Teaching and Learning in Engineering (TALE)
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Lecture - 18
Course Outcomes – POs and PSOs

Greetings and welcome to Unit 18 which is related to tagging the course outcomes.

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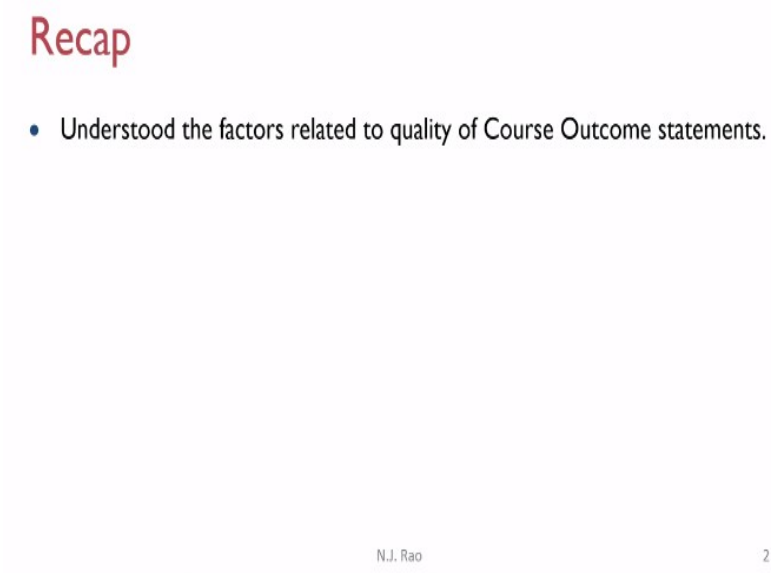

Earlier we understood all the factors related to the quality of course outcome statements. That means we gave several procedures and several factors identified so that following that; following are a framework that is defined by all of them that provides you a platform for writing good course outcome statements.

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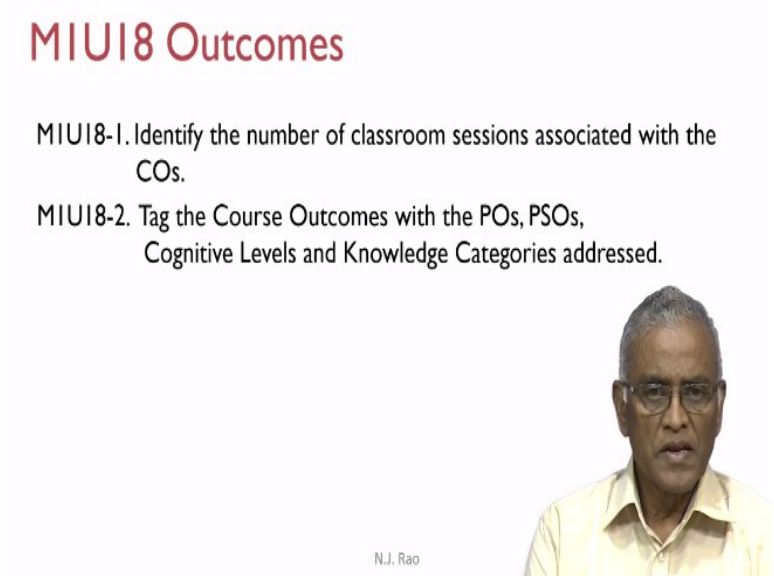

Now having written the course outcome statements, now what we would like to do is, first thing is with each course outcome statement we would like to associate the number of classroom sessions that are likely to be required. This is need not be very precise. It need not be identified to the extent of minutes and so on. Just roughly the classroom sessions need to be identified.

Then we tag each course outcome with the POs or the PSOs, cognitive levels and knowledge categories addressed because each course first of all is associated with one cognitive level through its action verb and then we have one or more knowledge categories that are addressed and now we also want to associate which are the POs and PSOs that a course outcome addresses.

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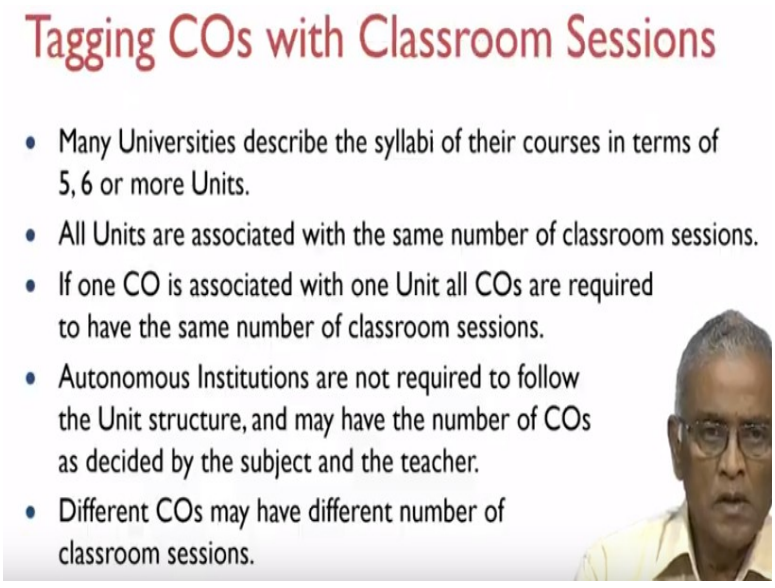

Now coming to the classroom sessions as we stated earlier many universities describe the syllabi of the courses in terms of 5, 6 or more units. 5, 6 is more common. Sometimes some universities we have seen they may even go up to 7 units or 8 units and then you unitize like that they associate the same number of classroom sessions with all units. So if you go by the by requirement that one CO is to be associated with one unit then all COs are required to have the same number of classroom sessions.

Like if you have a 40 lecture or 45 lecture course then divided by the number of units will automatically give you the classroom sessions. But autonomous (unit) institutions they are not required to follow unit structure and may have the number of COs as decided by the subject, subject matter and by the teacher. So different COs may have different number of classroom sessions.

So roughly even in non-autonomous institutions if one is willing to write more or less number of COs than the number of units, the CO, all COs need not have the same number of classroom sessions, okay? That is as with respect to classroom sessions.

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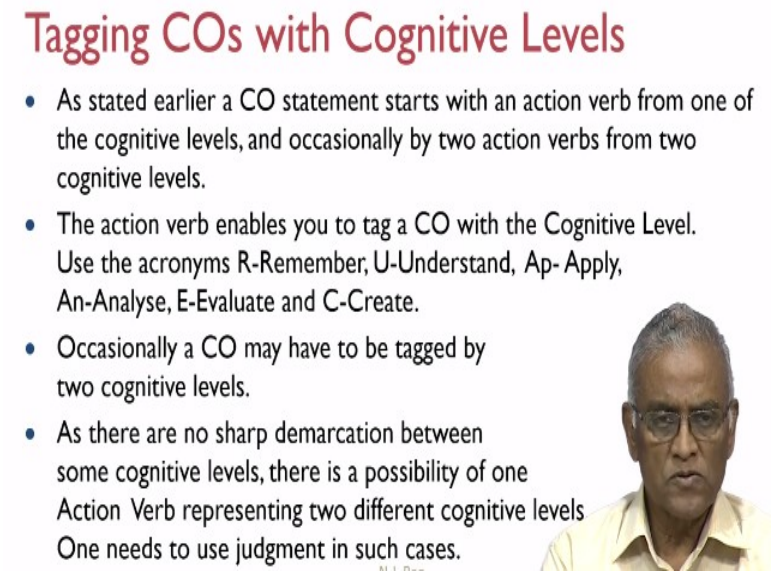

Now we come to the cognitive level. As we stated earlier, we always start a CO statement with an action verb and an action verb it comes from one of the cognitive levels. And we said occasionally by two action verbs from two different cognitive levels. But using two action verbs

should be an exception. So the action verb enables us to tag a CO with the cognitive level and we use the acronyms R for Remember, U for Understand, Ap for Apply, An for Analyze, E for Evaluate and C for Create.

As we said occasionally a CO may have to be tagged by two cognitive levels. And what happens as there is no sharp demarcation between cognitive levels. There is always a possibility one action verb representing two different cognitive levels. For example, one action verb namely "identify" is associated with both Understand as well as Analyze. Perfectly acceptable in both the cognitive levels.

So what happens is the teacher should use his or her own judgment in such cases to tag the CO with appropriate cognitive level.

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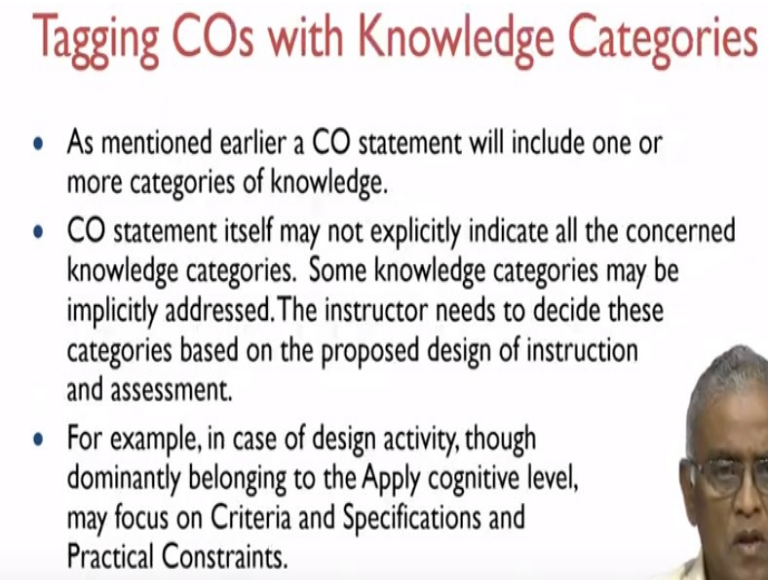

Now coming to the knowledge categories, every CO statement will include one or more categories of knowledge. Now what are these categories of knowledge? We can use the acronyms F for Factual, C for Conceptual, P for Procedural, M for Metacognitive and correspondingly a engineering knowledge categories if you want to look at the Fundamental Design Principles the FDP you can say.

And then Criteria and Specifications C and S and for Practical Constraints you can use PC and Design Instrumentalities you can use DI, okay? You can use these acronyms to tag the CO with knowledge categories. Now what happens this statement may or may not explicitly indicate all the concerned knowledge categories. Some knowledge categories may be implicitly addressed.

The instructor needs to decide these categories based on the proposed design of instruction and assessment. For example, let us say you want to ask, you expect the student one of the CO is design a filter in analog electronics you want to write a design in analog filter. So broadly it belongs to the Apply cognitive level and you have Conceptual and Procedural part is anyway implied directly. But we may also focus on Criteria and Specifications and Practical Constraints.

We may or may not write this as a part of the CO statement. But if only you should include them, you should tag with these two knowledge categories provided that you are actually implementing or you are actually conducting your instruction paying attention to these two categories and also your assessment instruments do reflect these two. That means there could be a quiz or a question that involves Criteria and Specifications or Practical Constraints.

So the summarizing this particular one the CO statement may or may not directly indicate all the concerned knowledge categories. This should be understood very clearly by the teacher when he is writing the CO statement and all the knowledge categories actually he wants to address.

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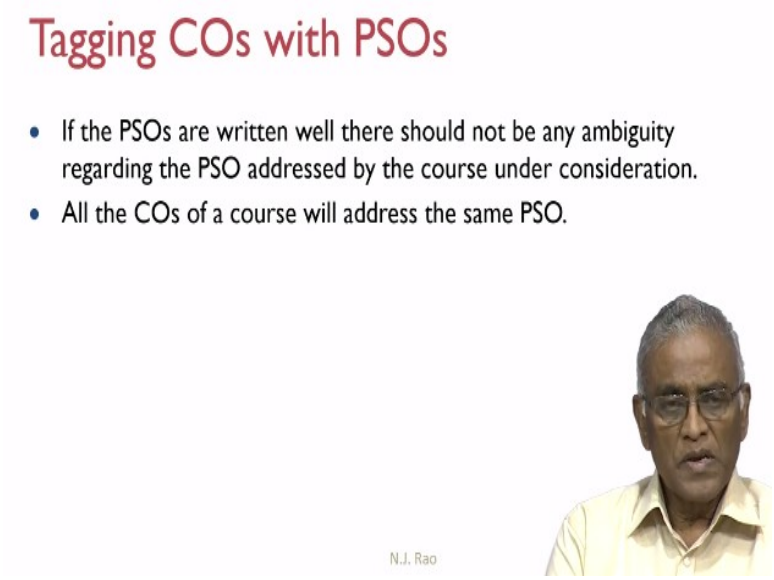

Now coming to the PSO, this is relatively easy when normally PSOs are written to represent various features of a, what do you call various streams of specialization in a given branch of engineering. Like if you take Mechanical Engineering, broadly there are 3 streams. You have Manufacturing, Design and then Thermal Engineering. Now what can happen? One can write 3 PSOs, each PSO representing one of the streams.

And occasionally you may write 2 PSOs for a given stream. So what happens whenever you look at; whenever you have a course, it is very clear which PSO it is addressing, the entire. So all the COs of the course will address the same PSO. That should make sense and it should be easier to identify which PSO it addresses.

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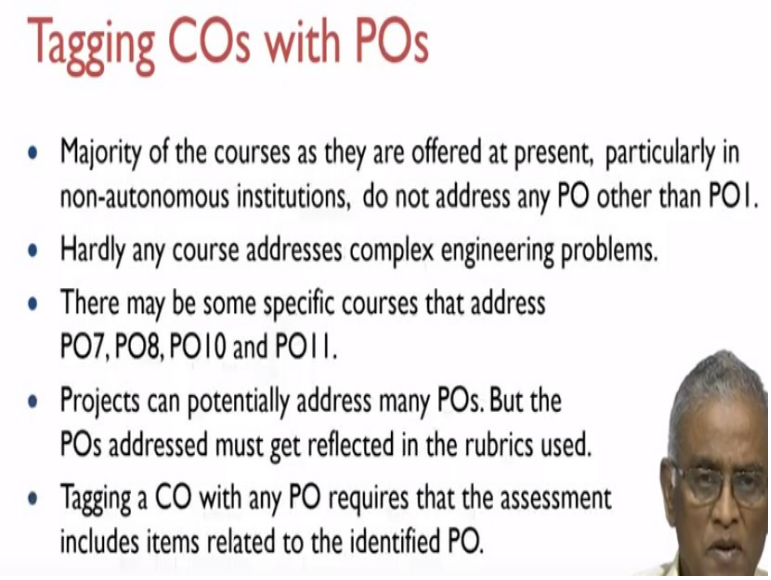

Now come, the a little more difficult and critical part namely tagging the COs with POs. Majority of the courses as they are offered at present particularly non-autonomous institutions do not address any PO other than PO1. Strictly if you go by, what/how do we decide that? For example if you look at the examination paper it would be very clear the, all the questions only address PO1. And on top of that even in PO1 we are not addressing Complex Engineering Problems.

So we just have to accept saying that presently the way the curricular designed or defined we do not look at Complex Engineering Problems other than at the level of projects. So already we are not addressing the full PO1 in the courses. And you may have some courses that address specific POs like PO7, PO8, PO10 and PO11. For example PO11 is related to project management and finance. So there may be a course exclusively for project management.

In that case that course obviously will address PO 11. But if there is no such course, the PO level only gets addressed possibly very indirectly. Then PO10 is related to communication. Yes, all programs have at least one course in English Communication whatever name they give but PO10 is directly addressed by that course.

But PO10 can also be addressed through other courses if you have some activity where you expect students to directly address this PO and do some activity and you also evaluate the student

performance with respect to the communication skills. If you are not evaluating the student for his communication skills then you are not addressing PO10 at all. For example PO8 is related to ethics. Some programs have a course on Professional Ethics.

In that case you are directly addressing and very rarely any other course directly or indirectly addresses this. And similarly PO7 is related to Environment and Sustainability. As per the UGC requirement most of the programs do have a course on, some course on environment or sustainability. In that case you are directly addressing PO7 through that particular course. But once again any other course, all other courses most of the times do not address these four let us say these outcomes.

Coming to the projects, projects can potentially address many POs. You can practically, if you want you can make them address all the 12 POs in that. But provided they do get reflected in the rubrics you use for evaluating the student performance. For example in project groups generally 3, 4 students form a group to do the project. In that case they have to learn how to work in a team and they have to write a comprehensive report.

So communication can be addressed and then depending on how you are putting constraints on or orchestrating the project the other POs can connect. But the main thing is unless you have used rubrics to evaluate or include rubrics that evaluates specific POs you cannot tag a course with that PO or the project with that PO. So essentially tagging a CO with its PO requires that the assessment includes items related to the identified PO.

So what can happen is if whatever you have written as CO addressing a wide range of POs then if I take the Assessment Instrument which happens to be the main instrument happens to be End Semester Examination. A quick evaluation of the End Semester Exam paper will tell us whether the designated POs are addressed or not.

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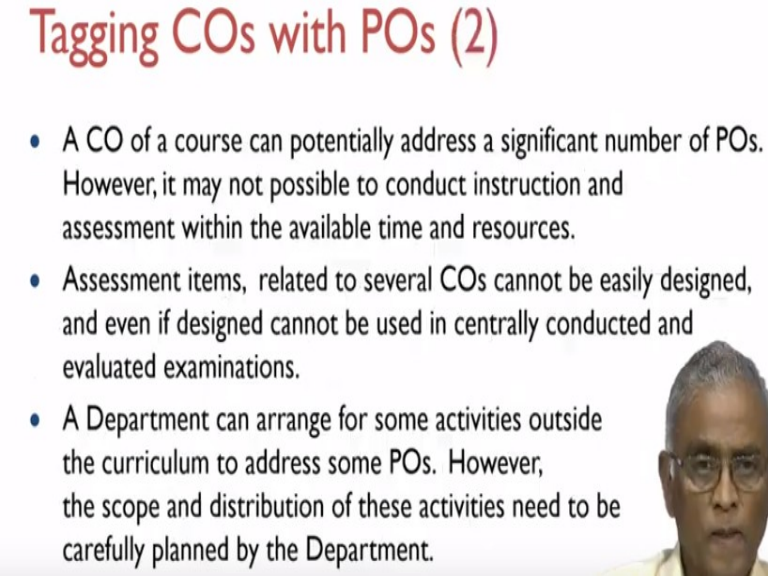

Further a CO of a course can potentially address a significant number of POs. out of the 12, I can write in such a way, I just want to address 6, 7 POs in that. But it may not be possible to conduct instruction and assessment within the available time and resources. Even if you want to you may not have adequate time in the semester or adequate number of sessions available to you to instruct in the course addressing all the selected POs.

And also sometimes assessments related to several CO cannot be easily designed. And even if designed cannot be used in a centrally conducted and evaluated examination. You may write a CO very well addressing a wide range of POs but then our End Semester Examination which is centrally controlled by the university may not want to, may not include items related to those POs. Generally because of the numbers involved, the students are expected to write a kind of a standard answer for that.

So in such a case it is difficult to include all the POs. but if you still want your students to address some of the POs then a department can arrange some activities outside the curriculum to address some of the POs because they are required. The familiarity or attainment of those POs is required from the placement perspective. But how do you organize, in which semester you organize, along with what course you organize, this requires considerable planning by the department.

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Kinematics of Machines - Credits: 3:1:0

	Course Outcome	POs/ PSOs	CL	KC	Class Sessions	Tutorial (Hrs)
CO1	Illustrate the terminology of mechanisms	PO1/ PSO1	U	F	03	01
CO2	Identify the degrees of freedom and motion characteristics of planar mechanisms.	PO1/ PSO1	U	C, P	05	01
CO3	Predict the motion of planar mechanisms graphically and mathematically.	PO1/ PSO1	Ap	C, P	08	02
CO4	Determine the friction losses in bearings, and power transmitted in belt drives	PO1/ PSO2	Ap	P, FDP	08	02
CO5	Draw the profile of the cam for a desired follower motion.	PO1/ PSO1	Ap	P, C & S	07	03
CO6	Describe the characteristics of motion in gears with involute profile	PO1/ PSO1	U	C	04	01
CO7	Calculate the velocity ratio or number of teeth for an epicyclic gear train drive.	PO1/ PSO1	Ap	P	03	02
Total Hours of instruction					38	12

Now let us look at some examples. As you can see this particular course, kinematics of machines, it is a 3:1:0 that means you have 3 lecture hours per week and 1 tutorial session per week. So that is how the hours are organized. While it adds up to 38, generally most of the courses have anywhere from 40 to 45 class sessions for a 3:1:0 course. So the numbers here do not exactly match but this is one sample as created by some faculty members.

Now, here if you look at there are 7 in this and coming to POs and PSOs is only including PO1. And PSO1 for all the COs it is only this. It is very clear the way the subject is dealt with only one PO is addressed.

Coming to cognitive level for example this is U. Illustrate the terminology of mechanism that is related to Understand and Factual Knowledge and there are about 3 classroom sessions and 1 tutorial session.

And coming here, identify the degrees of freedom and motion characteristics of planar mechanisms, the cognitive level is still U. That means identify verb, here is associated with Understand and you have Conceptual, Procedural Knowledge Categories. And there are 5 sessions and 1 tutorial session. Anyway coming to another one, determine the friction losses in bearings and power transmitted in belt drives.

So determine means it is Apply and it is a Procedural Knowledge and here this faculty member wants to address Fundamental Design Principles as well as one of the knowledge categories. As you can see it does not directly get reflected in the statement. FDP does not directly get reflected in the statement. It has to get reflected only in the instruction or assessment that he uses.

And here draw the profile of the cam for a desired follower motion. Now this is Apply alright. And here Procedural and Criteria and Specifications are also addressed. Possibly he is talking about criteria and specifications of the CAM that he is supposed to design. So as you can see this is how a course finally is designed and it is presented in a tabular column giving the course outcomes number then actual course outcome statements and then POs and PSO is addressed. Cognitive level, knowledge categories, classroom sessions and because in this case you have tutorial sessions you also represent number of hours that are used.

So this describes when you are discussing with a colleague or another faculty member who is, or with an industry or with any stakeholder this is the best way to communicate to what your course is, through course outcome statements and also identifying all the with all the tags.

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Fluid Mechanics - Credits: 4:0:0

	Course Outcome	POs/ PSOs	CL	KC	Class Sessions
CO1	Understand the fundamentals of fluid mechanics and fluids	PO1, PSO1	U	C	6
CO2	Determine the basic equation to find the force on submerged surfaces	PO1, PSO1	Ap	C, P	9
CO3	Calculate the center of buoyancy of floating body, and the, velocity and acceleration of a fluid	PO1, PSO1	Ap	C	12
CO4	Calculate flow parameters using fluid flow meters and using dimension analysis to predict flow phenomena, viscous effects using Hagen Poiseille's equation	PO1, PSO1	Ap	C, P	12
CO5	Calculate functional losses through pipes and to calculate the drag and life, displacement, momentum and energy thickness	PO1, PSO1	Ap	C, P	15
Total Hours of instruction					54

Let us look at another example. This is fluid mechanics. Credits 4:0:0 and that means the number of lectures that you will have - you have anywhere from 55 to 60 almost you can have for a 4 credit course. There is no laboratory, there is no tutorial. And there are only 5 statements that are

written. That means each course outcome is very very somewhat big in scope. So what happens is you have to again hierarchically further detail how do you conduct these 12 sessions.

As you can see it is simply stated. Again, once again PO1 and PSO1. Nothing else is included and then cognitive level is identified and none of the engineering category knowledge are identified but as you can see the way it is written you have large number of class sessions associated with some of the COs.

Is this the best way to write this? That the concerned teachers who are familiar with the subject matter and dealing with that subject matter at that particular level should discuss with each other and try to come with best possible set of course outcome statements. We will look at one more example.

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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

Analog circuits and systems. A 3:0:1 that means lab is associated with that and you have something like 40 lectures and 28 hours of lab and here if you look at there is an attempt to include other POs. For example take this, understand the characteristics of linear one-port and two-port signal processing network. PO1 is fine PSO1 is fine but PO10 is related to communication.

That means I am willing to that is when you write like this, the teacher is willing to have some assessments. It could be part of the classroom activity or it could be an assessment where I am willing to give some credit and some marks towards communication whatever percentage it is. If I do not give marks specifically for communication, I do not have right to write PO10 there, okay? It is the same story everywhere.

For example when you come here, design this VCVS, CCVS and so on voltage and SMPS voltage regulators we are now talking a PO3, PO4, PO5 and these are PO3 is related to conducting investigations about complex problems. PO4 is related to, sorry PO4 is conducting complex investigations. PO3 is design; as we included design that is natural.

PO5 is related to modern tool usage where we use possibly simulation for designing this using one of the software packages for that. And this is where we are also talking about Conceptual Knowledge, Procedural Knowledge, Criteria and Specifications and even Practical Constraints. So this is slightly ambitious in terms of addressing other engineering knowledge categories and also trying to explore how to address the other POs.

Designing this course will require lot of effort on the part of a teacher to make sure that you are addressing all these POs.

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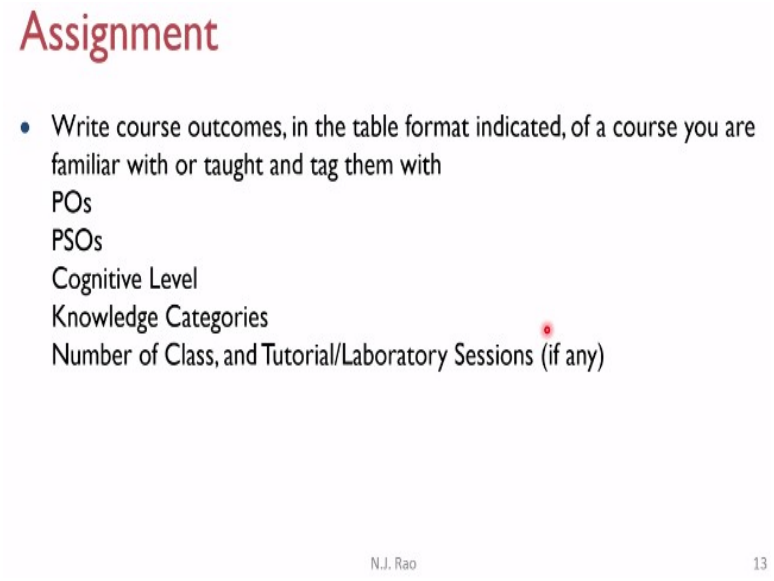

Now the assignment for this course, this unit is write course outcomes in the table format indicated of a course you are familiar with or taught and tag them with POs, PSOs, cognitive level, knowledge categories and the number of class or tutorial/laboratory sessions if there are any. That means you have already written course outcomes earlier through other units. Continue that activity and tag them with these elements. That will be your assignment.

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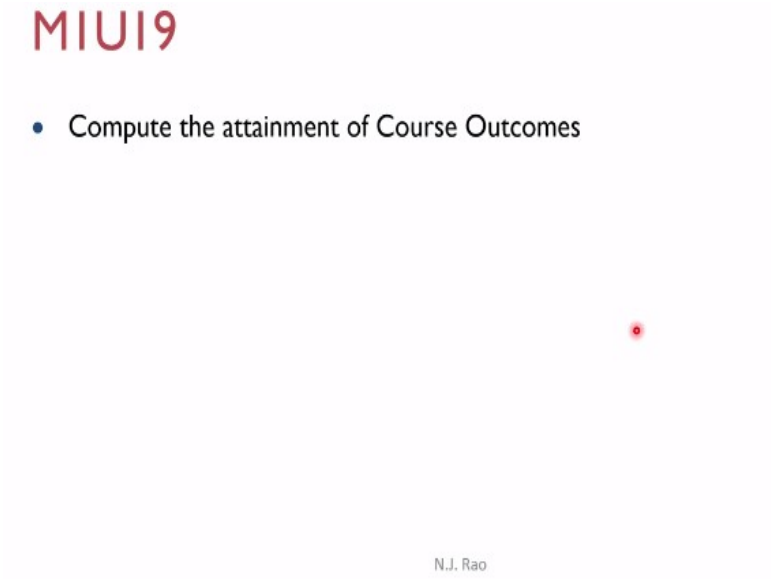

And in the next unit, we will try to compute the attainment of course outcomes. We need some mechanism of making sure that we are retaining the course outcomes. How to do that we will give a particular procedure though there is nothing like a standard procedure that is required to be followed. And the criteria that are required to have a good procedure we will state in the next unit. Thank you very much.