BUILDING ENERGY SYSTEMS AND AUDITING

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Week - 01

Lecture - 01

Lecture 01: Course Introduction

Welcome to this SWAYAM NPTEL course on Building Energy Systems and Auditing. So, first of all let me thank all of you to join for this particular course, which is the first time it is going to be offered in the NPTEL platform. So, we have 8 modules, it is the first module which includes the general introduction and building physics and we will actually in the very first lecture. We will just do some kind of the introduction to this particular course in this lecture. So, in that first of all let us first introduced with this particular lecture before we go to some other details

I am Dr. Shankar Pratim Bhattacharya. I am an associate professor in the department of architecture and regional planning. I am here in IIT Kharagpur in last thirteen years or so and almost twelve years I am teaching this particular subject to the undergraduate architecture course. And in our IIT Kharagpur we have a system that some courses it is a kind of an open kind of it is a core course for the architecture. But it can be opted as a depth elective for the other disciplines also. So, many students of the from the other department mostly from civil engineering and mechanical engineering and opt this particular course as the breadth elective those kind of the additional courses.

So, that actually initiate a thinking from my side that why do not I start this particular course as a NPTEL platform that the nation will be benefited or maybe the students of our country can be benefited. So, I have designed this particular course and we will start this particular course mostly from the lecture number two but today let us have some kind of overall understanding. So, as we all know that almost 80 percent of the time we will spend inside the building. Maybe in your institute you are spending, your home and then maybe you go to a stadium, you play some so that may be indoor stadium or so you may go to some some mall for purchase something. So, almost eighty percent of the time we

all are spending inside the building. And because of that kind of some of the activities inside the building, it requires some kind of energy and mostly it is due to the activity and the second one is due to some kind of the thermal comfort or so. Thermal comfort, acoustical comfort or maybe comfort from the the visual comfort like I need some kind of illumination here to read those lecture notes and whatever.

So, those required the comfort requirement and the activity requirement you may say, my mother will cook something for me for my lunch or for my dinner. So, that is the activity, that activity require some kind of energy. You require some kind of LPG or that kind of a fuel to prepare the breakfast, dinner all those things. So, everywhere if you see for the activities any kind of activities, it requires some kind of energy.

Even sometimes I may say that sometimes in the in maybe in the Facebook or some social media you put some like that some like that yes this you like this photograph or something like that. Even that particular activity is required some kind of energy even maybe very small amount of footprint, but still it is required some kind of energy you have to actually do some kind of the, you have to activate your laptop or maybe you have to actually charge your cell phone to make

that kind of an activity that I give a like to my friends photograph or something like that. That particular byte has to be stored in some space, some kind of the the server for long and long and long time. Ten years back if you have given somebody some like or some comment still it is there. So, it is storing that particular byte is storing that kind of a storing somewhere there.

So, each and each and every activity any kind of activity you can say that each and every activity is required some kind of energy So, this particular energy requirement day by day it is increasing in the urban areas also in the rural areas because we are increasing the degree of the electrification and almost Ninety Nine percent Ninety-Five to Ninety Eight percent of the India is now electrified, I mean electrification has been done.

So, people are getting benefit out of its electrification the energy Spending is if it is more on the other hand the economy will definitely going to boost. So, that is another thing economic if you want to boost. So, you have to have the energy supply has to be more. Level of urbanization is increased in our country.

So, you require more amount of energy for any purpose may not be in the building, but must be from other transportation sector, industrial sector. The amount of building area

per capita is also going to increase. We still have some kind of a housing demand. So, the in future lot of housing is going to come. Government of India has a lot of effort and they are going to give in lot of areas want to penetrate even in the rural area,

peri-urban area to built more and good and efficient house. So, that is another the potential areas to where energy is required. the prevalent climate and you all we know that there is a climate change and there is a temperature is increasing, there is a differential type of the problems that occurring and for that we encounter that one we need required more energy.

The national local policies promote efficiency, we see that there are some national policies are there sometimes there are some kinds of the state government also have some kind of policy that will actually going to promote some kind of some type of energy maybe the solar energy or something like that or maybe the energy efficiencies or so. So, more or less there is the things are actually moving around the use of energy and the the demand of energies and all.

So, that is why this particular course is very important for the architects and the budding engineers from mostly who are the building engineers, I must say civil engineers and the building engineers' architects to know about something on that. So, first of all, why save energy? it reduces the rate of natural resource depletion and all those kinds of things. It is going to reduce the pollutions, it is going to reduce the greenhouse gas emissions, fossil fuels are not clean energy sources or so.

It will actually be going to balance the environment and the ecosystems. So, it is all known to everybody. It will control the climate change, it will be going to save our money because finally and also earth as a whole finally, if I want to purchase anything, you have to purchase energy also for more energy So, you have to purchase more, you have to spend more.

So, now let us come back little bit from the energy to the sequence of courses in architecture. Most of the I am I am focusing on architecture because this there is a chain of subject in the architecture where we find this particular smooth chain. And here where I am where these particular courses let us see is the first of all what we understand what we teach student and when I was also a student like you, I was first taught on building physics which was a one kind of a chapter or maybe some small small concept in our climatology. So, the second one is the climate responsive the architecture or climatology we may say.

So, building physics is kind of embedded into the climatology course and this two become a kind of a course climate responsive architecture or whatever. So, in our time I have graduated in 90s long back. So, our time that was the finish there is no more course on this particular the arena. So, gradually in demand or you when you understand that yes there is a demand of the energy two thousand nine first ECBC code was first prevail in India and then there was a kind of a pressure that you teach you teach energy efficient building design and all those kinds of things. So, beforehand already it was started in the particular arena that we start some kind of a course called the energy efficient building design which actually coming down line of the climate responsive.

which is probably the focus of my this particular NPTEL course the name is different building energy systems and auditing. Why this name was there you will understand if you go through this particular course, it is the building systems which actually required or consume some kind of energy and definitely there is an audit required because you should know that how much you are gained or how much you are fall back or something like that by and that particular thing is required. So, the energy efficient design feature yes some part of it we definitely covered in the climate responsive one, but mostly the codes and the modern codes and the all those things fundamental things has to be look into in different perspective. So, this is the particular course which I am going to cover in this particular the lecture in this particular the NPTEL course. after that, it moves towards the green energy, green architecture also.

This course is also available nowadays as a sometimes is as a course, sometimes is an elective course also. And green architecture is all about the not only the energy, it is also about the soil, it is also about the site, it is also about the air. It is also about the the water; it is also about some greeneries and all these things say whole. So, there are IGBC, there are the TERI and the the GRIHA rating systems and the lead India lead rating systems and also. So, that is the whole.

So, it is now the from the energy to the other the environmental point part of it. And finally, it goes to the sustainable development. There are some courses of course, there are still today I mean now it is available in some of the very good institute or it is sometimes taught by everybody not institute dependency. I mean every I know every institute that teachers are actually going to give some maybe one or one module minimum on the sustainable development, where I am not only thinking of the environmental part if you see from the third one energy the first three is concentrated on

the thermal comfort and energy and the building design the first one may be the first two are may be the building design or so on the thermal comfort energy

when it comes to the green then it is environment when it is not only the energy it will also take care of the what i told water and the soil and air and everything and when come down to finally the sustainable development the one part is the environment, the other two part will be going to open out which is one is economy and another one is society. So, social development, economical development, environmental the the protections and all those kinds of thing and that is a kind of a. So, this is the sequence of the course in architecture. So, I mean exactly at the central point the CG point that is the the the energy efficient building design or so. in this particular lecture how, I map this particular course.

So, when I see this particular course or when you also will appreciate that if you cover this course that my first focal point actually, I have two focal point the second one I will write down little later. The first focal point is building life cycle energy consumption. and the building energy conservation principles. So, a building it in in its whole life cycle starting from the construction to the demolition maybe around fifty to eighty maybe hundred years it consumes energy. So, I have to look into the the whole life cycle I cannot only say yes initial five years or whatever maybe that is my focus no or maybe the only the operational energy I am going to focus no I have to see the building life cycle.

Mostly we will consider the operational energy, but also you have to see the embodied energy and the demolition energies and all those and we have to see the the the energy conservation principles. So, to do that we need to have some of the fundamentals of principles of climate responsive, the climatology, building physics and all we have to teach, we have to understand, we have to brush up and from there we have to take it out some kind of a theoretical concept on the building energy systems also. So, that will be implemented how in this particular concept or particular understanding we have to see and also, we have to see the practical application of the building energy estimations also, how to actually estimate the energy. See if I do not estimate the energy, I do not know to estimate the energy I cannot prepare my budget

And it is without leaving out all those kinds of the mathematical or the numerical computation if I want to design this course it will be very very flat. So, please prepare for some kind of numerical in every lecture, but those numerical are very simple numericals and those numericals are practical implementable these things. and those is required otherwise a particular energy conservations, energy requirement, energy spending, energy

generation cannot be a kind of a course otherwise it will be very flat very flat kind of a things are there very theoretical will be there and that will not going to serve any purpose you have to have calculate the total amount of energy demand by virtue of some kind of ideas and some kind of a theory and the numericals. So, that we cannot bypass we have to see how the through the heat gain how it is heat is gaining.

So, we need to know some kind of a basic heat movement heat generations and the heat conductivity equations and all which is not at all very complex in nature it is very simple addition multiplication and maybe divisions this and subtraction something like that. Then the other part of it is this the there are some handbooks, there are some codes we have the ECVC code, we have the Eco Nivasang Vita code given by the Bureau of Energy Efficiency, we have NVC, we have some kind of ASHRAE guidelines, some handbook of the on the the functional requirement of the building. So, what that code we have to actually follow that what they are saying that we have to follow and then we have to judge that yes, my building is not efficient enough. or my building is fifty percent efficient. So, those we will going to learn the how to do that kind of a and again that will be going to go back to my life cycle mostly on the basis of the the the embodied the the operational energy.

The second focus will be my energy audit and the energy retrofit. Now, we have to do the audit otherwise I do not know the what is going to what is my present state. if I do not do the audit of my whole every day's budget the market every day, I am going to market to purchase some vegetables or so I need to know I need to have some kind of a budget and I have to audit it maybe yearly or whatever that yes, I am spending much more maybe in some some sector. So, have to reduce it down.

So, energy is also something like that in various sources I am going to purchase energy I can purchase from the electricity grid I can actually purchase some kind of a petrol to run a particular DG, DG means diesel generator also. I can purchase some kind of an LPG to my hotels for running the for cookings and all. So, I need to know the whole amount of gamut of energy I am going to purchase and I have to see through some kind of a audit that yes what where I am going to actually there is a energy leakage also or where actually most of the energy is unnecessary maybe or some part of the energy unnecessary is non utilizing or maybe the heavily utilized or something like that. So, based on that I can actually see how much I can actually go for some kind of a green energy generation. So, that is also we going to discuss in the very last module the the the solar energy generations and all. Again, those everything again giving me back to the first objective as

the the building energy conservation source. So, those are required sometimes we have to go some kind of energy retrofit after running ten years I may change my roof.

I can go for the cool roof solutions and all those kinds of a thing. So, those are the energy retrofit and that may be benefited me from the energy use from point of view. So, this is the overall map, but next I must say tell you we have to go through some kind of a simple numericals with some excel sheet will provide you in the excel sheets in our forums we I have computed the numericals in the all the lectures in my lecture schedules are. So, if you require some kind of a kind of some doubts and all and maybe some kind of a other type of the help we can actually provide those kind of a help.

My only objective is that you should learn it properly. You should learn it properly and you should actually after this particular course successfully you should do some kind of energy calculations channel from your own. The next important point and last point is this particular course is prepared such a way that it will going to help you. for your GRIHA or LEED certification course. It will be going to help you definitely it is going to help you all of some of my student told me that they have benefited out of it number one.

And I also have a kind of a focus that is the GATE architecture examination those who are going to write GATE architecture examination in the future. There are sometimes there are some questions coming from this domain always. So, you can actually prepare by virtue of that and by virtue of the assignments and all. So, in this particular course as you know it is an 8 week course each week we called as the module. So, first module or first week we will go through the general introduction of the building physics.

The second module it is already there in the poster and all other in our website and all in the NPTEL in my domain. So, the second is on the building energy systems where we have to first week, we are just going to have some kind of brush up. of the building physics. Second, we have taken see one of each system we have heating, ventilation, air conditioning, then the electrical lighting, electrical machines we will going to do, vertical transportation system we will discuss, we will discuss some amount of water surface system and low energy cooling system. The third building heat load estimation particularly the third and fourth we will actually see the going to deep into the the heat load calculation because the HVAC energies are the most of the energy that actually consumed by the building and that will be going to increase the total amount of energy consumption and what energy conservation building course said for that. So, what is the tradeoff method? So, those envelop the performance factors and all. So, those you have to

learn. The fifth week we will go through some another code which is Eco-Niwas Samhita specially mentioned for the residential building of our country and also we will discuss about the thermal comfort.

The sixth module again we are going back to the life cycle analysis energy audit per life cycle energy analysis from the embodied energy the demolition energy and the operational energy and some tools that we can use for the energy audit. The seventh module will go with the operational energy and the energy retrofit, how the BEE bureau of energy efficiency is given the star rating systems to the buildings also. So, that also we will discuss and last, but not the least the green energy and the sustainability mostly we will discuss about the renewable energy through PV cell, wind, biogas those we will discuss. Again and again, we will have all the lectures to some kind of a numerical computations, do not worry. it will be very simple if you have any difficulty please keep in touch with us.

So, in brief again let us come back the definition of energy. Energy is a physical term that gives us the perform how much work I have performed it is kind of a thing it is given in a sense of in SI unit a Newton-meter. Suppose there is a load of one Newton if I push that by one meter, that is I am doing some kind of work how much work 1 Newton 1 meter. So, one Newton-meter is equal to one joule.

So, that is the unit of energy. So, that is the unit of energy joule and there are different type of energy sources. So, there are classification of energy, we can do by primary and secondary, commercial, non-commercial and the renewable and the non-renewable. So, just a brief about that primary and secondary. The primary energy sources are those which is available in the nature.

In raw form right. We can extortion can do some kind of mining, we can have petrol, we can have coal, we can have natural gas, we can have nuclear power, some uranium, we can some moving water can give me some kind of energy, some biomass. So, those are the primary form What is the secondary energy form? Secondary energy would be some kind of a processing and then we can actually use it.

We can use through steam, we can use through heat, we use through electricity. So, if I give you some one litre of petrol, it is not going to be useful for you. This is a primary energy definitely it has a calorific value, but you have to actually burn it in a machine called internal combustion machine then only your you can run your scooter or you you can run your car or whatever right that will create some kind of a heat energies also. You

can use coal for some kind of a to produce steam and from the steam you can run some maybe some vehicle or maybe some machine.

only coal will not be going to help you, coal may have a very great calorific value, but it no one going to help you. So, primary energy has to be processed to the secondary form and the secondary energy we can use, we can use heat, we can use steam, we can use actually electricity for our end use. So, this is the two different classifications of the primary and the secondary energy, the commercial and the non-commercial energy. The commercial energies are the which is available in the market and we have to purchase with a definite price. electricity it is commercial energy, you have to actually pay some specific price maybe seven rupees per unit or something like that maybe it can hike after two-three years, maybe petrol price now it is almost hundred six rupees or whatever.

So, it may hike after maybe few months or maybe it may there is a drop down. So, overall, there is a kind of a definite price that was fixed by the government or maybe some kind of a local agency, with advice to the government of course. So, coal also there is a price of it, I mean you cannot just have the kind of there is a government has put some kind of an upper limit lower limit whatever petroleum products everything. So, there is a regulatory body which actually I mean create some kind of a price index on that.

So, those are commercial energy there are some non commercial also which is available in the market, but not like a price tag or whatever you can have different type of price tag or it is depend upon the where it is available or so. Examples are firewood, examples are cattle dung, agricultural waste yes those are also used as energy for cooking for heating in our village areas or peri urban areas or so. Few years back also it was more now maybe the gradually it is going to be reducing, but those are also some kinds of a non-commercial energy where government does not have any role to play as to price as per the price indexing or so. but that is also there in the in the behind the screen as a use of energies in our country or any country maybe and then you all know that is the renewable energy and the non-renewable energy

Those are the two very distinguished sources of the energy you may say non-renewable or from the fossil fuel from the nature and these energies are going to burn through burning or some kind of a transformation that will going to give some kind of a bad effect to the environment also. Renewable sources clean energy the starts from the hydroelectricity, it can be solar, tidal, wind or maybe bioelectricities also. So, those are

different types. Now, again let us come back to the little bit of the historical development of the energy use.

Till the industrial revolutions what happened to how this particular energy was used as a muscular power or biomass and all. Sometimes we use some kind of a windmill or water mills or so. Please see how it is transformed within the last one hundred fifty years or so. Then what happened in the end of the 19th century? we devise the coal and steam engine.

So, gradually we shifted to that after the industrial revolution and in the early 20th century we discover oil and then there is a internal combustion engine IC engine and that is going to give a more more productive things and Gradually our economy is also driving our technology and science develop a very faster rate because of that and it is also there is a shadow of the different type of energy we are going to use and calorific value of the energies are much much higher. One gram of coal and one gram of petrol definitely one gram of petrol has a much higher calorific value much higher potential of the energies also. Then what happened afterwards? We discover natural gas; we discover nuclear fusions.

So, by virtue of that the late twentyth century, we can go for the nuclear power or something like that. Natural gas is used everywhere nowadays that is also having much higher calorific value than oil both nuclear of course, and the natural gas. And what is now at present what is happening? We are thinking of nuclear and we are thinking of the much clean energy as a renewable source of energy biofuels energy from the hydrogens and all. So, this is the wonderful transformation of the energy since the industrial before the industrial revolution and today from the muscular power to the biofuels and whatever.

So, again come back to this teaching, I am supported by my two TA, the TA we called as a teaching assistants Ms. Dipali and Mr. N Kumar they are my PhD scholar, they are doing in IIT Kharagpur and they are helping me to the design those particular PPTs and the question papers and all those kinds of things. So, in your forum they will be very actively interact they will be actively interacting with you and also if required of course, I will be there and I will definitely be going to clarify your all the doubts

They will give me the doubts as a whole and then I will be going to clarify if we need to have some kind of meetings and all online, we can also do. So, there are some kinds of the academic rules or regulations we will keep in touch in through our forum. The forum should be very much actively used by you such a way that we also very much keep in

touch with you. So, any doubt any silly doubt though there is no silly in in this world. In learning at least in this domain there is no silly.

Even if a small doubt you feel like should I ask? Yes, you should ask this thing. we will try try we will definitely be going to answer. If you do not know then will I go to some other professor ask them that what is the answer I will come back to you and I will give you the answer. Say I should not say that everything I know in the world.

So, I will try to give my best to give you the right answer and the right clarification to you. contact through us with the forum for any kind of subject related doubts. If required this is very important if required, we can also organize some kind of an online Google meet interaction, after this COVID online meeting with people is not a any issue nowadays. So, we can actually meet we can create a kind of a meeting time convenient time in the evening time or whatever maybe little late also after you come back from your host the classes or maybe you know from your work

we can actually meet for a half an hour to one hour for any periodical interval for the introduction for the google meet if is required we can definitely tell us in the forum and you know for eight modules we have the eight assignment has to be there and we have designed already the eight assignment and this particular assignment are very simple in nature and this will be twenty-five marks of each assignment. And there are five marks MCQ questions of one mark is very simple true false like that fill in the blank's kind of a thing. Of course, it will be all in the computer.

And there are ten questions of MCQ and the essay numerical type with two marks. MCQ is out of the 4 choice you have to write 1 choice or whatever. And essay numerical is the you have to actually solve this problem and then put the answer into a blank box. Suppose the answer is twenty-five point seven, so you have to just type two, five decimal and then the point seven like that. So, that is the there will be no choice you have to fill that.

So, that is there. So, two marks each of that question. So, twenty-five marks if you go through this particular lecture five lectures per week just go through note down something it will be very easy to answer those the the assignment questions. Assignment questions will give you some kind of a confidence and believe me if you can do well in the assignment, if you definitely do well in the ends and it will be almost the similar type of questions and all. And I hope that each of all of you will go for that particular assignment to the

Do well in the assignment definitely is not a big thing you have to go through my my lectures and all and I hope everybody will going for the registration at the end of the course for the the certification and write the end semester. Any point of time if you require any kind of help from us through the Google meet or from the forums and all we are ready to give you that help that is the bottom line. kindly enroll yourself for the end semester examination and get a certificate. So, those are the fine some of the reference and thank you very much to join this particular course from the lecture number two onwards we will actually go into the actual course content.

Thank you.