Kumar Dubey, I am a faculty member in the Department of civil engineering at IIT Kharagpur and I will so we have already talked and I will give you in

this particular week, this is the 1st week and during this particular week we will be doing of course overview.

So we will have will what we will do is a snapshot of the different issues that is there in terms of waste management, so that is like a big picture will be shown in this particular week and then in the subsequent week we are going more detailed, more depth for each and every component of the waste management and more focused on municipal solid waste management for the 1st 8 weeks.

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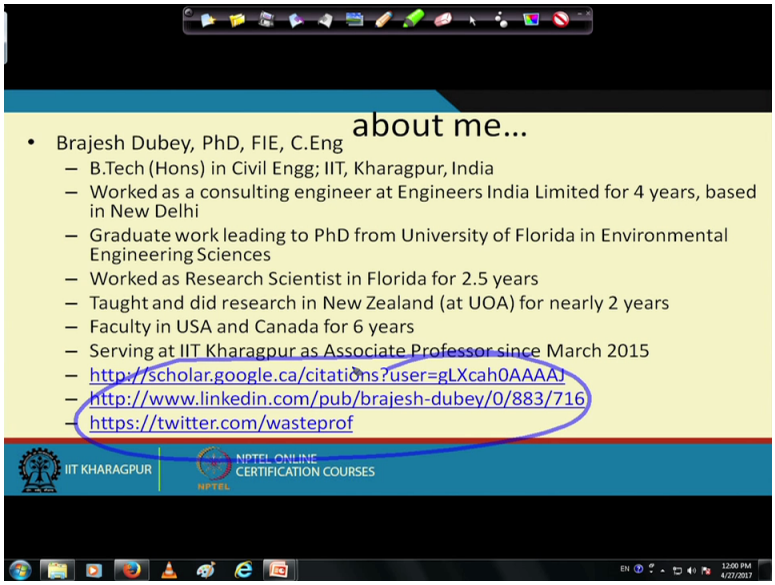

So before we go into the course, I wanted to give you a little bit background about myself I am I have done my as I mentioned my name is Brijesh Dubey I have my B.Tech is in civil engineering from this institute from where you are taking this course it is from IIT Kharagpur and then I have worked in industry for some time and after working in industry for (())(3:45) I decided to go for my Ph.D. so I went to the University of Florida and in environmental engineering sciences department there and the focus was on waste management, so the my research group where from where I got my Ph.D. my Ph.D. advisor is Prof Timothy Thompson and he had was one of the leading he is still is one of the leading researcher in the area of waste management.

So it is from under his lab in his lab I have done my Ph.D. then I worked in several places in Florida and in New Zealand in USA in Canada and after working for several places I came back to India and join my (())(4:24) as a social professor in March 2015, so are spend in nearly 14 years overseas and working on waste management luckily for me I had a chance to

work on several aspect of waste management in North America I have done some projects for United Nations in Africa.

We also did some work in China and I do go to China and teach every year there again this summer I will be visiting China and teach on life-cycle analysis which is my other course on NPTEL, which was offered last semester and so that is I do teach alternatively one year I teach solid waste one year one year I teach life-cycle in my as a part of a program in China for like a short-term course, it is a small course.

So after working I been working in in India since March 15 and my major area of work is on waste management as well as life-cycle analysis, so those of the 2 areas where I focus on and they are connected as those of you who have taken my LCA course you may have seen that have talked about life-cycle I have talked about waste management is not a lot in LCA course and similarly things will do over here as well. I will be talking about LCA as how the LCA is used waste management.

It is a very interesting area in terms of the overlap between LCA and waste management and then I do exist in social platform which is very common these days you need to be that to have a joke on this earlier if you have watched they used to be a show on Doordarshan, Doordarshan is that Indian official channel and there called Ulta Pulta which was Bhatti Jaspal Bhatti and he had one episode where he would talk about that if you do not have the ration card, many people do not have ration card today but if you do not have ration card then you do not really exist in the system and today we have Aadhar card and all those things for that but similarly if I say that if you do not have a Facebook account, if you do not have a Whatsapp account, you really do not exist, especially in today's younger generation.

So we I do have all those accounts including the Twitter account where so you can also and I keep on posting stuff related to waste management there, so those things are also available. Suppose so that is the kind of little bit background about myself and since it is an online class I cannot have a personal one-to-one introduction of you but I would like to see your introduction in the discussion forum, so that we know each other well and that that will help me to deliver the class better. So in terms of this big picture solid and hazardous waste management, what we are talking about?

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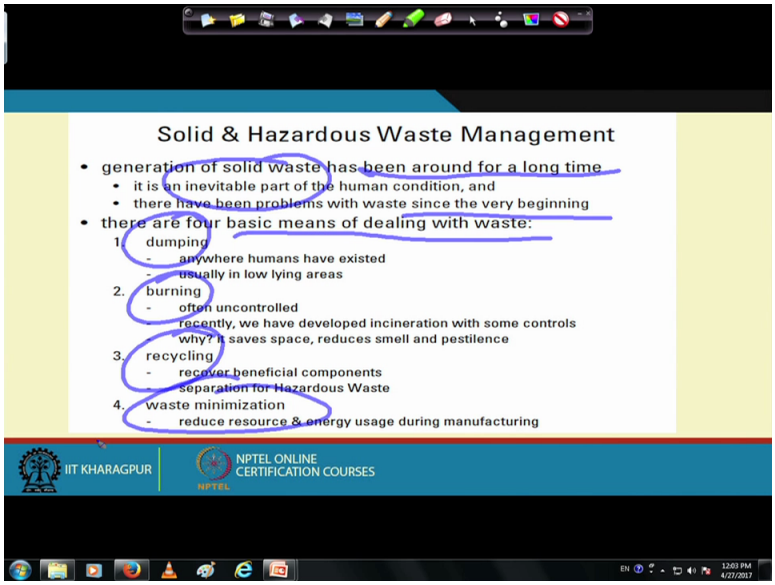

We are talking about is waste that is being produced, waste produced since time as well as the humans started inhibiting this earth and started producing fire and started cooking and producing some utensils and producing some equipments or as well as some tools for fighting, we started there was there was a portion of that material that was used to make this, there was a portion which went on waste because you cannot when you when you cut when you chop off then you have lots of things which is produced as a waste.

Initially most of these were organic in nature. There were things which was not only organic in nature there were things which was coming directly from nature as well, so it say it can be easily bio-degraded, it can there was no heavy metals to worry about and we had we had not learned how to mine for heavy metals we had not learned how to do the metallurgy and we are not using lots of electronic gadgets and all those fancy chemicals which have been manufactured now, so there is a concept called anthropogenic chemical and as well as what is known as geogenic chemicals. Geogenic is which is already there in the is there so you not really producing that, so something like a which is mother nature is producing.

Mother nature has a mechanism to deal with that. If you look at the waste in a for the things form a bacterial world or micro biological world, waste from one species becomes the food for another species and the cycle continues and there is a recycling, composting all those things happening in nature but as we have made lot of industrial revolution we have been producing more and more of these products, we are after usage of the products or even during the manufacturing of this products, we are dumping lots of lots of waste which has certain chemicals there which mother nature is not able to handle it.

So we need to help their mother nature, the whole aspect of this waste management is so that we need to help mother nature so that we can treat this waste materials before we are dumping get back into the environment, so that it does not cause health problem, does not cause environmental issues. Ultimately the whole aspect is human health and environment to prevent human health and environment we have to do that.

So generation of waste has been around for a very long time which we know there is an inevitable part, it will happen we cannot do many things much about this. Now there have been problems with waste since the very beginning there has been problems associated with that. In terms of how they have been managed basic means of dealing with waste, essentially it used to be dumping, burning, recycling and the waste minimization.

So that is where we have been doing, so we have been dumping the garbage. Anywhere humans have existed they dumped the garbage, usually in the low-lying area you put it in a low-lying areas where because is a low-lying area you fill the garbage up and then you have like a same level. You can burn it mostly uncontrolled burning, these days after the waste (()) (10:10) we are trying to have a controlled burning where we are burning the garbage in a control environment to produce heat, produce electricity and all those kinds of stuff. Why you have to do it? It serves safe space, you can have a more because if you have hundred tons of garbage and if you burn it, you are ending up with 10 tons of residual.

So rather than having hundred tons of garbage to be disposed on the landfill, you burn it, you recover energy from that and then you have 10 tons of residual. Many countries around the world even for that 10 tons they are going for recycling of that (())(10:45), separated into different fraction they use it for or as a construction material for road construction or for some other construction.

Fly is used for cement manufacturing, so that is those things are being like the reuse and so whatever is residual that goes to the landfill in the developed country specially in the Western European countries, that value has although gone almost gone down to 2 – 3%. So when I say 2 to 3% like if you have a start with hundred tons of garbage you are only sending 3 tons of the residual to the landfill after treating in a thermal treatment plant, so that is a recovering nearly 97 – 98% in different forms.

So that helps in terms of the waste going to the landfill that helps in extending the life of the landfill and so that is because of that will do not have to build a new landfill later on, so but

then recycling, recycling is recover the beneficial component you want to make sure there is no hazardous waste there. Then waste minimization, where you reduce the resource and energy used during manufacturing and all these thing we will explain a little bit more detail in later on slides, so that is in terms of the big picture, this is how the solid waste solid and hazardous waste management is looked at, so before we go into the more detail, will talk little bit about the history of the solid waste and I till that in each and every class that I teach, it is very important to know why this course?

That is like if you understand what is the need of this course, why this course? That is kind of keeps you motivated to learn about this course, so let us look at the history of the solid waste. As I said earlier, as soon as the human started producing things we started producing waste and so and then we have this we have been dumping this waste in wherever we could find a space. As the population increase that the cities and towns grew this the dumping space keeps on going outside of the city boundary, usually between the 2 city boundaries you will have the dumps sites and but when you take it outside of the city boundary we have transported.

So the transportation of the garbage becomes important. Today collection and transportation of the garbage is actually the number 1 in terms of the cost factor, the cost of transporting and disposing the garbage is very high, collection and transporting the garbage is very high so we always try to minimize and then that collection and transportation of waste is similar it is the same problem as your transportation of goods which are sold by Amazon or Flipkart and all those different Snapdeal and all those different companies.

So it is the same logistics, same sort of linear programming, same sort of routing problem, so if you want to like do some work in waste management area in terms and your expertise lies in those likely linear programming, operations research and optimization of route, you can apply that because that is actually there are software is out there of course there is always you need to refine that software and things does get site specific as well because of the geometry of the city, the layer of the street in the city and based on that you need to decide what should be on route for collecting of the garbage and if you can help reduce even one truck for a city like Delhi, one garbage good quality garbage is almost 200 – 250 thousand US dollars.

So if you can help and remove reducing by coming up with a better route, better optimization if you can help in reducing even one truck that helps in reduction of cost of almost 200,000 US dollar. That would be you can hire several manpower to do lots of other things for that or you can do something else. So uncontrolled dumping has been going on for many societies

for century as in terms of the history of solid waste. There have been cases where people have got sick.

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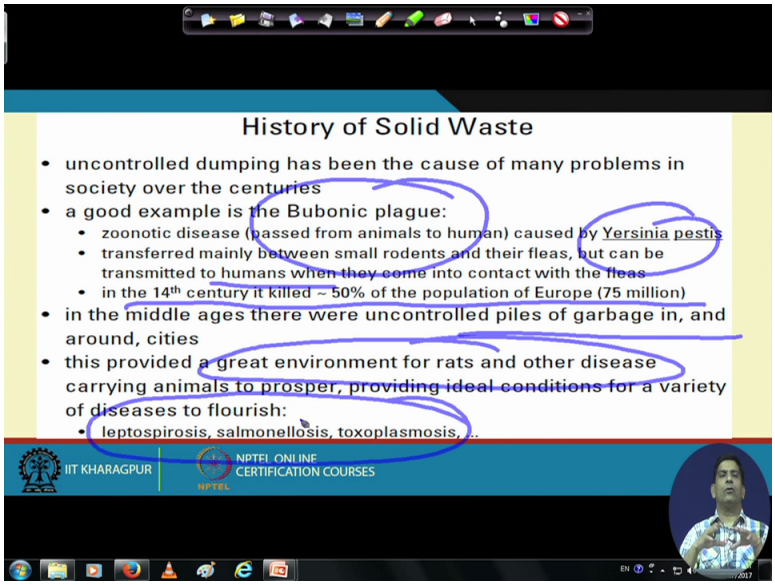

They has been cases where people have got sick and this bubonic plague is one big example where people have this was a disease caused by certain like a bacteria and microorganism, so it then got transferred between small rodents and fleas, it transmitted to humans as well and in 14th century it killed 50% of the population of Europe which is 75 million. 75 million is around in terms of Indian it is around 7.5 crores so that is if you can add up Delhi, Bombay and maybe Kolkata and Chennai something around that and that would be around at least 3 metros, so 3 metros of the population was the population of the Europe in 14th century.

So there is a population explosion, not only in India of course there is other countries as well and but so this population explosion we need we are producing more and more waste as well. So in the middle ages there was uncontrolled piles of garbage, uncontrolled piles of garbage that you see in and around cities so there is a uncontrolled piles of garbage swing up in an around cities and this they provided great environment for rats and other disease carrying animals creating lots of problems and that is a lot of different types of disease happens like leptospirosis, salmonellosis, toxoplasmosis.

We will have to worry about the names of those diseases but essentially, it is since telling us that waste improper manageable waste was directly linked to the human health and of course the environmental health, so that is why this course is important, we have to learn about this course so that we can make sure our environment is safe and we are safe, so that is the

bottom-line we have to learn about this course so that we can understand that how this how to better manage the waste material. What we can do in terms of proper management of the garbage.

When we manage the garbage properly helps in terms of preventing the environmental damage, when we have the environmental damage when we say environmental damage what does it mean? We mean the damage to air, damage to the soil, damage to the water and in that in terms of those damages it leads to if water is damage that means my drinking water source is getting polluted. My drinking water sources getting polluted our drinking water plants are not they are designed to treat certain things and if it get contaminated water I consume contaminated water either through my food intake or also my water intake, I will get sick.

So that is it is linked right there, if the soil is contaminated, you will have this whatever is grown on the soil will have a chance of getting contaminated too most of the plants are by natural little bit of there is some phytoremediation which is a term used to use for if you have a contaminated site you grow certain plants and the plans actually uptake those contaminants into the biomass and then you can harvest that biomass and manage to that waste that way so that you can decontaminate those sites that way that is phytoremediation, so all the plans have a natural phytoremediating tendency a bit.

So that is even your letters or tomatoes and other things will have will does uptake little bit of these contaminates and then we consume that contaminants through our food intake, so that is that problem is also there. So in terms of so that is water, air, air again if the air is polluted whatever we inhale, whatever we like breath that is polluted so those problems does show up.

So that is so that is why the subject of this waste management becomes very important because it is link to the environmental health also linked to the human health and they are all linked together which I was trying to explain it to you. So in terms of waste management we have looked at historical what has been happening, so what is happening today so we will talk about that in this particular next part of whatever time is left in this particular module.

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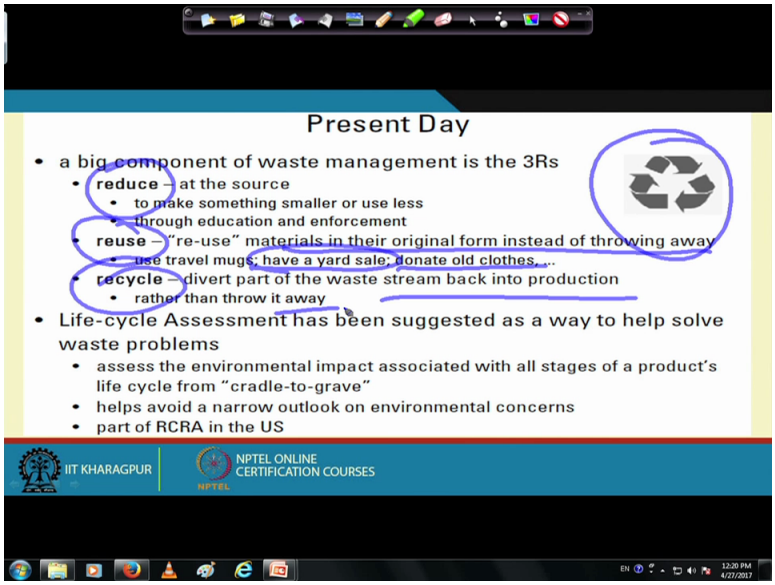

So in terms of the present-day a big component of the waste management is 3Rs. 3Rs is very common that you see you may have also seen many of these place you see this recycling sign so this recycling is basically you are trying to recycle the material and we will talk about that little bit detail as well, so big comparable of waste management today is the 3Rs. What is this 3Rs? Reduce, we are trying to reduce the waste that is being produced in the 1st place and then reuse the waste and then recycle.

Many times these days that you see we have 4Rs - 5Rs, it they say reduce, reuse, recycle, recover and there are some cases they also used 5 Rs but the bottom line is tried to reduce the bottom line is that amount of garbage going to the landfill amount of waste needs to be minimized and there is another term used for that, that is called the diversion. When you look at the European Union or the Canadian or the US solid waste management rules or solid waste management reports city reports or the county reports or the state-level reports or even at the federal level report and they will tell your term called diversion. Diversion means what fraction of the garbage was diverted away from the landfill.

So that is what essentially it means, so diverted away from the landfill is considered a diversion so which includes recycling includes reduce reuse part, it also includes waste to energy part it also includes the composting another (())(20:38) digression and everything together, so that is your part you show that so in terms of reduced what is the meaning of reduce, like you reduce at the source. We produce less amount of garbage to start with to make and then for that you make something smaller, you through you do some educational

enforcement, you try to…for example one big example is you can reduce the amount of paper waste that is being produced by using both sides of the paper.

In I told you earlier that I have been in New Zealand and in the universities and I was working in New Zealand, all the printers by default has been set in double sided printing, so they will do double sided printing unless you tell it to print single sided. So most of time they will have double sided printing unless you tell it to single sometimes you may need single sided printing for some legal documents and another stuff but most of the time you can work with double sided printing.

So it is done similar things have been done on our Indian campuses we make the decision that all the paper all the printer that we will buy, has to be a double sided printer and double sided printer are a bit expensive but if you look at the long-term in terms of its impact you would like in terms of the reduction in the paper waste and not only paper that that leads to less amount of paper waste that means management of paper waste goes down, at the same time when you using double sided your also saving the amount of paper that you using so that you have kind of lead to all that less number of trees to be fallen down and all those things associated with that, so that is the reduce part.

Then the reuse part is that when you reuse try to reuse the original material use the material in the original form instead of throwing away, so you do not throw that material away you use it in in its in its original form rather than recreating it, for example use of travel mug you can have used travel mug for rather than buying bottled water you trying to use like we use and throw glasses. You have your own travel mugs and then you use for your coffee and other stuffs you can use that. Many a times it is difficult to do that specially in today's marketing world I would say share with you an experience from one particular university campuses were I was I was around.

there we have been trying as part of the sustainability initiative of the campus, we have been trying we are trying to force this companies to actually gave us we can give us permission to use this reusable travel mugs reuse this travel marks for filling up, so say if I want to after my lunch I want to have a Coke or Pepsi for whatever drink I can use my travel mug and fill it up but the companies are not really keen on going that way because when you….. They want you to carry that Coca-Cola cup or they wanted you to carry that Pepsi cup for example.

The Coca-Cola cup or the Pepsi cup when they carry it around it you are actually although you paid for the drink and of course for the cup as well and but at the same time what they are doing is they are using you the consumer as there as their marketing as that advertising agent as well because when you are carrying the Coca-Cola cup in your hand and you carrying it around people see that okay we just had a Coke cola and people then some people will say okay I will go and get one too.

So it is it is so the companies are actually forcing us to be a marketing doing marketing for them or advertising for them so if you have a reusable coffee mug or reusable travel mugs which you can use around the entire campus of say IIT Kharagpur then they may not like it because every time it is you their advertisements are gone, so if say there is a dispenser there are many places you will see where they will have dispensers now for Coke, Pepsi and other stuffs and then you just take your travel mug you fill it up whatever is the price we pay that you do not pay for the cup and if you do not pay for the cup at the that kind of saves money for the company but since they want to promote their product they then in that case if they are using a travel mug nobody can distinguish whether you are using with your drinking coffee from that or whether you are drinking Pepsi Coke or whatever. So it all looks the same it is the travel mug.

So that too that is why is uncomfortable for those companies to do that but those things are coming those things will come. Some campuses are actually forcing these companies that you have to do it otherwise we will not give business to you, so that is that way regulation will force companies to go that route and then other thing is that you can have a yard sale. Yard sale basically you can throw you can sell your our old stuff and people do buy it. You can donate your old clothes you can donate your books and other stuffs and that can be used by somebody else.

So that is the reuse part recycle part is when you divert part of the waste stream back into the production rather than throwing it away so you are recycling that material back, so rather than throwing that material away you are recycling it back and using it that way recycling is done a lot in Indian context we have most of the recycling at least kind of process gets initiated by those kabadiwalas who come and collect those recyclable from your home and that is where the process gets initiated and then that it's used for kind of it goes from a smaller dealer to the bigger dealer and then ultimately it goes to recycling facilities.

Some of these recycling is done in a very crude way but some of the recycling is there in a more sophisticated way for example the plastics today actually the number 1 buyer of recyclable plastic is Reliance company and the number 1 buyer of recyclable paper is ITC and so recyclable plastic, they buy it they produces new plastic out of that, they also produce polyester out of that and that is use to make T-shirts and other stuffs that the fancy IPL T-shirt that you see people wearing around those nice shiny ones are has a certain percentage of recycled plastic there, so it helps in the industry that way too. So that is the recycling part so you rather than throwing it away you are using it in some fashion.

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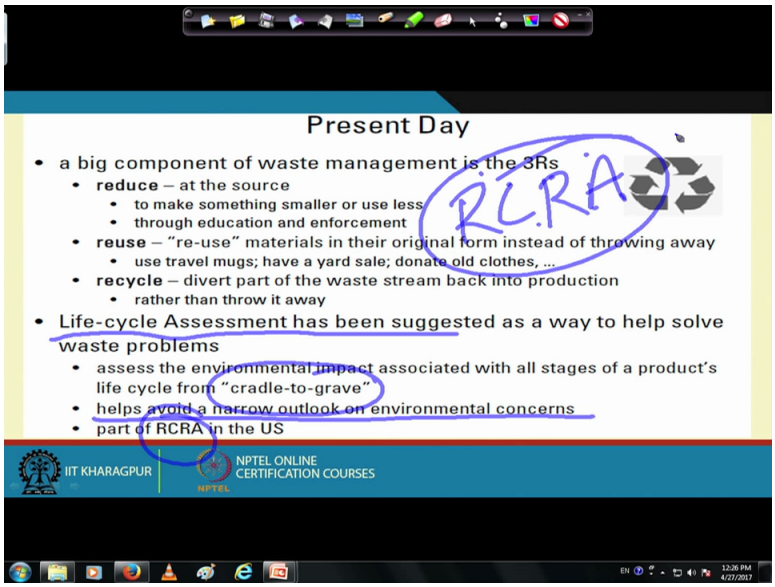

So this is how things are being managed today and to make all these discussion about the management part there is a concept of life-cycle analysis which is getting very popular these days. This concept of life-cycle analysis which I taught about this course just if you have if you have taken that NPTEL course so which was offered person semester ago, you know what I am talking about but for those of you who are not or even for a recap for those who did, life-cycle analysis is to has been suggested to solve this waste issue and in terms of assessing the environmental impact of all stages of product life-cycle, so from cradle to grave, cradle means when the baby is born grave means when the person is died and has to be put in to a for a burial.

So since the concept came from the Western world we are talking about cradle to grave, but in today's scenario actually we also talked about cradle to cradle, cradle to cradle is where we are talking about like you are doing a circular economy you are recovering a material then you are putting it back into the into this process chain, so that is your cradle to cradle. I many

a times I joke around saying that it looks like the whole world is starting believing in Hinduism because we talk about reincarnation so cradle to cradle is more like reincarnation of the material that is being used, so in the material cycle material used and the product is made and then it goes into the disposal and rather than this just throwing it away, recover the material and putting it back to the production cycle, so that is the concept of circular economy as well.

So that is where we have been using this concept of circle economy. So this cradle to cradle or cradle to grave, those concepts are used in life-cycle assessments and life-cycle assessments is essentially a is a tool, it is an environmental tool which helps us to find out how much is the environmental footprint of any process, any product or including for the waste management system. We have done work in the past where for a certain city that work was done in near Toronto there is a region of Peel. Those of you who are familiar with Toronto area, you have region Peel which is Brampton Mississauga and Caledon, those 3 cities.

Brampton and Mississauga are the big ones and there they want it to find out what is the best way to manage their municipal solid waste so there were 3 – 4 different options out there and as a the LCA practitioner at I was hired to do that life-cycle analysis for those 4 – 5 different options and that we looked at different options we had to collect some data and then do some LCA exercise to find out which option will work better for this region of Peel. So similarly if things can be done so for example in Kolkata or in Bangalore or whichever city we are talking about, there are different ways we can manage the waste.

We can if we if we have to make a decision in terms of what is the best way to manage this waste which will have the least environmental footprint, you can go for something like LCA exercise and someone who has knowledge of both waste management as well as the LCA well you can always that is why like last semester I had the LCA course this semester I have the waste management course, if you have taken both the course that gives you a very good understanding of the concept of LCA how it is applied in the waste management sector and we will try to talk about that in the class as we make progress in this particular course for next 12 weeks. So cradle to cradle and that is the new concept not cradle to grave anymore but cradle to grave is what is the from the start of the finish and as I as I planning to talk to you what having a narrow outlook on environmental concern.

It gives you a big picture of the system so you don't really look at the narrow that is what we have been doing, we have been (())(30:59) different in different compartments what is known as the silos approach rather than having a big picture approach we have been doing silos like we are only looking at this particular aspect not worried about how this is impacting on the side on that side only looking at a very narrow focus, that needs to go away. Mother nature does not work in a like a on a multidisciplinary sorry in a single disciplinary aspect. We need to kind of move away and go for multidisciplinary approach to solve the problem of any problem including that for waste management. Waste management is a very highly multidisciplinary field as you will see as we make progress here in this particular course.

And this life-cycle assessment approach is also part of a resource conservation and recovery act which was enacted in USEPA long back so you can around 20 years back they started thinking in terms of resource recovery so that is why they act is not for waste management act the one thing if you watched if you have looked at carefully in terms of the USEPA United States Environmental Protection Agency although they are focused in terms of the waste act they call it RCRA R C R A this RCRA stands for it is R C R A where you resource conservation and recovery act, so although it is a waste management act but we call it resource conservation and recovery act.

So focuses on how to conserve the resource and how to recover the resource and when you try to conserve and recover the resource, if you try to find out the what is the environmental foot print of that your LCA exercise will help you to do that, so with that I would like to close this particular module which is the 1st module. So again welcome to this course and I really look forward to working with you for over the next several next several weeks so we will end I hope you enjoy this was again if you have any concern if you need any help with anything, feel free to put your question on the discussion forum.

Why I said just you can send emails as well but I encourage you to use the discussion forum so that the answers on the discussion forum can be seen by other students so that we can other students also benefit from whatever query has been raised then many times you may raise a certain question which can lead to certain good lively discussion and that is our hope to have that, it will be really nice to have some real good discussion going on with arguments both back and forth both for as well as against so that to make things interesting. So I hope that you guys will make this course it is in your hand to make it interesting and I will try my best

as well so again welcome to this course and this with this we will end the first module of this of the first week. Thank you.