Teaching and Learning in Engineering (TALE)
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Lecture - 19
Attainment of COs

Greetings and welcome to Unit 19 of Module 1. Here we address the attainment of course outcomes.

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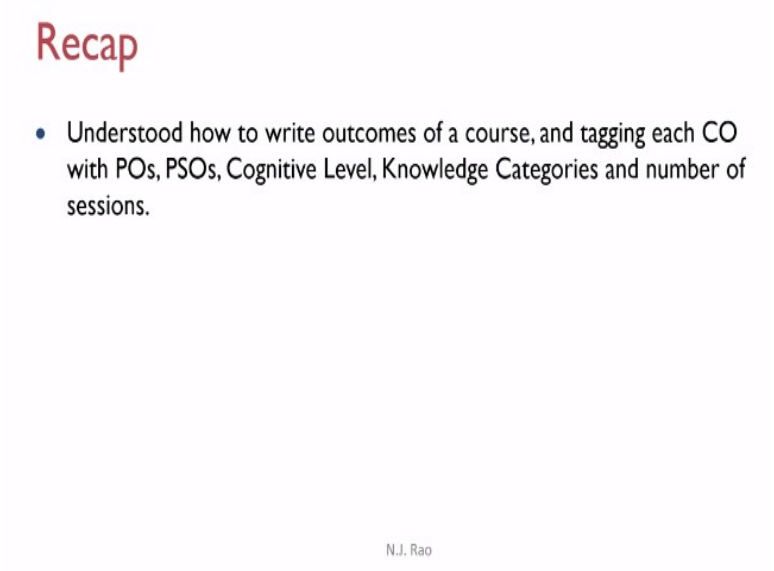

In the previous unit we understood how to write course outcomes and tagging each course outcome with corresponding POs, PSOs, cognitive level, knowledge categories and number of classroom sessions you are likely to use to address that particular PO. So now we have a picture, a complete picture of writing, a complete picture of COs for a course.

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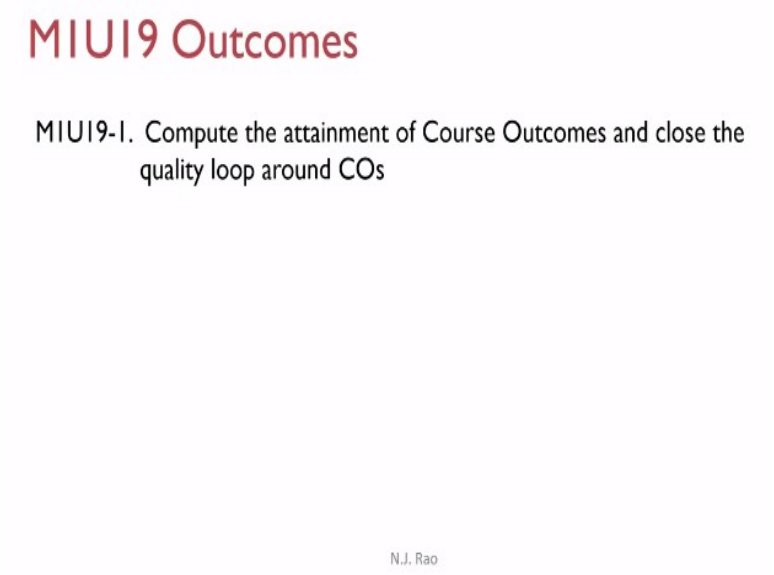

In this unit what we will be doing is compute the attainment of course outcomes and close the quality loop around COs. Because the whole purpose, the whole philosophy of NBA is to close the quality loop which we have explained extensively. That means you plan, you aim at something and then you set a target for yourself and then you attain something and you find out how far you are from the target and then plan action and implement it next time you offer the course.

This is broadly the closing of the quality loop. So we will be looking at in this unit how do we go around closing the quality loop.

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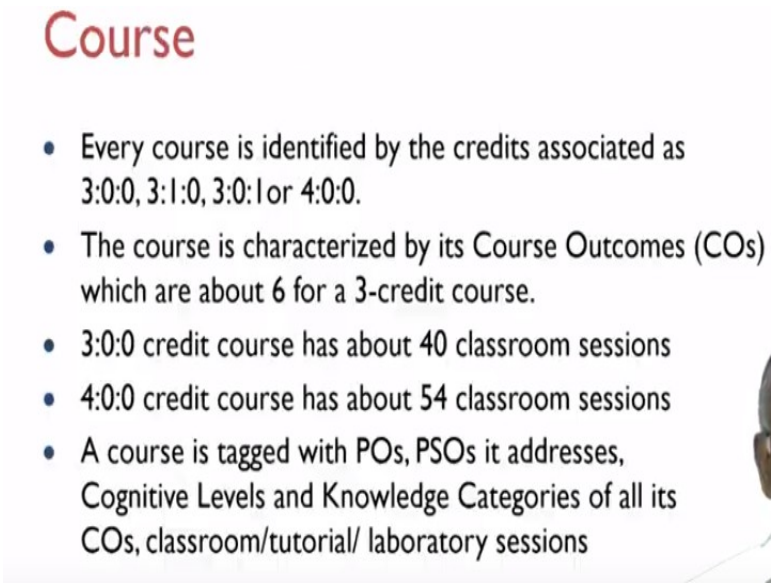

In this whole process it should be remembered there is nothing like a, the only way to do things. So we are presenting you a complete solution in the sense you can follow this but if you want to change you can modify and build a complete solution for yourself. Starting with what a course is, every course is identified by the credits associated as majority of the courses fall into one of these categories. It is 3:0:0 that means 3 classroom session, no tutorial and no laboratory.

Or you may have 3 classroom sessions, 1 tutorial and no laboratory. 3:0:1 means 3 classroom sessions and 1 laboratory or sometimes not too often that you have 4:0:0 that means 4 classroom sessions and no tutorial and no laboratory. A course, any course is characterized by its course outcomes and they are about, we have explained earlier, they are about 6 that means we talk about 6 plus or minus 2 for a 3 credit course.

A 3 credit course has about 40 classroom sessions. It depends on the number of planned week. Sometimes you may have let us say 15 weeks. In that case it will slightly go up to 45 or it may be if it is 14 weeks it could be 42 sessions. By and large it is good to plan for 40 classroom sessions in a 3:0:0 course. And for a 4 credit course like 4:0:0 you are likely to have about 54 classroom sessions.

A course is also tagged with the POs, PSOs it addresses, cognitive levels, knowledge categories of all its COs and classroom or tutorial or laboratory sessions that are associated with that.

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Analog Circuits and Systems - Credits: 3:0:1

	Course Outcome	POs/ PSOs	CL	KC	Class Sessions	Lab Sessions (Hrs)
CO1	Understand the characteristics of linear one-port and two-port signal processing networks	PO1, PO10, PSO1	U	F, C	3	
CO2	Model one-port devices including R, L, C and diodes, two-port networks, and active devices including amplifiers, Op Amps, comparators, multipliers, BJTs and FETs	PO1, PO10, PSO1	U	C	9	4
CO3	Understand how negative and positive feedback influence the behaviour of analog circuits	PO1, PSO1	U	C	4	4
CO4	Design VCVS, CCVS, VCCS, CCCS, and DC and SMPS voltage regulators	PO3, PO4, PO5, PSO1	Ap	C, P, C&S, PC	10	4
CO5	Design analog filters	PO3, PO4, PO5, PSO1	Ap	C, P, C&S, PC	8	8
CO6	Design waveform generators, phase followers and frequency followers	PO3, PO4, PO5, PSO1	Ap	C, P, C&S, PC	6	8
	Total Hours of instruction				40	28

Now let us look at an example. If you look at this it is a 3:0:1 course; 3 classroom sessions and 1 laboratory session per week which means 2 hours of laboratory session per week and here we have described the course in terms of 6 course outcomes. It does not have to be 6. For example the last one is fairly large, I can break it into two. I can also break the other one CO4 into two. So I can make it 7, I can make it 8 without any compromise with respect to the content of the course.

And here what we have said is each course outcome we have separately tagged with the POs and PSOs it addresses. As we mentioned earlier, generally a course gets associated with one PSO. Here it happens to be PSO1. So PSO1 is associated with all of them. And as you can see different COs here are addressing different POs. In this case we are a bit ambitious to include PO3, PO4, and PO5 as well. It is a bit ambitious but let us say you can make the course more interesting. It is more challenging to the teacher and if you are really attaining these program outcomes the students will learn lot better.

And then we have cognitive levels. We have described it as U, U, and U. And as we mentioned already, most of the courses will generally not go beyond the Apply category. Very very rarely they will go beyond this because our examination methods still do not permit properly addressing the higher cognitive levels.

And knowledge categories here we are using Factual, Conceptual, Conceptual and here Procedural but we are also adding the engineering knowledge categories like Criteria and Specifications and Practical Constraints and these are the classroom sessions and these are the laboratory sessions. So generally if you have 14 weeks, active weeks that you have, you have 28 hours of laboratory and about 40 hours of classroom sessions.

This particular course will serve as the platform within which we are going to do all our computations related to CO attainment.

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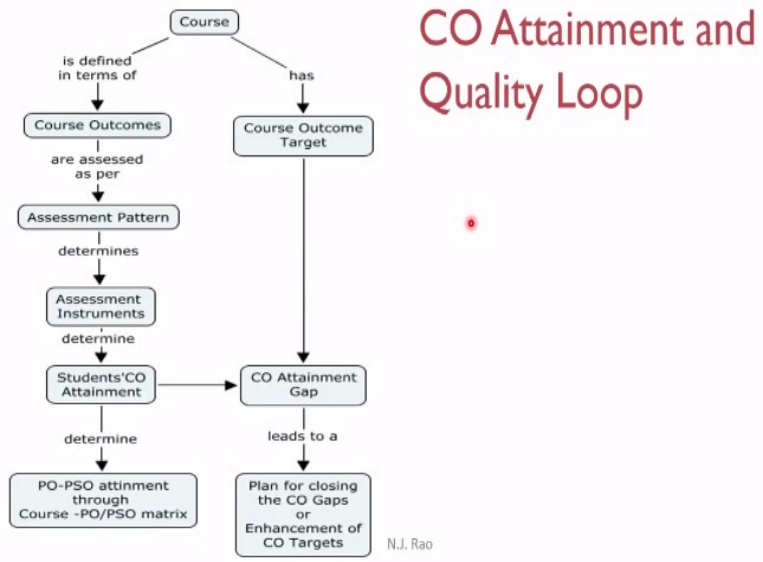

To graphically understand what the course is, a course has you set some targets. How to set the targets we will see. You set some target. Then what happens is a course is defined in terms of course outcomes. Course outcomes are assessed as per some kind of assessment pattern, we will explain that and assessment pattern determines the assessment instruments like assessment instruments could be assignments, quizzes, class tests or end semester exams.

And these assessment instruments determine the students' CO attainment. To what extent, it is based on the performance in these assessment instruments. Now this students' CO attainment is compared with course outcome targets that we have and you compute the gap. You set the target, you measure to what extent it has been done and then you are measuring the gap. And this gap leads to plan for closing the gaps.

Because you do not want to work with those gaps. You want to plan next time you offer the course to close the gap or reduce the gap and if the gap is 0 or negative that means you have exceeded the target then you raise the target. So that is the basic mechanism of closing the loop. And incidentally you as the courses are the main tools vehicles for attaining the program outcomes as well; so we work through from course attainment from CO attainments we also determine later the PO, PSO attainment as well.

So that is the relationship between COs and POs. So presently in this particular module or this particular unit we will look at this part of the loop.

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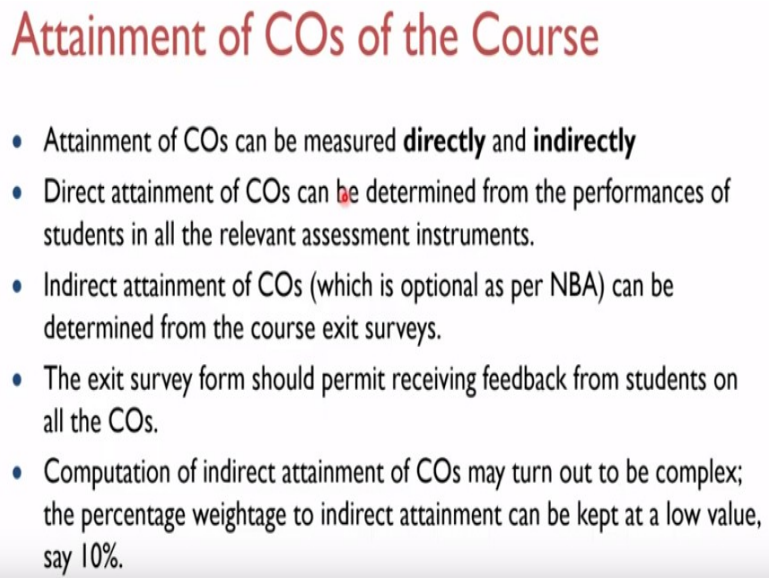

Now we try to follow a little bit or rather we try to follow the procedures indicated by NBA. Now the CO attainment can be measured either directly and indirectly. Direct attainment of COs can be determined from the performances of students in all the relevant assessment instruments. Like what are the marks that he obtained or grades that he obtained in various assessment instruments which we set; which will include the class tests and end semester exams.

And indirect attainment of the COs which is as far as CO attainment is concerned it is optional as per NBA. They can be determined from the course exit surveys. That is towards the end of the semester you conduct a course exit survey. But this course exit survey is not about the instructor,

how he conducted that kind of thing. The course exit survey is related to the course outcomes. To what extent you have gained, you have understood or you have learnt the course outcomes.

That means you have to design a form in such a way that you indirectly ask the student to what extent he has learnt or he has attained the course outcomes. You cannot ask a question to what extent have you learnt CO6? We cannot ask questions like that. But, so these course exit survey forms become subject specific or course specific. They have to be designed accordingly.

And now what happens, whichever way you do, the computation of indirect attainment of COs because of the survey form can turn out to be complex. So one cannot be assured of the results that would come out of that. So while you take into consideration, you give less weightage for the indirect attainment.

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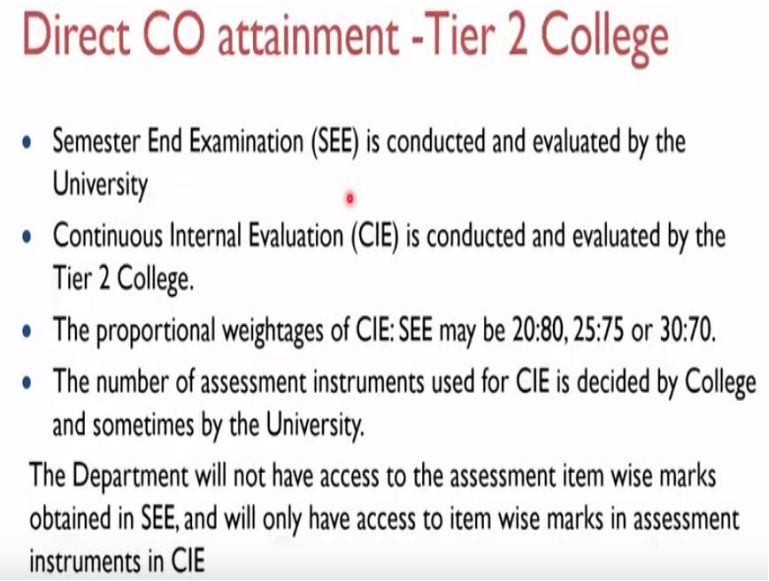

Now we come to, we have to differentiate between Tier 2 and Tier 1 colleges. For example in tier 2 college Semester End Examination is conducted and evaluated by the university. The college or instructor has no direct role in that. Whereas the college has only access to Continuous Internal Evaluation and both the tests as well as evaluation is conducted by the college or by the institructor.

To this extent the present practices in tier 2 college across the country if you see, there could be anywhere from 20:80 to 30:70. 20:80 means 20% weightage is given to Continuous Internal Evaluation and 80% to Semester End Examination. And the number of Assessment Instruments used for CIE that is Continuous Internal Evaluation where it is decided by the college and sometimes even the university specifies even this, how many instruments you can have.

And there are instances where the tests are designed centrally and sent over to the college. So it is practically like SEE. That means the university will set the internal tests as well as, only thing is corrected at locally. So though it may not be desirable to do so but some universities have such practices. So what happens is the department will not have access to assessment items or for each assessment item what marks the student has obtained in SEE the college will not have access to that.

Generally university gives only one mark or one grade for the End Semester Exam. They will not give further details. At least that is the current practice. So in a Tier 2 college, the college will have only access to item wise marks in Assessment Instruments in CIE. Your own class tests you will have item wise marks available to you.

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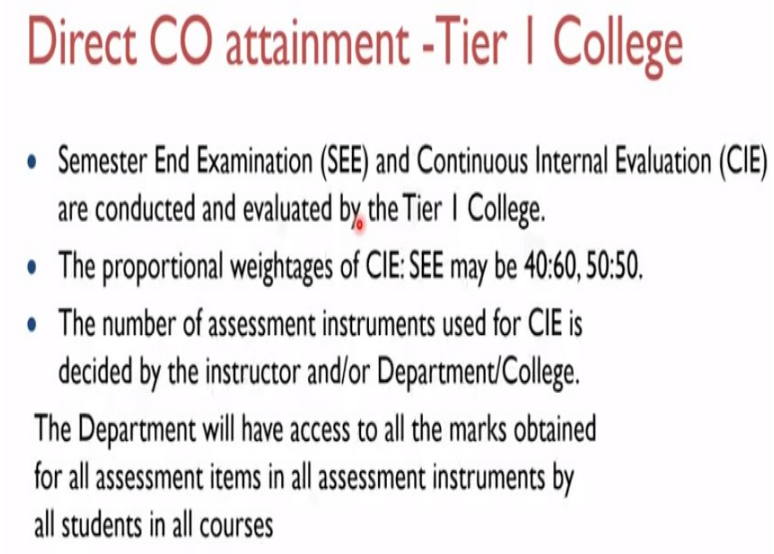

Whereas in Tier 1 college the End Semester Examination and the Continuous Internal Evaluation both are conducted and evaluated by the Tier 1 college. And it is quite normal practice to have

CIE, SEE weightages as either 40:60 or 50:50. And here you have further choice, the number of Assessment Instruments used for CIE is decided by the instructor in some higher end institutions or there may be a standard practice followed in a particular college.

In such a case, the department will have access to all the marks obtained for all Assessment Items in all Assessment Instruments by all students in all courses. So you have complete data. From that one can compute the CO attainment much better compared to what do you call in Tier 2 college.

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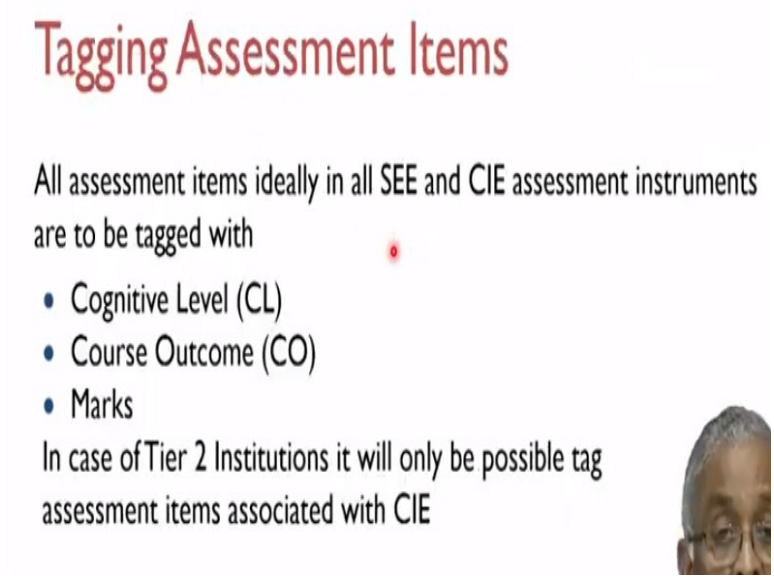

Ideally, all assessment items, these assessment items could include it could be 1 mark questions, 2 mark questions, 5 mark questions, 10 mark questions and so on, each one of the assessment item is ideally to be tagged with the cognitive level and course outcome and the marks. These are the minimum three requirements. For planning instruction you may want to have more information than that like POs, PSOs, and knowledge categories and so on.

But as far as computing the attainment is concerned these three will be adequate. In case of Tier 2 institutions it will only be possible to tag assessment items associated with CIE.

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CIE Instruments - Tier 2 College

- Sample Assessment Pattern for all the concerned CIE Instruments in Tier 2 Colleges (assuming 25% weightage for CIE) indicated.

CL	AI 5	TI 10	T2 10
Remember	0	2	2
Understand	0	6	4
Apply	5	2	4
Analyze	0	0	0
Evaluate	0	0	0
Create	0	0	0

Now we talk about assessment pattern. What do we call assessment pattern? Essentially to say which are the assessment instruments or how many you have and how much weightage you are giving it to each one of them. Let us say in the example presented here in a Tier 2 college, I give one assignment which is given as 5 marks but you can also have 2 or 3 assignments and the total marks associated with all the assignments could also be 5.

Out of 25 that we have, 5 marks are assigned to or given to assignments and test 1 has 10 marks and test 2 has 10 marks and how are we distributing? This is again a choice of the instructor. It depends on the subject. For example my weightage for test 1, Remember type of questions I ask 2 out of 10 and Understand 6 marks questions and Apply 2.

Similarly, I may change that weightage for test 2. As we said this distribution completely depends on the instructor as well as the nature of the subject. And because assignment by and large are problem solving exercises, all the 5 marks we are assigning in this particular case to Apply, okay? This is the assessment pattern.

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CIE Instruments - Tier I College

Sample Assessment Pattern for all the concerned CIE Instruments in Tier I Colleges (assuming 40% weightage for CIE) indicated.

CL	AI 5	A2 5	TI 15	T2 15
Remember	0	0	2	1
Understand	0	0	7	8
Apply	5	5	6	6
Analyze	0	0	0	0
Evaluate	0	0	0	0
Create	0	0	0	0

Now, whereas in Tier 1 college, I am taking 40% weightage for CIE and they are distributed. Just this is an example. You can follow your own pattern. For example you can have test 1 - 10 marks and 20 marks for test 2. That is another possibility. So this is one sample. There are two assignments and two tests and the weightage as given for various cognitive levels is as indicated. And as we said these are only sample values.

You decide depending on the course you have and what your preferences are with respect to this.

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Class Average in CIE - Tier 2 College

Class average in CIE in Tier 2 College with 25% weightage to CIE

CO	AI 5 CI Ave	TI 10 CI Ave	T2 10 CI Ave	CIE Class Average %age
CO1	0	2.3/4	0.6/1	2.9/5= 58
CO2	1.5/2	2.1/3	0.8/1	4.4/6 = 76
CO3	0.7/1	2.3/3	2.3/3	5.3/7= 76
CO4	1.7/2	0	1.2/2	2.9/4= 72
CO5	0	0	1.1/2	1.1/2= 55
CO6	0	0	0.7/1	0.7/1= 70

Now we compute the class averages. For example each one, each assessment instrument that you have let us say take the first one, assignment 1 there are 5 marks associated. But these

assignments can be given in anyone of these what do you call course outcomes, okay? So I have 2 marks assigned to CO2, 1 mark assigned to CO3 and 2 marks assigned to CO4. So what happens, out of the 2 marks if I look at the class average, it is 1.5.

As far as CO3 assignment is concerned it is 0.7 out of 1 and CO4 - 1.7 out of 2. Okay coming to test 1, 10 marks are divided between CO1, CO2, CO3 as 4, 3, 3 and the class average out of 4 marks that are possible is 2.3 and 2.1 out of 3 for this class average and so on. Or depending on what kind of targets that you want to have these can differ. It depends on how you are planning to set the targets. But here out of 3 marks the class average is 2.3.

So for this test 2 as well and then CIE class average is computed like this. That is you add up all the marks they have obtained for CO1 and what is the maximum mark and you compute the percentage.

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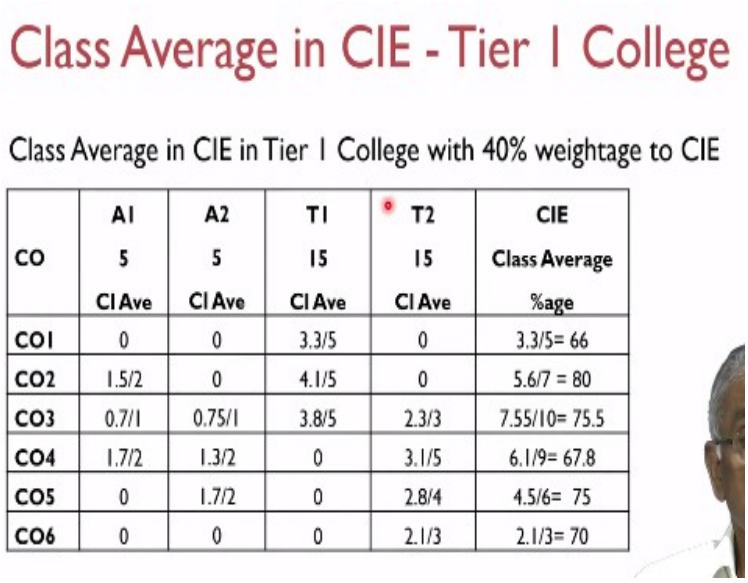

CO	A1 5 Cl Ave	A2 5 Cl Ave	T1 15 Cl Ave	T2 15 Cl Ave	CIE Class Average %age
CO1	0	0	3.3/5	0	3.3/5= 66
CO2	1.5/2	0	4.1/5	0	5.6/7 = 80
CO3	0.7/1	0.75/1	3.8/5	2.3/3	7.55/10= 75.5
CO4	1.7/2	1.3/2	0	3.1/5	6.1/9= 67.8
CO5	0	1.7/2	0	2.8/4	4.5/6= 75
CO6	0	0	0	2.1/3	2.1/3= 70

Whereas if you come to Tier 1 college, you have more assessment instruments and the marks are different and you compute the class averages in a similar way. So you finally get class average percentages for CIE for each CO.

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Setting CO Attainment Targets

There can be several methods

Example 1:

- Same target is identified for all the COs of a course.
- For example the target can be "the class average marks ≥ 60 marks"

Example 2

- Targets are the same for all COs and are set in terms of performance levels of different groups of students.
- While this method classifies students into different categories it does not provide any clues to plans for improvement of quality of learning

Targets			
(% of students getting < 50)	(% of students getting >50 and < 65)	(% of students getting >65 and < 80)	(% of students getting ≥ 80)
10	40	30	10

Now we talk about setting the attainment targets. How much should you attain? Again it is subjective. We will offer you four examples. That means you set the same target for all COs of a course like you can say the class average marks for the entire class for all COs put together should be greater than or equal to 60 marks. That is a very gross way of measuring. Example 2, targets are the same for all COs and are set in terms of performance levels of different groups of students.

So what do we say? I must have, this is the example. For example I must have 10% of the students having less than 50% marks in the entire what do you call assessment. That is including SEE and CIE the number of student or the percentage of students getting less than 50 should not be exceeding 10%. Similarly, students getting between 50 and 65 marks should be more than 40%.

Similarly for 65 to 80% in 30 and percentage of student getting 80 greater than 80 should be at least 10%. So this is my target. That means you are looking at class averages but you are now the students. This has a justification that in any class you have students of different abilities, different motivations, so you cannot expect all of them to have roughly the same kind of marks.

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Setting CO Attainment Targets (2)

Example 3:

- Targets are set for each CO of a course and for different groups of students separately
- Provides considerable details which can lead to specific plans for improvement

CO	Targets			
	(% of students getting <50)	(% of students getting ≥50 and < 65)	(% of students getting ≥65 and < 80)	(% of students getting ≥ 80)
CO1	10	40	40	10
CO2	20	30	40	10
CO3	20	30	40	10
CO4	10	40	40	10
CO5	20	20	50	10
CO6	20	20	50	10

You still have another complex thing. Very similar to example 2; that the previous one but now I set these percentages for each CO. So I put a very elaborate table like this. This has certain advantage of for example if you want to improve then I can identify the group of students who are getting very much less and try to plan some action at or rather additional inputs to them but this is a lot of data, lot of computation to be done.

But this can be done if you have a software tool implementing this should not be difficult at all.

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Setting targets for Course Outcomes (3)

Example 4

- Targets are set for each CO of a course separately
- It does not directly indicate the distribution of performance among the students. It has the advantage of finding out the difficulty of specific COs

CO	Target (Class Average)
CO1	70%
CO2	80%
CO3	75%
CO4	65%
CO5	70%
CO6	80%

And then we have a slightly less complicated than the previous one but something that one can relate more easily. Targets are set for each CO of a course separately. Each CO the class average

should be 70, here for example CO1 should be 70%. That means I aim to get 70% class average marks for CO1. That means all the assessment items I have related to CO1 in CIE as well as in SEE the marks percentage should be 70.

So this is, so you can draw some conclusions about each CO what additional activity that you should do to improve the performance of the student. So here for our presentation we are using this particular target or rather this example 4 will be the basis for computation.

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Computation of CO Direct Attainment
Tier 2 College

Attainment of COi in a course Cxxx = 0.25x Attainment of COi as percentage in CIE + 0.75x Class Average Marks Percentage in SEE

CO	CIE 25 Cl.Ave (%age)	SEE 75 Cl.Ave (%age)	Direct CO Attainment 0.25 CIE Cl.Ave +0.75 SEE Cl.Ave (%age)
CO1	2.9/5= 58	63	60.5
CO2	4.4/6 = 76	63	65.9
CO3	5.3/7= 76	63	65.9
CO4	2.9/4= 72	63	64.7
CO5	1.1/2= 55	63	59.6
CO6	0.7/1= 70	63	64.1

Now how do we do this? For Tier 2 college attainment of COi in any particular course you just call it Cxxx you compute 0.25 that is 25% weightage given to the CIE and 75% to SEE so you compute. That means I have already computed the class average for CIE in the previous table. But coming to SEE, I do not have individual values for each CO. The university is not going to give me those marks. They give me one class average.

For want of anything else I take that all COs are attained to the same extent. So I use the same percentage and I combine these two 25% and 75% to compute the direct CO attainment.

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Computation of CO Direct Attainment Tier I College

Attainment of COi in a course Cxxx = 0.4 x Attainment of COi as percentage in CIE + 0.6 x Class Average Marks Percentage in SEE

CO	CIE 40 Cl.Ave (%age)	SEE 60 Cl.Ave (%age)	Direct CO Attainment 0.4 CIE Cl.Ave +0.6 SEE Cl.Ave (%age)
CO1	2.9/5= 58	63	61
CO2	4.4/6 = 76	61	67
CO3	5.3/7= 76	56	64
CO4	2.9/4= 72	71	71.4
CO5	1.1/2= 55	67	62.2
CO6	0.7/1= 70	55	61

Now Tier 1 college is where you have access to all the marks. So the SEE class averages, I have individual values, I can combine like this, okay? CIE average I have and SEE class averages also that I have. I combine 40% and 60% for both and then I compute the finally class average.

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CO Attainment and Attainment Gap - Tier 2 College

Computation of Attainment of COs in Cxxx = 0.9 x Direct CO Attainment+ 0.1 x Indirect CO Attainment

CO	Direct CO Attainment %ge 0.25 CIE Cl.Ave +0.75 SEECl.Ave (%age)	Indirect CO Attainment (Exit Survey) %ge	CO Attainment %ge	CO Target %ge	CO Attainment Gap %ge
CO1	60.5	78	62.3	60	-2.3
CO2	65.9	85	67.8	75	7.3
CO3	65.9	76	66.9	70	3.1
CO4	64.7	89	67.1	70	2.9
CO5	59.6	78	61.4	80	18.6
CO6	64.1	85	66.2	70	3.8

Note: When there are no attainment gaps or attainment gaps are negative it is expected that the instructor will enhance the CO target next time he offers the course.

Now let us look at the next one because we want to look at direct CO attainment as well as indirect CO attainment. If you look at direct CO attainment, CO attainment is the first column where you have percentages are shown that is 25%, 75% are combined and you have that column. And then indirect CO attainment where based on the exit surveys you compute to what extent COs are attained.

And you combine these two by 90% for direct attainment and 10% for indirect attainment and you have the third column that is showing 62.3, 67.8 and so on and they give you CO attainment and compare it with the targets that you have selected. Targets, these are already selected and then you compute the CO attainment gap, okay? So if you have exceeded the target like for example in CO1 we got CO attainment percentage 62.3 but the target we initially set it up for 60.

So that gives you -2.3. That means you have exceeded the target. When you exceed the target, what you do or you meet the target then what you do next time you offer the course, you raise your target. That means instead of 60 I can make it 65. And push the entire class towards attaining higher values for your COs.

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CO Attainment and Attainment Gap

Tier I College

Computation of Attainment of COs in Cxxx = 0.9 Direct CO Attainment+ 0.1 Indirect CO Attainment

CO	Direct CO Attainment %ge 0.4 CIE Cl.Ave +0.6 SEE Cl.Ave	Indirect CO Attainment (Exit Survey) %ge	CO Attainment %ge	CO Target %ge	CO Attainment Gap %ge
CO1	61	78	62.7	60	-2.7
CO2	67	85	68.8	75	6.2
CO3	64	76	65.2	70	4.8
CO4	71.4	89	73.16	70	-3.16
CO5	62.2	78	63.78	80	16.22
CO6	61	85	63.4	70	6.6

Note: When there are no attainment gaps or attainment gaps are negative it is expected that the instructor will enhance the CO target next time he offers the course.

And the same thing for Tier 1 college. Here you have in two places we have attained the targets. So you have to increase the target levels for that, okay? The same computations are done for Tier 1 college.

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Closure of the Quality Loop

	Target %ge	CO Attainment gap (%ge)	Action proposed to bridge the gap	Modification of target where achieved
CO1	60	-2.3		Increase the target to 65%
CO2	75	7.3	Explain in detail the need for macro modelling, and the models of BJTs and FETs. Present the parameters of presently available commercial devices	
CO3	70	3.1	Present more simulations of frequency dependence of transient behaviour of feedback systems	
CO4	70	2.9	Work out more examples of amplifier and regulator design	
CO5	80	18.6	Demonstrate the effects of parameter variations using mathematical models and Graph	
CO6	70	3.8	Include more open ended experimentsin waveform generation and FLLs	

Now we show only one example of Tier 2 college. What do we do? We got the target as we showed there and the gap also we have shown and then you have to plan an action proposed to bridge the gap. For example because it is -2.3 the modification of the target where achieved so you increase the target to 65%. Whereas in the case of CO2 there is a gap of 7.3. That means there is something that needs to be improved.

And the instructor who offered the course will fully understand based on his classroom experiences what more things to be done. Here we just given indicative samples rather than this is not the exact just these are samples actions proposed. For example we said explain in detail the need for macro modeling and the models of BJTs and FETs because as we said we are giving a course on analog electronics as the basis for all these computations. So these solutions are also given in case of the same course.

Present the parameters of presently available commercial device. And CO3 there is a 3.1% gap. We said present more simulations of frequency dependence of transient behavior of feedback systems. Like that for each one, as you can see CO5 has 18.6. That means there is something seriously wrong - either in terms of our presentations or the way we organized our material or we conducted the laboratory sessions, whatever it is.

There is a serious gap. So we say demonstrate the effect of parameter variations using mathematical models and the package graph. So this is how you plan for that and you have to demonstrate later that you are actually using this information when you are planning, when you are conducting the course in the following semester or following year.

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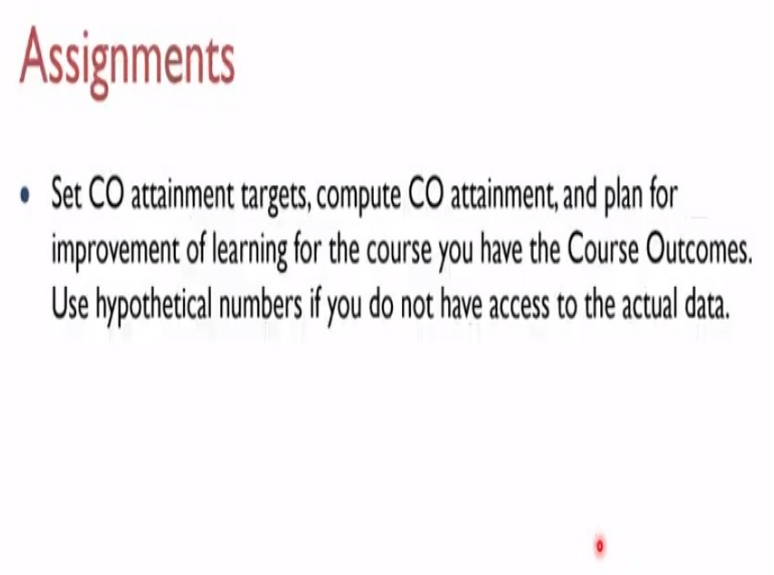

Okay, now we come to the assignments. You take, you have already done in the earlier units you have designed course outcomes, tagged them all and now you set CO attainment targets, compute CO attainment and plan for improvement of learning for the course. And just for exercise if you do not have all the data accessible to you, use some hypothetical but reasonably realistic numbers and to compute the, to complete the assignment. This will give you once you do it by yourself it will give you or rather you will understand the role of computing the CO attainment.

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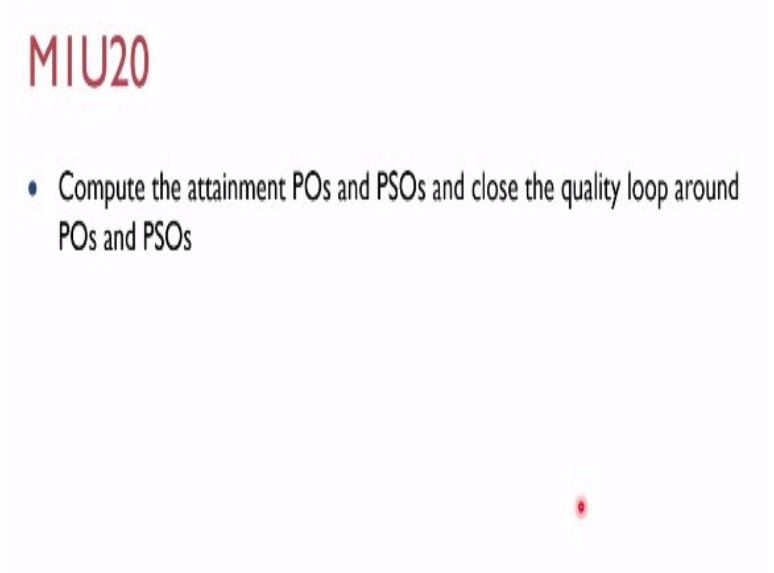

And in the following module or following unit 20, we will be computing the attainment of POs and PSOs and close the quality loop around POs and PSOs. Unless you do the, compute the CO attainment we cannot move to PO attainment. That is what we will be doing in the next unit that is U20. Thank you very much for your attention.