

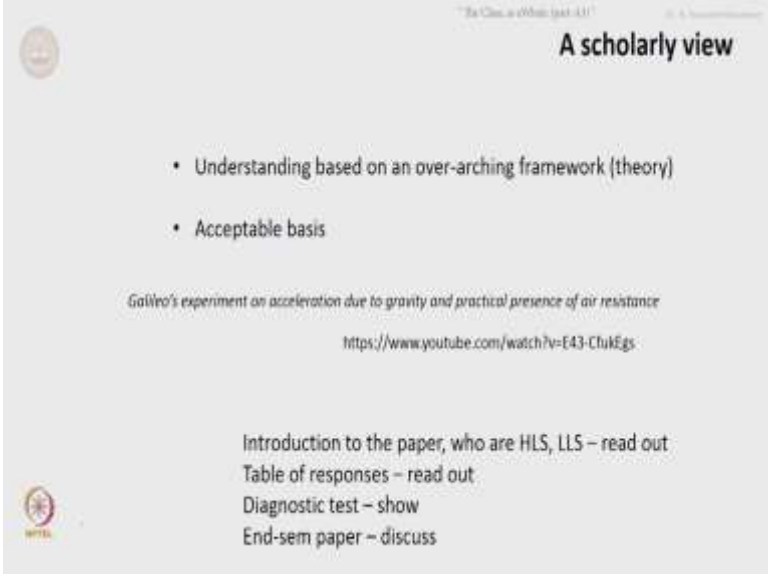
Effective Engineering "Teaching" in Practice
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Department of Biotechnology
Indian Institute of Technology, Madras

Lecture - 11a3
The Class, as a Whole - (part - A3)

Welcome back. In the previous lecture we looked at how to use the research information that is available in the literature, how we could access it, first how to access it and then you can think of how to use it and we are just trying to introduce you to the kind of literature that is available there, just to give you a slight peek into the literature.

To do that, we started at our usual stage where we are, an intuitive stage and then some work done on that and I said in this lecture, I would let you know more about the scholarly view on things on this particular aspect. So, let us move forward with a scholarly view. Just to recall we were looking at the left students, right students and means of improving the learning of left and right students in the previous lecture.

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The slide is titled "A scholarly view" in the top right corner. It contains two bullet points: "Understanding based on an over-arching framework (theory)" and "Acceptable basis". Below these, there is a line of text: "Galileo's experiment on acceleration due to gravity and practical presence of air resistance" followed by a URL: "https://www.youtube.com/watch?v=E43-ChukEgs". At the bottom, there is a list of activities: "Introduction to the paper; who are HLS, LLS – read out", "Table of responses – read out", "Diagnostic test – show", and "End-sem paper – discuss". There are small circular logos in the top left and bottom left corners of the slide.

- Understanding based on an over-arching framework (theory)
- Acceptable basis

Galileo's experiment on acceleration due to gravity and practical presence of air resistance
<https://www.youtube.com/watch?v=E43-ChukEgs>

Introduction to the paper; who are HLS, LLS – read out
Table of responses – read out
Diagnostic test – show
End-sem paper – discuss

The scholarly view usually brings about an understanding based on an over-arching framework or theory right. This is what it is, let me explain this a little better as we go along. And the acceptability of the theory is important, it should be acceptable to the relevant peers around for the theory to be useful.

To understand where we are coming from, let us take a look at an experiment that all of us would know, we are all engineers, we would certainly know this experiment from physics. The Galileo's experiment, where Galileo was supposed to have dropped a cannonball and a feather from the top of the tower of Pisa. That is given as the experiment that established the fact that the acceleration due to gravity is the same on all objects, but the conditions under which that experiment was done was realistic.

So, on top of the Pisa tower, the person dropping the cannonball and the feather at the same time that is realistic conditions that is equivalent to us teaching a class. The fact that the acceleration due to gravity acts equally on both objects is the theory part, is the framework, the understanding that is necessary for us to be able to generalize some aspect across various different objects and so on so forth to make it a lot more general. And this acceleration due to gravity aspect equivalent is the one that we are going to look at in this particular lecture on theory, scholarly view and so on so forth.

So, you get this idea, there is a practical aspect, there is a framework aspect, theoretical aspect, the theoretical aspect will help us understand things in a lot better fashion. We all know the role that the understanding of the same acceleration due to gravity on all objects plays, in various designs and so on so forth, it is so gentle; it is widely applicable.

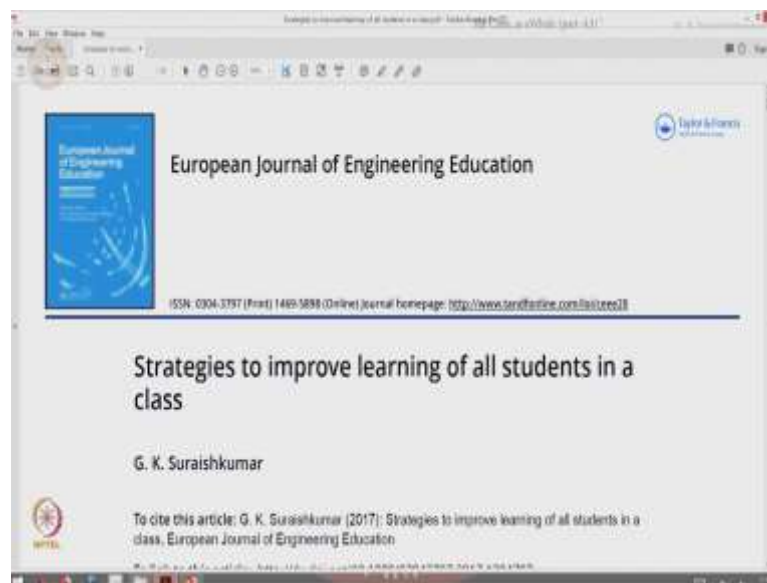
So, the wide widely applicable aspects are the ones that we are looking for. In fact, you might want to watch this particular video that is available to everyone. I cannot play it here of course, this shows the same experiment that was done in a chamber, a huge chamber that is made into a vacuum, the air is completely removed and it involved a huge expenditure and so on so forth.

Under those conditions actually the cannon ball and the feather when dropped, reached the ground at the same time. It is wonderful to watch and that is an experimental demonstration of the theory that the acceleration due to gravity is the same for all objects.

So, I hope you get the distinction between the importances of theory and how you could possibly use the theory in practice, do not confuse the two. Usually the thinking about theory is that yeah it is theory, it is not applicable in practice, no. It is applicable in a very fundamental fashion across, only thing is that you need to be wise enough to see how to apply it.

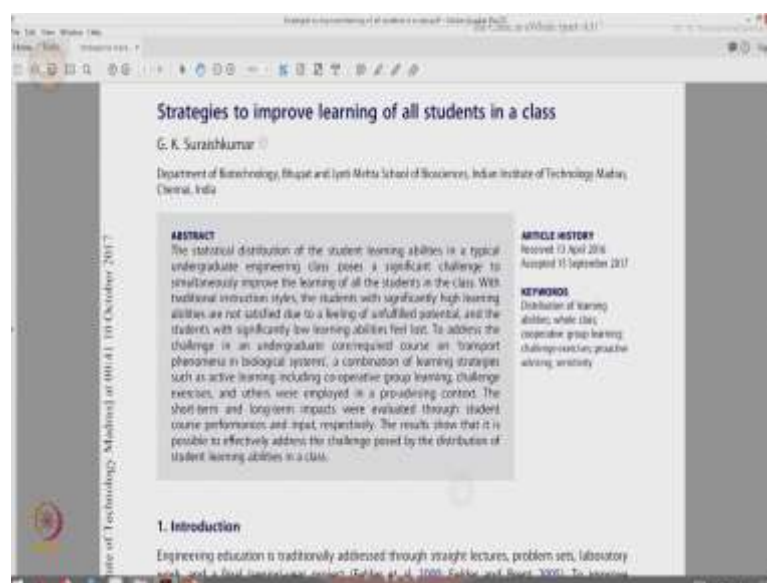
So, please take a look at that. Here what I am going to do is, we looked at the left students and right students in an intuitive fashion, I told you how I went about addressing their learning needs. When converted into a scholarly contribution, let us see how it was done and this kind of bridges the practical world with the theoretical world and then we will move more into the theory where you will see the applicability suddenly encompass a large canvas.

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So, to do this, let me pick up where we left off here. This is full view, I think, yeah very good. This is the paper, I have been talking about strategies to improve learning of all students in a class, this was published recently in the European journal of engineering education. I am going to read out only relevant parts here.

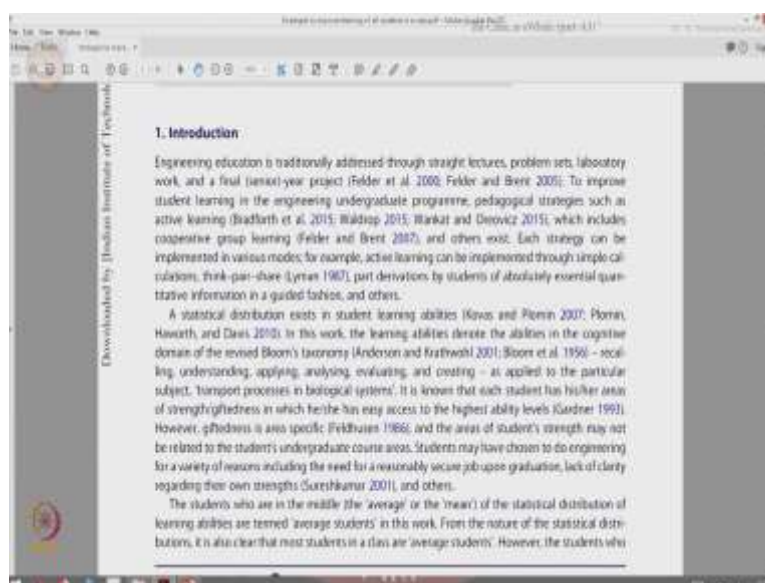
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First the abstract, the statistical distribution of student learning abilities in a typical undergraduate engineering class poses a significant challenge to simultaneously improve the learning of all students in that class. With traditional instruction styles, the students with significantly high learning abilities are not satisfied due to a feeling of unfulfilled potential and students with significantly low learning abilities feel lost. To address the challenges in an undergraduate core course on transport phenomena in biological systems, a combination of learning strategies, such as active learning including cooperative group learning, challenge exercises and others were employed in a pro advising context. I would like you to note the terms active learning, cooperative group learning, challenge exercises, pro advising context.

The short term and long term impacts were evaluated through student course performances and input respectively, this is very important it, or anything that you say needs to be backed up by data. Otherwise it is not really acceptable in a scholarly framework; the results show that it is possible to effectively address the challenge posed by the distribution of student learning abilities in a class.

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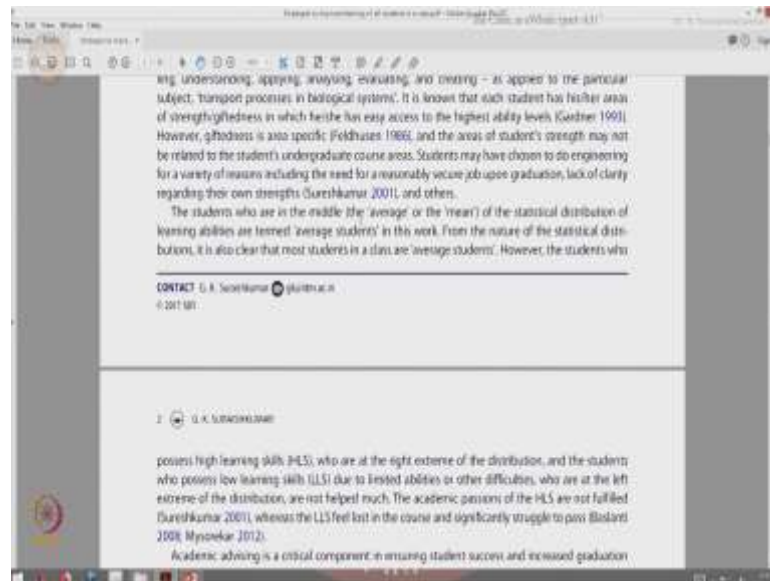


So, let me read out some parts of this. You can read out, read the entire paper later. I will start somewhere here. A statistical distribution exists in student learning abilities references are given. In this work, the learning abilities denote the abilities in the cognitive domain of the revised Bloom's taxonomy references recalling, understanding, applying, analyzing, evaluating, and creating - as applied to the particular subject "transport processes in biological systems".

It is known that each student has his or her areas of strength or giftedness in which he or she has easy access to the highest ability levels, a reference given there, this might be an intuitive thing now, but it needs to be backed up by a hard reference here.

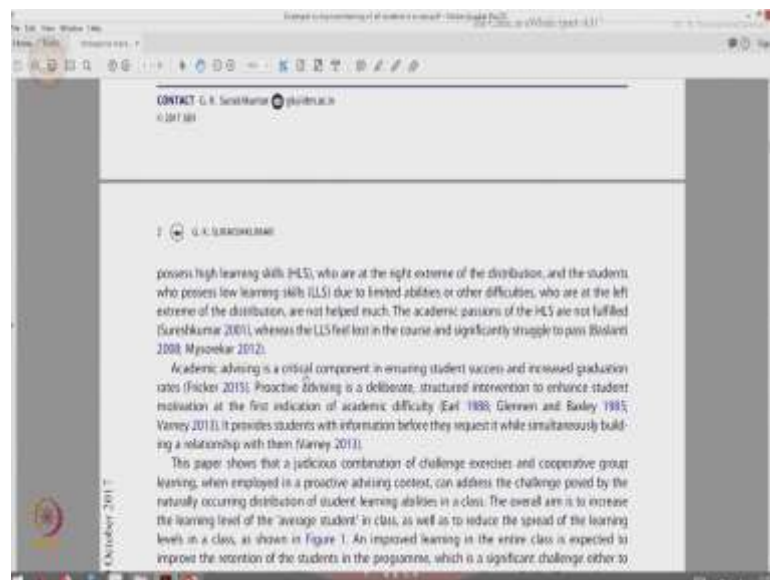
However, giftedness is area-specific reference and the areas of student strengths may not be related to the students undergraduate core course areas or course areas. Students may have chosen to do engineering for a variety of reasons; reasons are given there.

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The students who are in the middle, the average or the mean of the statistical distribution of learning abilities are termed 'average students' in this work. From the nature of the statistical distribution it is also clear that most students in a class are 'average students'. However, students who possess high learning skills, who are at the right extreme of the distribution and students who possess low learning skills due to limited abilities or other difficulties, who are at the left extreme of the distribution are not helped much by such an approach.

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The academic passions of the HLS are not fulfilled, whereas the LLS feel lost in the course and significantly struggle to pass. Academic advising is a critical component in ensuring student success and increase graduation rate, academic advising becomes a theoretical concept, some other aspects active learning, theoretical concept and so on.

Proactive advising is a deliberate structured intervention to enhance student motivation at the first indication of academic difficulty. It provides students with information before they request it while simultaneously building a relationship with them.

So, you see the various things that were done as a part of improving a practical situation, a practical challenge has these theoretical frameworks, then what one can use to understand things a lot better and apply it much wider. That is a whole idea.

So, this is where I will stop and then you I welcome you to read the paper, what I am going to finish up with is a couple of things you could, I will also invite you to read the comments in table 2 for the CFA exercise, how it helped him I did mention I was surprised by some fraction of the class which found it helpful

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Table 2: The responses of students who completed the course between 2014 and 2016 to the survey regarding the CFA exercise

The questions in the survey:
Q1: Did you find the CFA exercise helpful toward improved learning as the homework course? (Yes/No)
Q2: If you did not like it, on the most you found it useful?

Q1	Q2	Response (optional)	CFA marks (out of 100)	Grade
1	No	It helped me to study a particular topic that is not enhanced learning	Arise	Arise
2	No	Encouraged logical thought	Arise	Arise
3	No	Encouraged student to research beyond curriculum	Arise	Arise
4	No	It made us to look into the multiple application of principles studied in class. It gave us a mathematical understanding of real life systems. It gave an initial idea of building a real life system for solving many problems. It showed the practical way of thinking and finding solution to a problem. Encouraging for class for CFA as well as going further with each other has deepened my understanding of the core concepts of the course and their applications.	Arise	Arise
5	No	It added to my work on a different kind of problem not offered in usual coursework. Other than that it was an amazing learning curve for me and personally, I learned a lot because of it which I couldn't do in a long time.	Arise	Arise
6	No	Firstly, this course really differed in my opinion from the way it has been taught in my previous classes. About everything is really useful and there is much to learn in everything. The main part I liked was this course motivated the concept of learning for the end rather than making learning which improved the quality of course rather than the other course even if we have much interest in it. We end up missing for marks. I learnt many things, which I thought I understood each concept clearly and thoroughly. Another important thing was that we were not just memorizing the book but we were really able to apply it and easy to recall and understand in my case. CFA has made efficient because of all these factors which were done in the course.	Arise	Arise
7	No	CFA exercise has covered general purpose is that to do. Through this, we learn how the basic general things work. But I didn't find it improving my knowledge towards deeper course and also understanding it was actually not too hard.	Arise	Arise
8	No	When we were asked to work on a project related to diabetes, even when I knew biological engineering, but the work itself the necessary was more than we and another way they made problems coming off to work on a project like that. The better understanding I started working on CFA. Everything looked vague and I didn't like it but I got confused. But after starting to work on it for a couple of days and thinking it through properly, it seemed simple to solve. Though there were a couple of assumptions I had to make while doing the work, now I have the confidence that I can manage making a lot of research papers, abstract and content at the knowledge to analyze what is required.	Arise	Arise
9	No	First of all, it gave us a glimpse of applying their own knowledge to real life problems. I personally liked it because it was designed to think up the knowledge in a particular subject rather than learning everything and not having a clear-cut big picture of it. All other courses also have the type of project but the impression created was incompatible with CFA. This is a great platform for the student who wants to learn the subject personally and get something out of it at the end.	Arise	Arise
10	No	We were made to choose our own topic, so we could pick a topic of our interest and work on it rather than doing something half-heartedly.	Arise	Arise
11	Yes	In my last years here, this was one of the most interesting courses I've ever been a part of. It was designed perfectly to motivate the student and brighten their eyes. It was a great exercise of learning, research, and work. It was a great experience. It was a great experience. It was a great experience.	Arise	Arise

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Question	Response	Grade
14	Yes	5
15	No	8
16	No	9
17	No	5
18	No	6
19	Yes	9
20	No	9

You could see that people even with a C and a D have actually found it helpful. So, this was the surprise that I was talking about. You can go through this table to understand that a little better.

The last thing that I am going to talk about is the question paper design.

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After graduation, which was completely different from their undergraduate level (e.g., mathematics, finance, art, public service). However, the remaining about 60% of the students with a retail mind set may not be bright, and some of them become LLS.


-4.4 Impact of the relevant strategies on LLS learning

As mentioned in Section 3.3, groups with approximately the same ability levels were formed for solving problems in the tutorial/lecture sessions. The group work contributed well to cooperative group learning (Jewell and Bond 2007) and was an important strategy in the effort to improve LLS learning. Many LLS regained their confidence and improved their problem-solving skills when they solved problem sets in groups. After learning to solve the problems in the problem set through group work outside the classroom, the LLS were able to solve the problems on their own and answer relevant questions that tested their understanding when called to solve the problems on the board during tutorial/lecture classes. The tutorial group to solve a particular problem on the board was selected by drawing lots, and the author called the LLS in the group to solve the problem on the board. About 70% of the LLS were able to do also the simpler problems in the examinations, and work D or C grades; the lowest pass grade was E.

It is common practice in quantitative courses to use examinations that have only numerical closed-ended problems, with varying degrees of difficulty (Miller 2002). However, closed-ended problem-solving requires at least applying and analyzing (higher-level skills). Therefore, the examination was designed as detailed in Section 3.6. The author discussed the examination design in class a few times to enable LLS to appropriately prepare their exam strategies. However, some LLS attempted the most difficult question first in the in-semester exam and lost out on time to do well in the questions they could handle. To help such LLS, the author, after making sure that he had given them that, directly advised LLS, in private, to answer that they answer the direct questions first, before attempting the more difficult problems.

The student performance in the 2013 final examination is presented in Figure 2. The student performance in the 2013 final examination is also given in the same figure for comparison. 2013 was the last year during which no strategies were consciously employed for improved LLS learning, although

That I said needed to be balanced, said I will tell you that later, I am going to tell you that now the; this is essential to help the left students.


Indian Institute of Technology Madras
 Department of Biotechnology
 BT 201 Transmembrane Phenomena in Biological Systems, End semester exam

- Open-ended, essay, short-answer and pre-approved tables/graphs/exams.
- Communicate your approach clearly; significant weightage will accompany clarity.
- 10th November 2016, Duration: 3 h

Max. marks: 100 Weight: 30%

I. A. Syncretic differentiation between:

- Aerobic and fermentative fluxes in a pipe
- Neurotransmitter fluxes and Rhythmic plants
- Work done in mechanical systems and its electrical limits
- Charge compensation and Ohm's law
- Mohr's law of minority and Fowler's law

(Marks = i v 1 x 10)

J. An ortho-timer is to be installed at a 100 cm line to measure the water flow rate. The maximum expected flow is 1 m³/s.
 K. "The osmometer used to measure the diffusion pressure is to be filled with mercury and water is to fill the bulb above the surface of mercury. If the maximum vacuummer reading is to be 2 mm, what diameter do the narrow tube should be open for the column? (ii) What will be the power required to operate the meter at full load?" (marks: 10)

L. In a certain cell type, the distribution of K^+ , Na^+ and Ca^{2+} determine the electrical characteristics of its membrane.

- Represent the membrane as a suitable electric circuit
- When there is no net charge transport across the cell membrane, what is the relationship between the intracellular and extracellular concentrations of the above ions?

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Appendix A1: Sample diagnostic test

Indian Institute of Technology Madras
Department of Biotechnology
BT 3011 Tutorial 1 and diagnosis for group formation

- Communicate your approach (or any significant insights) to group members orally.
- 8th August 2016 duration 10 min. Max marks: 100

1. Many students in biotech use liquid respiratory reporters. A normal cell containing 25 ml of the reporter body for 40 nights (12 hours a night). Supposing a median cellular λ of 1000 h^{-1} , what will be the concentration of the reporter in the event of 100% by the best mixing? Dimensions of the container: $1.5 \times 1.3 \times 0.8 \text{ m}^3$. Assume that the windows and doors are shut and the building for acts as a vessel to maintain a uniform distribution of reporter in the room. (Marks: 10)

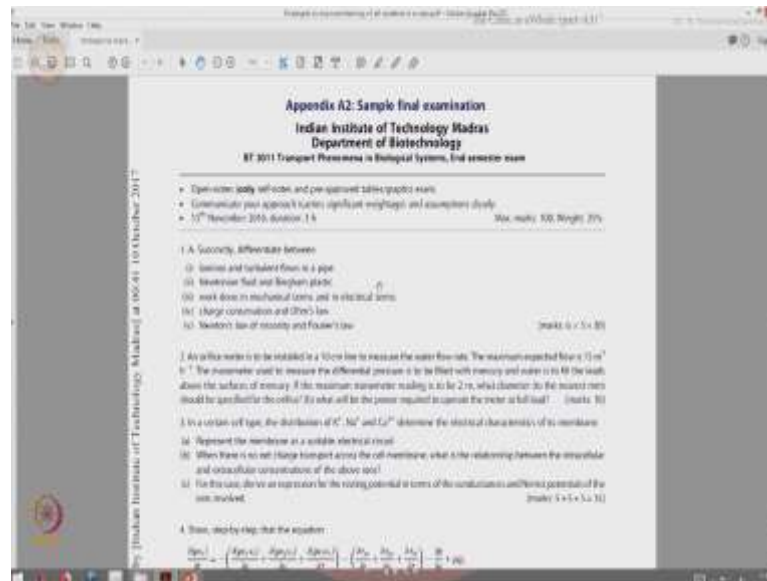
2. For an analysis of oxygen supply to a bioreactor of fixed volume V , an effective option for testing the oxygen balance is usually Baffle – Dubblets. Also, it is assumed that the volume of bubbles is negligible compared to the volume of the liquid. In addition to aeration, if the discharge of H_2O_2 by catalyst present in the cells is used to provide oxygen, in situ in the bioreactor, write a material balance on oxygen for the system. Baffle – Dubblets. A first order reaction with a rate constant k can be assumed for H_2O_2 decomposition. Also, the mass rate of oxygen supply through aeration in this case can be represented as $(1 - \phi) Q_{\text{O}_2} - C_{\text{O}_2} V$ where ϕ is a constant under the given conditions of operation, C_{O_2} is another constant, and Q_{O_2} is the consumption of dissolved oxygen in the liquid. (Marks: 10)

3. A Christian continued, single Link Bioreactor is connected up to the bioreactors to produce Bioproducts. The feed (gas) stream consists of substrate for the cells to grow and the output stream consists of cells, products and unreacted substrates. The difference in pressure of the input and output streams can be an unreacted negligible. The concentrations of substances in the output stream are the same as those inside the bioreactor, at steady state.

The cells produced are a major interest. Increase cell up to the actual factors producing the product) - higher the cell concentrations reacted, lower the product produced, usually. The rate of cell formation μ can be given by a first

An example is given there, you can go through that, that is appendix a 1, appendix a 2 is a sample final examination. This was the actual examination, that was used, the end semester examination that was used in 2016 when after which this manuscript was finalized.

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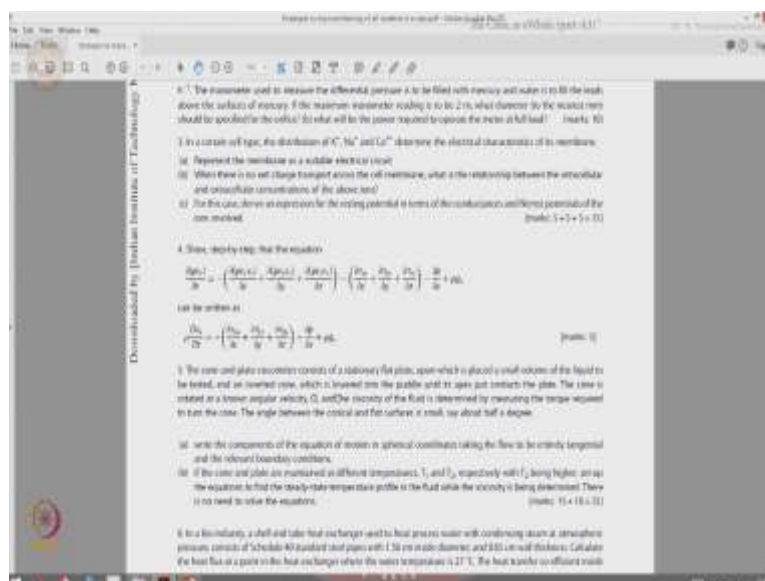


You can see here that this is a quantitative course transport phenomenon in biological systems, a standard way of giving questions in the examination is all problems at different degrees of difficulty. That is a little difficult because problem solving is a higher level skill, that we already seen and therefore, it is good to start out with or good to have some questions which should test the understanding of students at various levels.

I typically design the papers such that about 30 percent is answerable by somebody who understands the very fundamental aspects of the course; at the very essential aspects of the course to some extent and if they do that, then they can attempt to do something more and pass the course. This is the way I look at it.

So, the first question here a 1 (a) is succinctly or 1 succinctly differentiate between laminar and turbulent flows in a pipe, Newtonian fluid and Bingham plastic, these are very essential things to know if you have done a course on transport. So, I test these first, that carries about 30 out of hundred and then various problems, closed ended problems at different degrees of difficulty that are covered here.

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And some highly mathematical ones also. These are actually challenging problems here, the level of challenge increases as we go down, not always and so on

So, this gives you an idea that we need to give significant thought to the design of the examination or the question paper as we call it. So, that we address the needs of the entire class including the left students. This is the point that I have trying to make.

So, to summarize we looked at some link between practical aspects that we are used to and theoretical aspects where there is a lot of information that we can understand and use ultimately. There are advantages to doing that, the advantages to understanding the theoretical aspects in applying it to a more general situation. And then I told you the importance of designing the examination in a balanced fashion. Let us stop here, when we meet for the next part of this chapter. Let us take this forward, let us move more into the theoretical aspects. See you there.