Effective Engineering "Teaching" in Practice
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Lecture – 04a
Problem based learning (PBL) & Problem Solving (part -1)

Welcome to this lecture, on in the course effective engineering teaching in practice.

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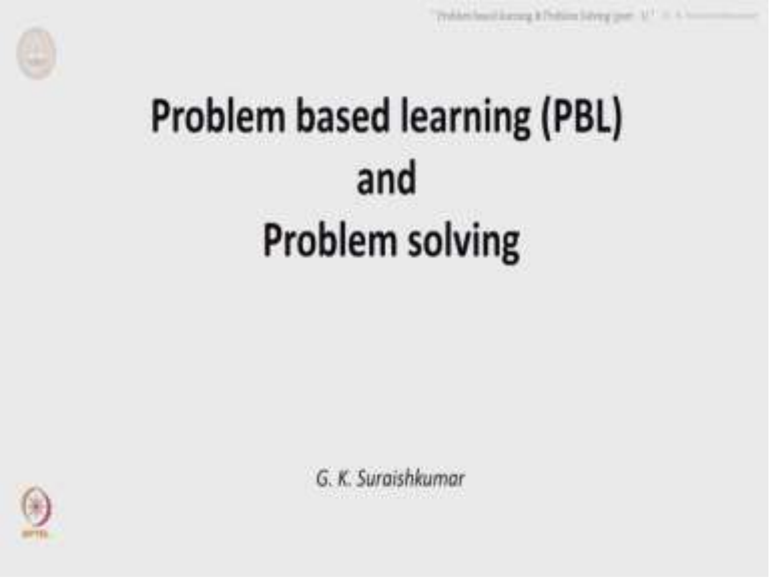

This lecture is on problem-based learning, PBL for short, and problem solving. I somehow thought they could go together. The problem-based learning is used by different people in different contexts. I am going to use it in a particular context. The context is, we are at a level where teachers have realized that they need to improve the learning of students; just speaking out something and covering content is not good enough. How do you do that in the context of the lecture, which is still the most predominant means of conveying information? Or in a class that is in an educational setting, the lecture still rules. In the context of a lecture, how do you improve that lecture to bring in aspects that would improve the learning of students is what we are going to see.

The first thing that I thought we can do is problem-based learning, which is slightly changing things or it can be interpreted in a way in which you slightly change things, to directly improve the learning. Let us move forward.

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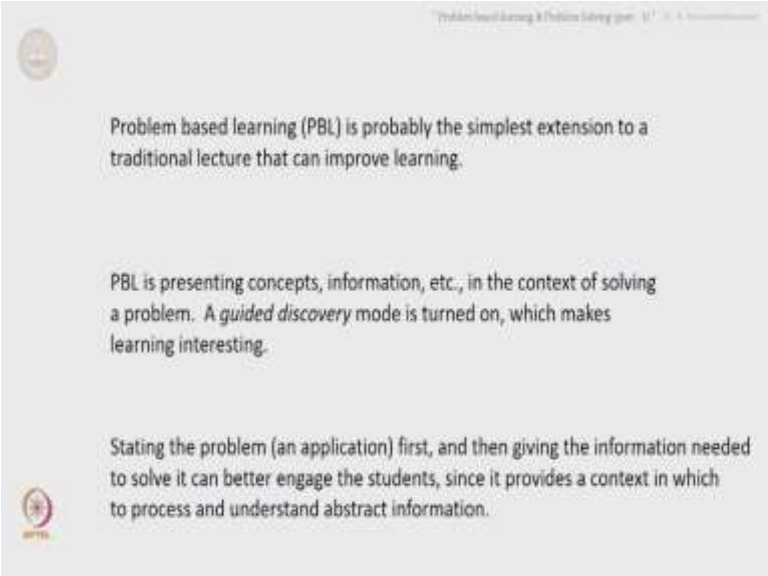

So, problem-based learning PBL is probably the simplest extension to the traditional lecture, I talk you listen, that can improve learning. So, PBL is presenting concepts, information etc., which you normally do just like that, in the context of solving a problem. Let me read this again PBL is presenting concepts information etc., in the context of solving a problem. A guided discovery mode is turned on which makes learning interesting.

PBL could also cover very many different aspects of doing in this particular thing that has presented concepts in the context of solving a problem. I am going to give you probably the most simplest aspect, which is the simplest aspect is stating the problem first or an application first, and then giving the information needed to solve it. And that can better engage the students, since it provides a context in which to process and understand abstract information, or even just information, abstract information even more crucial, right. This is this is what I am going to do as problem-based learning, or this is the way I am going to see problem-based learning, to extend the effectiveness of a lecture format, a traditional lecture format.

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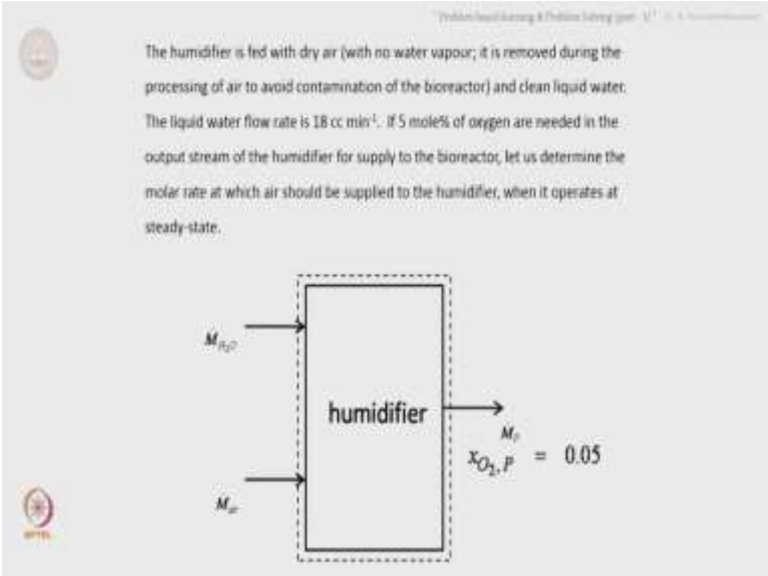

As an example, let me give you this. This is the first thing that I present to students. I am going to do an application of the material balance principle to macroscopic systems, and what I do first is to put this up on the projector, right the data projector on the screen, and ask students to first take this down, and then think about it and then we will go further.

This read as - a humidifier is fed with dry air with no water vapor. It is removed during the processing of air to avoid contamination of the bioreactor. And clean liquid water is also added. The liquid water flow rate is 18 cc per minute. If 5 mole percent of oxygen are needed in the output stream of the humidifier to supply to the bioreactor, let us determine the molar flow rate or determine the molar flow rate, at which air should be supplied to the humidifier, when it operates at steady state.

I just put it this up first without telling them anything. Of course, if you have probably covered the principle earlier or you can even use this to illustrate the principle. But I think in this case the principle was covered much better earlier through various different groundings and the need for a rate and so on and so forth. So, that I think that I would prefer to do. And this an illustration of the usefulness of that principle.

And the figure is given here, which students take down, give them time to take down and look for the slowest person in class, wait till the person finishes. And then tell them how to do the problem. Once you do the problem, when you tell them how to do the problem, tell them how you are going to apply in the principle, what is the essence of applying that principle and so on and so forth, right.

So, this is problem-based learning which is very easy to do. All you need to do is project this problem on the screen right in the beginning, and then do the same things that you have been doing. This small change is good enough to improve the learning significantly.

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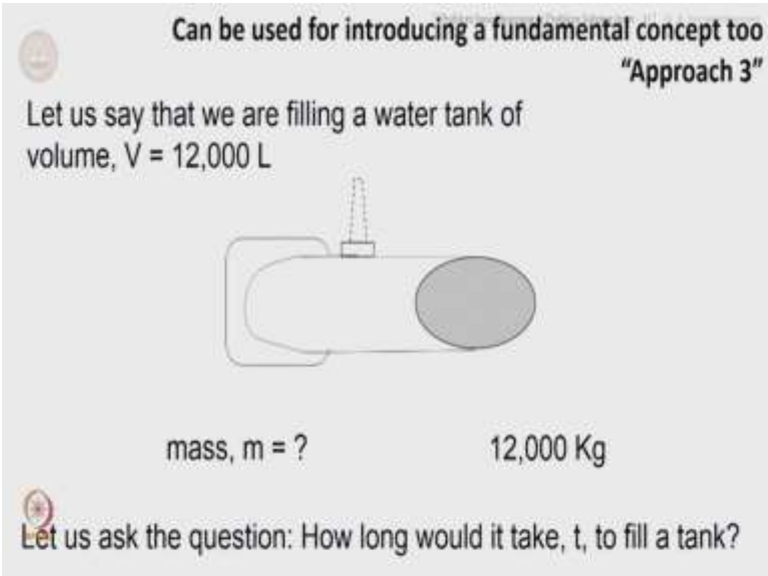

So, let me give you another application of the same thing. This can also be used for introducing a fundamental concept. I am going to give this as an example although I prefer to do it another way. Or I think I am doing it another way here. Whatever I mentioned I am going to do it here.

Remember I approach 3 in the very first lecture, I am going to present that in the context of a problem-based learning. That is a concept, it is a very important concept. I am going to present that itself in problem-based learning, which has already been done. Just looking at it again from this context would give you an idea.

So, let me do it a little fast here. Remember the water tank aspect. So, let us say that we are filling a water tank of volume 12,000 liters. And that is the figure, some similar figure that I have shown here. That is the water tank here right, and this is the water that is filling it and asks for the mass right. I am posing a problem asking them for the mass this is more of this thing. I can just write down the mass directly 12,000 liters and you know the density of water is one gram per cc or thousand kilograms per meter cubed, therefore, mass is 12,000 kg is something that I can directly write down. I do not have to ask them there.

And let us say without waiting too much and so on so forth. Let us say, let us ask the question how long would it take t to fill the tank, right. I have not told them anything about material balance, I have just presented this first. So, I am providing them a context or a problem to pick up the principle that is necessary to solve the problem right.

So, the remaining is pretty much the same except that the way it is presented may not be in an interactive mode, or need not even be in an interactive mode, because the person is still getting used to the interactive mode, the person is just a plain lecturer - I talk you listen mode, and then the person is going to the next level.

So, even if you will just run through the thing, just by posing it as a problem first, that improves the learning significantly. Because the students have started thinking about it, they want to pick up things to solve it and therefore, that gives them a motivation that leads to better engagement, better learning.

So, this is the same thing, you need to know the rate,

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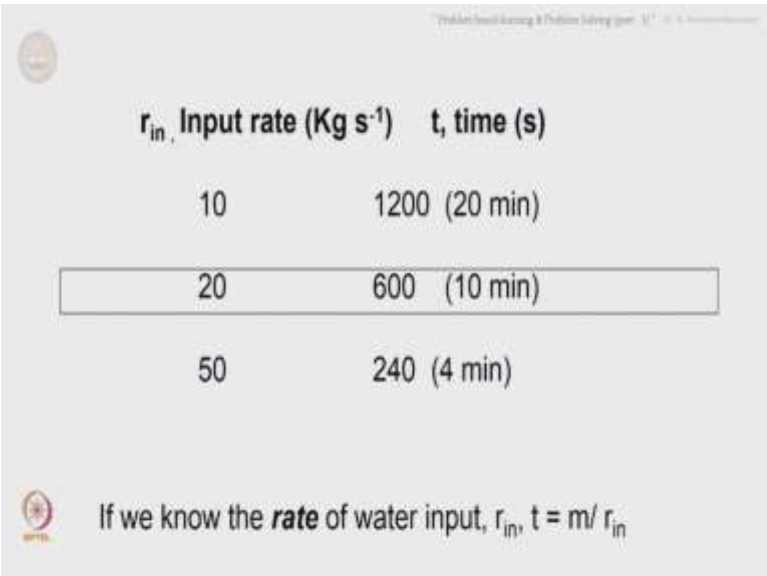

and once you know the rate, you will know the time. If it is 10 it is also 200 seconds, and so on the typical rate is about 20, and therefore, let us choose that to be the input rate here, and that leads to a time of 600 seconds or 10 minutes.

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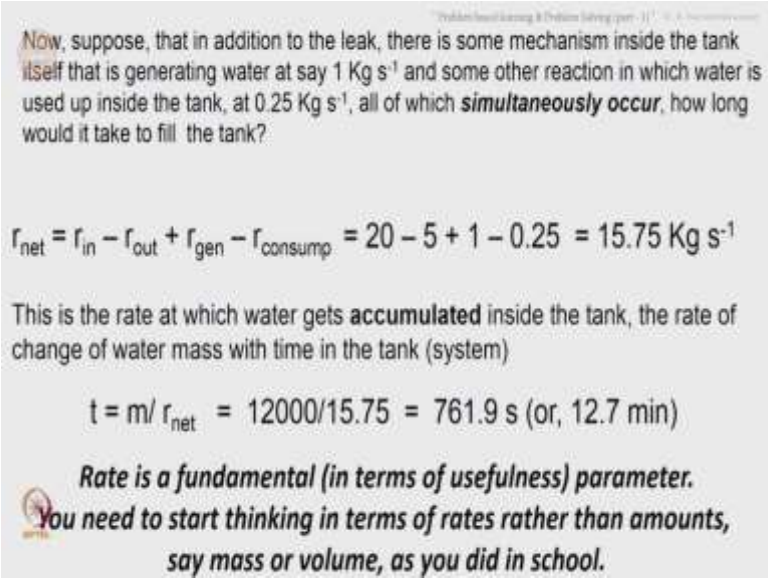

And then you say, suppose there is a hole in the tanker which oozes water at a rate of 5 kilogram per second, how long would it take to fill the tank, you can just present it and give the solution, you do not even need to wait.

This itself would improve the learning. If you do all that that is a much better way of improving the learning, the students would be a lot more engaged, but even just stating this and giving the answer immediately. You know, you need to know rate net rate to do this. And therefore, net rate is input rate minus output rate, 20 was input rate, 5 is output rate here, which is the rate of leak. The therefore, 20 minus 15 is 15 kilogram per second. And therefore, the time is mass by the net rate, or 800 seconds.

Similarly, just presenting and presenting the solution immediately is fine. The problem has given them a context to pick up the principle of material balance, and then it can be worked out right.

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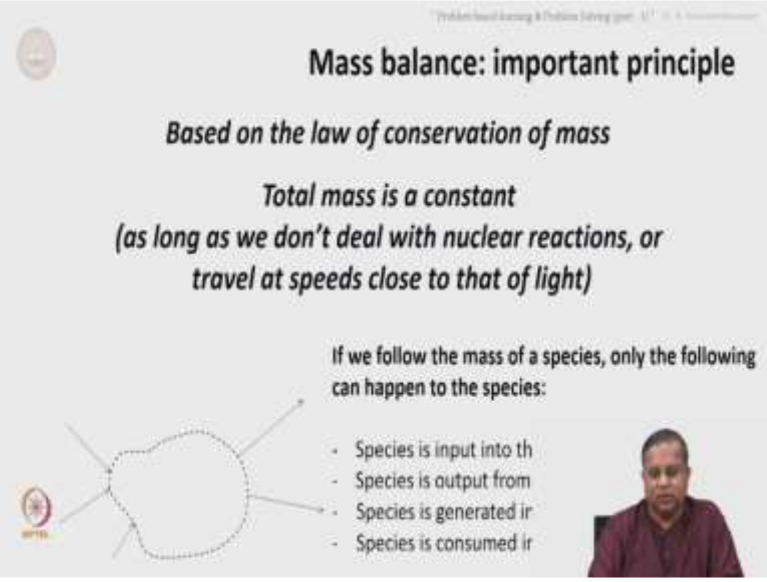

This I have already shown in great detail. Therefore, I am not getting into the details here. And once you have done that, once you have shown the need for working with the rates, working with net rate to answer some important questions, and that you have gotten across the fact that rate is a fundamental in terms of use parameter, then you can present the principle the abstract aspect which can be apply to anything, which is what is coming up next.

So, the mass balance is an important principle based on the law of conservation of mass, which is essentially that total mass is a constant as long as you do not deal with the nuclear reactions or travel at speeds close to that of light.

And this is a system, on which you focus, your attention, there could be input and output streams, and if you look at a species, the mass of a species, or just species first there are only the following things that can happen to the species, input, output generation or consumption. And the logical relationship between those rates is the net rate: is input rate minus output rate plus generation rate minus consumption rate.

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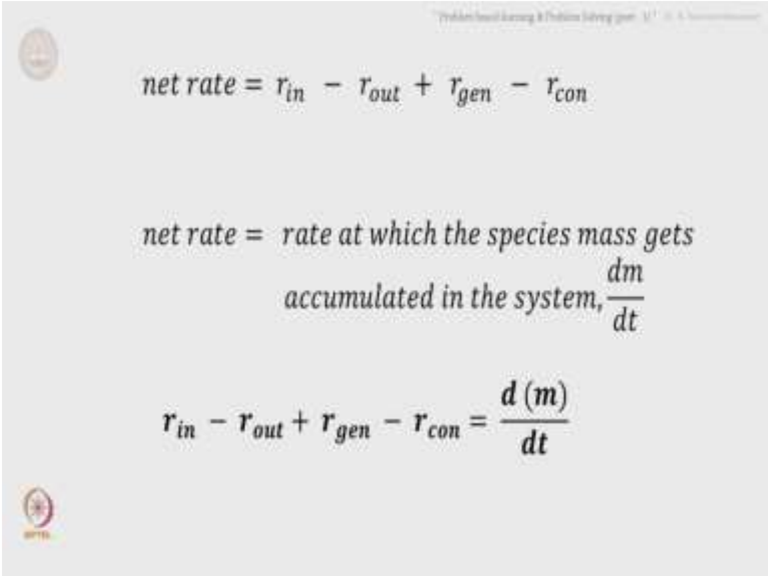

And the net rate is the rate at which mass of that species gets accumulated in the system, that can be represented as a derivative of time, $\frac{d(m)}{dt}$

$$r_{in} - r_{out} + r_{gen} - r_{con} = \frac{d(m)}{dt}$$

So, to present this principle, even this principle which is very fundamental, you could use a problem-based learning process. Just posing the problem itself is good enough - an example of problem-based learning. A very primitive example of problem-based learning. There could be many different ways in which you handle it.

When we meet next, what I am going to talk about is problem solving, closed ended problem solving. What I find is many engineering students have not yet developed the skill of problem solving. And that is a very important skill to develop in students, it can be developed. Some people are natural born problem solvers, they would solve it in the best possible way, in ways that you and I cannot think of, leave them alone, but the average student needs to pick up. There are some students who have picked this up because of a need of an entrance exam to get into engineering stream itself, such as the IIT's and so on yes IITs, NITs.

So, they may need only a little bit of, well even in IITs, there are students who are not very comfortable with problem solving. So, it helps to give them a conscious way in which you could solve the problems. That is what we are going to see next when we meet next. See you there.