Teaching and Learning in Engineering (TALE)
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Lecture - 16
Course Outcomes 1

Greetings and welcome to Unit 16 of the Module 1. This unit is related to writing Course Outcomes. We will have two unit of this.

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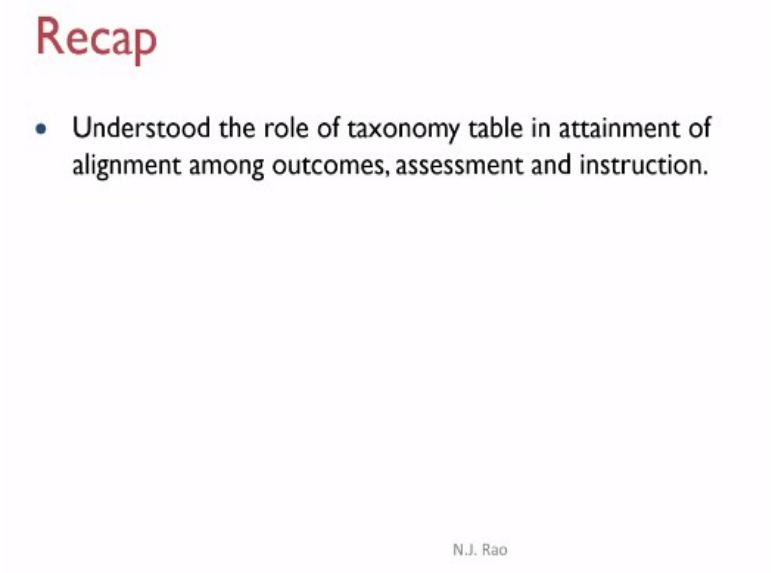

In the earlier unit we tried to understand the role of taxonomy table in attainment of alignment among Outcomes, Assessment, and Instruction. Taxonomy table really does not tell you how to write Course Outcomes but having written Course Outcomes it will kind of, it provide a framework for looking at the issues of alignment, tutoring and so on.

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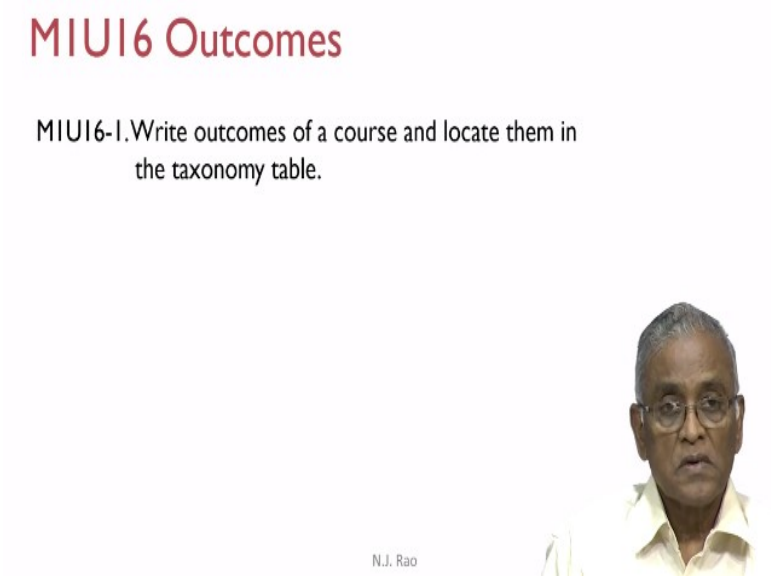

Now the present unit, M1U16, the main outcome is write outcomes of a course and locate them in the taxonomy table. It is like writing outcomes for a course. This is the point or this is the main goal of the Module 1, how to write outcomes in the context of Outcome Based Education.

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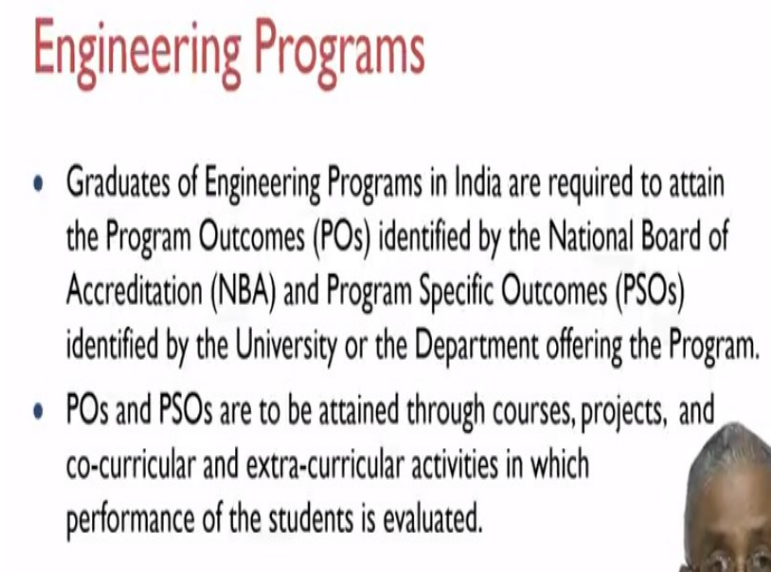

Engineering programs if you look at, the graduates of engineering programs in India are required to attain a set of Program Outcomes identified by National Board of Accreditation. And Program Specific Outcomes identified by the university or the department offering the program. That is in the case of autonomous institution it is the department and its board of studies will decide whereas in non-autonomous institution it is the Board of Studies of the university identify the Program Specific Outcomes.

POs and PSOs as we call them are to be attained through courses, projects, and co-curricular and extra-curricular activities in which performance of the student is evaluated. Now POs and PSOs are to be attained by the program. How do you attain them? The only activities that are available to us are courses, projects, and sometimes co-curricular and extra-curricular activities.

They are there but you can only include them formally in trying to compute the attainment of POs and PSOs if they are properly, the performance of the students is properly evaluated. If it is not evaluated and only students participate in some extracurricular activities that we cannot claim to be directly contributing to the attainment of POs and PSOs.

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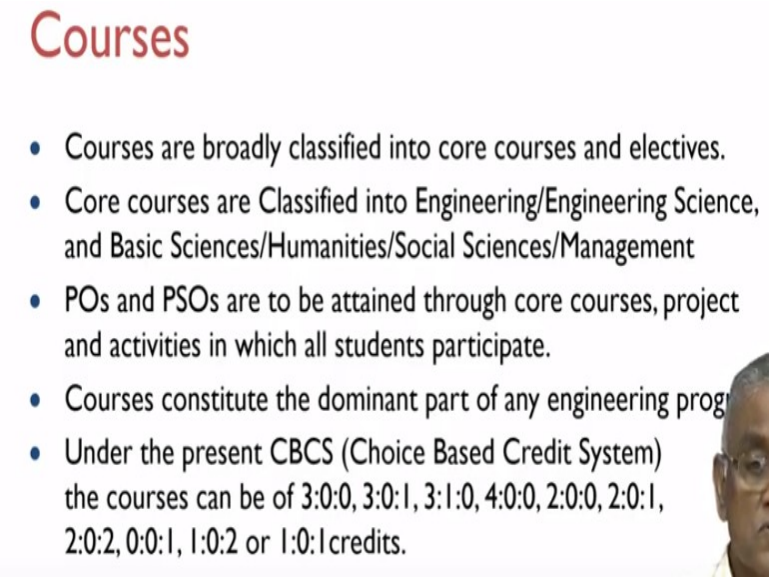

Now, courses that you have are broadly classified into core courses and electives. You can say broadly courses are maybe electives you further subdivide as open electives and professional electives and so on but they are electives. Core courses are classified into broadly two categories. One is engineering or engineering science courses. The other ones are basic sciences, humanities, social sciences, and management.

The second category of courses can come under any of these four classes. And POs and PSOs are to be attained through core courses project and activities in which all students participate. This is a very important aspect when you talk about even writing course outcomes that is POs and PSOs

their attainment needs to be computed only through core courses and projects and activities in which all students participate in the sense these are related to what every student participates.

The main issue of elective is same elective may not be taken by all the students of the program. So you cannot count that and many places, many colleges and faculty feel a little disappointed with this because electives do constitute anywhere from 18 to 24 credits of a program. In such a case why are we not including them in computing the attainment of POs and PSOs?

Once again it should be seen that we are not trying to, the general feeling is that you are losing marks because I am doing my electives well and they are not getting counted in the accreditation process. So it should not be seen like that. This is only whatever you do under electives is over and above what you call the NBA accreditation process. So NBA accreditation process should be seen as looking at the minimum requirement of a program, not the maximum requirement.

Courses constitute the dominant part of any engineering program as you can see. Because out of 170, let us assume today 170 to 175 credits is the credit load of a program in which something like up to almost up to 150 credits will be through courses or maybe a little less let us say about 140 credits will be courses, formal courses that is these courses at present are offered now in multiple formats like it could 3:0:0, 3 corresponds to the number of lectures per week.

Second digit corresponds to the hours per week for tutorial. The third digit corresponds to number of laboratory sessions per week. Normally laboratory session is considered to be 2 hours. So 2 hours of laboratory constitutes 1 credit. We do not use numbers like 1.5 credit saying that I am doing it for 3 hours. So you have to do it for 2 hours or 4 hours. In that case it will become 2 credit, 2 credits of laboratory.

So you have variety of formats available especially the autonomous colleges can take a great advantage of this like you can have 3:0:1. That is 3 lecture hours and 1 laboratory session per week. Or 3:1:0 or 4:0:0. You can have 2:0:0, 2:0:1. The smaller number of credit courses can be mainly used to cover the breadth of the, for example if you want someone to be want to be familiar with certain aspect you do not have to give a full-fledged 3 credit course.

You can also have 1 credit course if you want. So you have 2:0:2, 0:0:1; that is quite common where laboratory is a standalone course or you have 1:0:2 or even 1:0:1 credits. So you have a wide range of courses and when you write course outcomes it should, if there is a laboratory integrated into that the course outcomes should reflect the laboratory activity as well.

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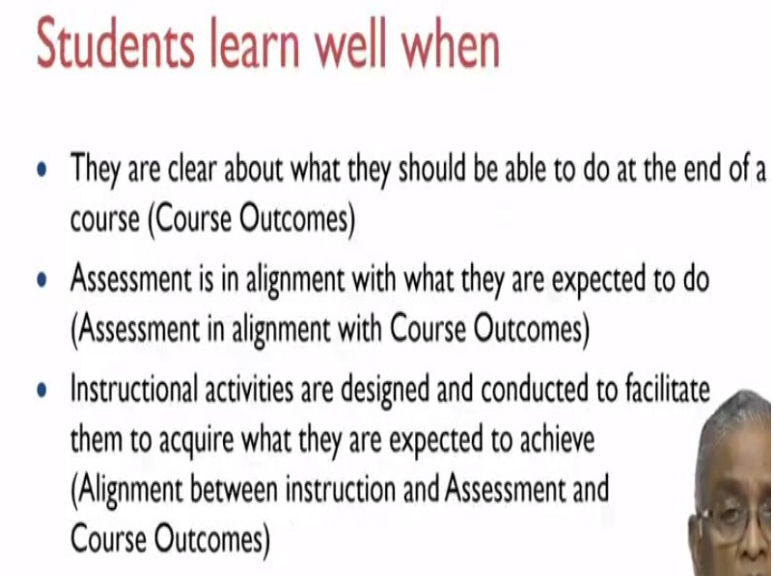

Now, we have stated this earlier. Students learn well when they are clear about what they should be able to do at the end of a course. That means that is stated. What they should be able to do at the end of a course is stated in terms of course outcomes. That is where it comes. Assessment is an alignment with what they are expected to do. That is assessment in alignment with the course outcomes.

This we have explained in the previous unit saying that alignment is interpreted as the assessment being in the same cell of the taxonomy table as the course outcome. That is perfect alignment. If it is one cognitive level lower than the cognitive level of the course outcome it is acceptable but less alignment. Similarly, instructional activities are designed and conducted to facilitate them to acquire what they are expected to achieve.

That means alignment between instruction and assessment and course outcomes that is what it means. So students learn well when you have good course outcomes that you are very clear

about what the students should be able to do and when assessment and instruction are in alignment with the, our course outcomes, okay? That is what the role of course outcomes and the alignment through what we call as a taxonomy table.

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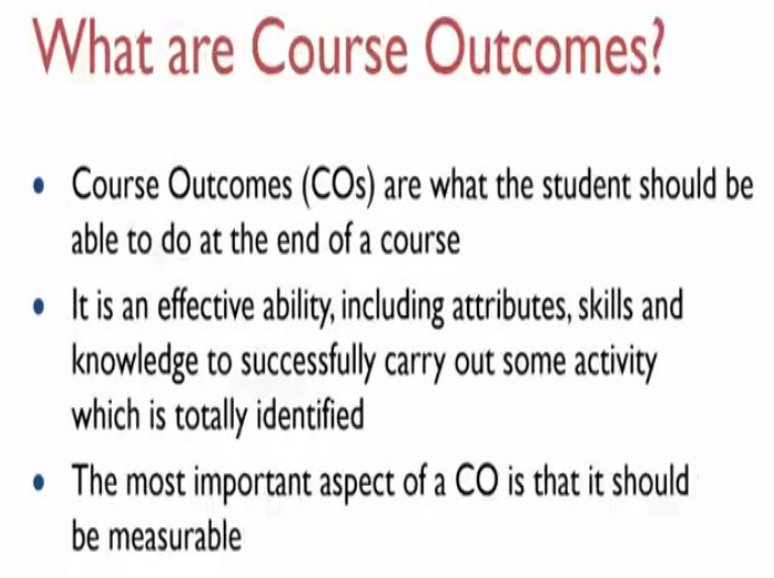

Now we formally come to what are course outcomes. Course outcomes are what the student should be able to do at the end of a course. We have said it several times. In another words it is an affective ability including attributes, skills and knowledge. And this is where you are even including attributes, which statement of these attributes may come under what you call as the affective domain as well.

It is an affective ability to successfully carry out some activity which is totally identified. The most important aspect of CO is, it should be measurable. I cannot write a vague statement giving a vague intent and it has to be very clear and when a student performs something I should be, when I look at a course outcome it should be measurable, okay? We will see plenty of examples where things are not measurable, where things are measurable.

Measurability is one major or most important aspect of a CO statement and this requires certain amount of practice because what we observed many teachers kind of because of their old their habits may slip into a statement. Their intention is okay but when it is presented that intention is

not very clearly is not clear from the way the statement is written. Okay, this is a major aspect and it comes only with the practice.

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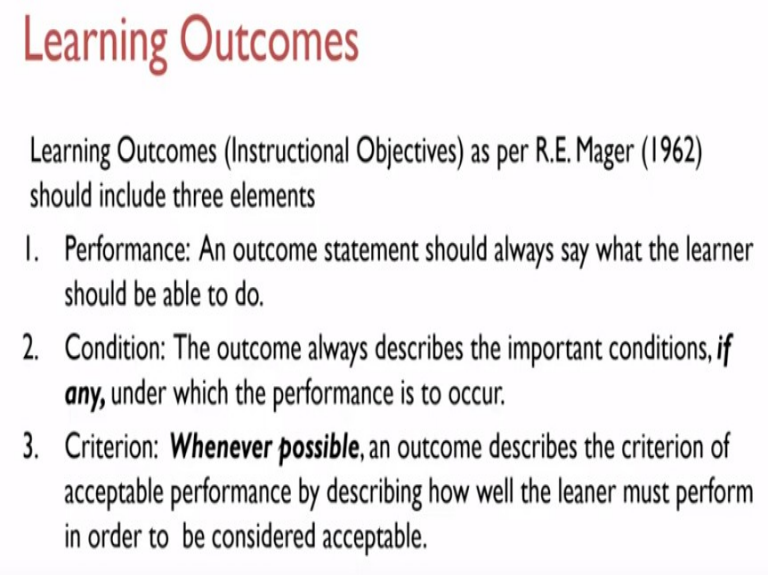

Now learning outcomes is not or what we call today we are calling it course outcomes at engineering programs but broadly the word learning outcomes and instructional objectives are the words that are being that have been used in the literature related to education for more than 50 years or 60 years. As you can see as per Mager 1962 where his first book came; they already gave a mechanism of defining how to write a learning outcome or he called it instructional objective.

Both mean the same. Now there are 3 elements in Mager style of writing. One is, first one is performance. The outcome statement should always say what the learner should be able to do. So it is as good as saying that write an outcome statement. Because it is not saying very much except that it should be related to what the student should be able to do. Then come the condition.

The outcome describes the important conditions if any under which the performance is to occur. You have to, the student should be able to do something under some conditions. Like for example using a certain procedure you should solve the problem. That means the procedure the

student is expected to use is the condition or the condition could be the, perform or determine some value of some variable using a particular piece of equipment.

Or you solve a problem or simulate something using a pre-specified software. So pre-specified software or the stated equipment or a procedure, they become conditions. And here Mager himself has identified say if any. If there is a condition then only, then you need to include. If there is no condition, the second part of the outcome statement is optional. Similarly criterion.

Again, whenever possible an outcome describes the criterion of acceptable performance by describing how well the learner must perform in order to be considered acceptable. So criterion of acceptance that can in some courses like music or sports there can be where the criteria are very clear. In some cases it is, in many cases actually in engineering programs they become optional except where the laboratory experiment has to be performed and where you have to obtain results to with certain accuracy.

That requirement of accuracy becomes the criterion. And once again the statement is qualified by whenever possible. So what happens, condition and criterion they are optional elements if they do not exist. The only part as per Mager that stays is performance. So somehow when you merely say performance it is like another word for learning outcome, okay?

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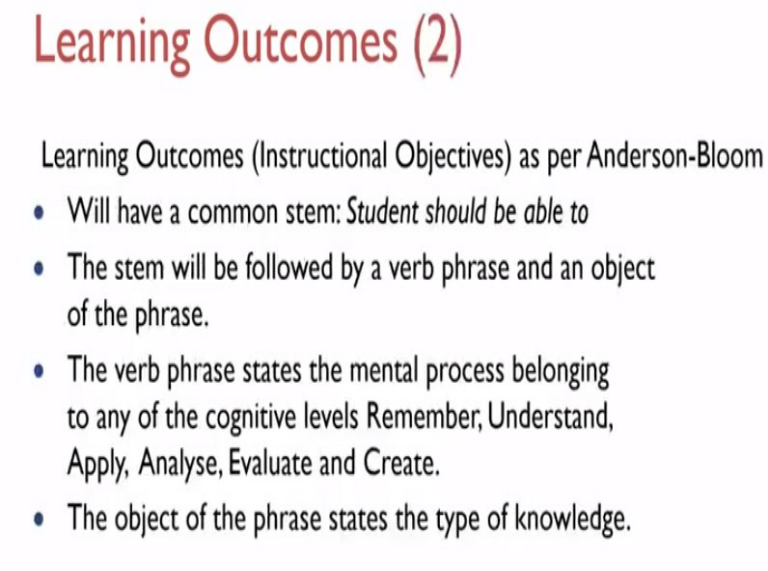

Now comes as per Anderson-Bloom they provided 3 aspects. They say any course outcome or any learning outcome you will have a common stem: “Student should be able to”. Actually you do not have to write that stem in front of every course outcome statement. Student should be able to if you write at the top and write below the course outcomes that should be adequate. One can combinedly read any outcome which student should be able to do something.

Okay, this stem will be followed by a verb phrase and an object of the phrase. So those are the words used. Verb phrase states the mental process belonging to any of the cognitive levels namely Remember, Understand, Apply, Analyze, Evaluate, and Create. We have already seen in the taxonomy that the six cognitive levels or six cognitive process they can be identified by a set of action verbs.

Some action verbs you may find them common between two because sometimes it is very difficult to draw a let us say a sharp line between Understand and Analyze. Sometimes it is difficult. So we may find some words which are common across one or more maybe two of the cognitive levels. And the third part the object of the phrase states the type of knowledge. Anderson and Bloom will only identify four general categories of knowledge.

So the third part of the course outcome as per Anderson and Bloom, learning outcome as per Anderson and Bloom will have a verb phrase and the type of knowledge.

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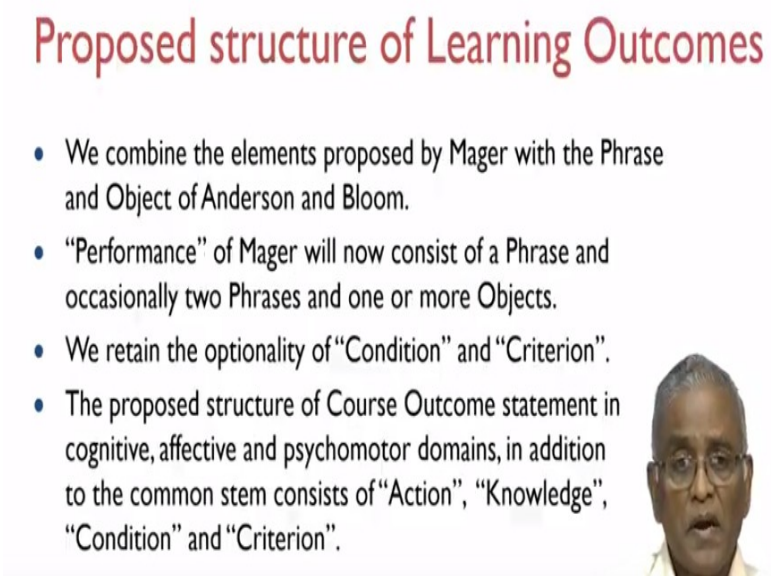

So we are combining these two Mager style and the phrase and object of Anderson-Bloom into our present, we are proposing a structure for the learning outcomes. We retain the optionality of condition and criterion. So in some cases you have, so we retain that optionality. The other one is the proposed structure statement in, it can be in Cognitive, Affective, or Psychomotor Domains. It consists of Action, Knowledge, Condition, and Criterion.

There are four elements of the proposed structure of which two are optional.

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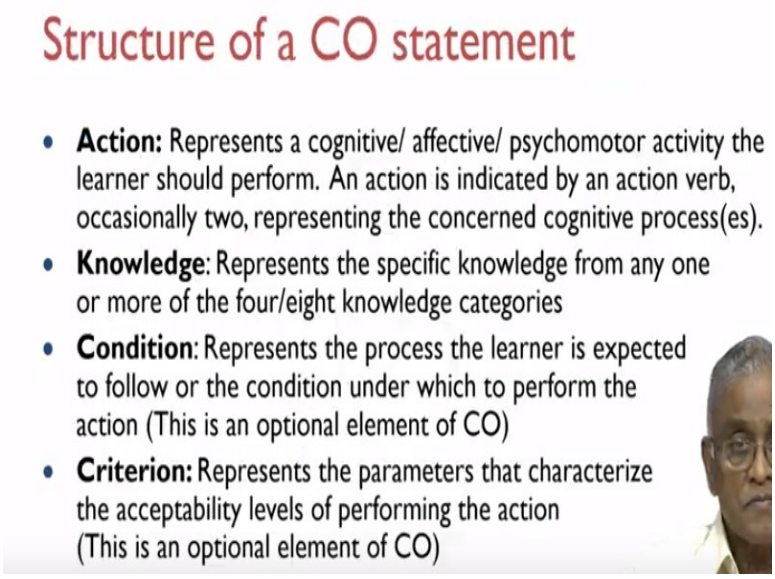

Let us take a look at structure of a CO statement. Action represents Cognitive, Affective, Psychomotor activity the learner should perform. An action is indicated by an action verb,

occasionally two, representing the concerned cognitive process or processes, okay? So this is what it is and we will not be looking at Affective and Psychomotor activity. But there are action verbs also identified with Affective and Psychomotor domains as we presented earlier.

But our focus is right now on cognitive activity. Then knowledge represents the specific knowledge from any one or more of the 4 or 8 knowledge categories. If it is general categories, we are having 4. Whereas if it is engineering we are adding additional 4 and it becomes 8 categories of knowledge. One or more actually you can take from the, these 8 knowledge categories.

Condition represents the process the learner is expected to follow or the condition under which to perform the action. This is an optional element of a CO statement. Criterion represents the parameters that characterize the acceptability levels of performing the action. This is also an optional element. This is what you have. Again to reiterate the CO statement can have four elements out of which two are compulsory and two are optional.

The compulsory elements are action and knowledge and optional elements are condition and criteria.

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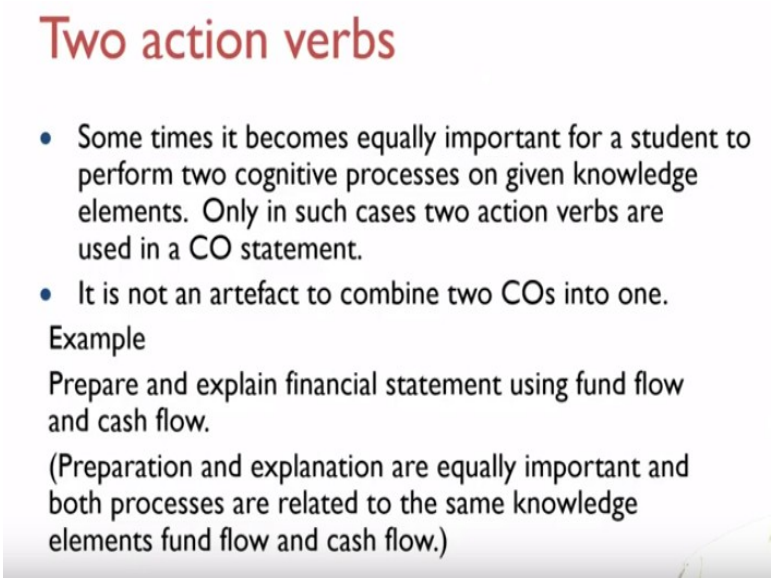

Now there has been a bit of controversy (if you) around the world when you look at the, these are written. In some cases they used multiple action verbs, sometimes two and dominantly one. So our current position is the need for using more than one action verb is not that very common. If you write something well, one action verb can take care of most of the situations. Occasionally you will have a situation where two action verbs are required.

And (where do we) it should not be used as a matter of routine to combine two outcomes into one. Let us say you are required to write six outcomes for a course and you are not able to write. You are coming with two statements. You cannot combine them and write it as use two action verbs and write a single sentence. So it should not be used as an artefact to combine two COs into one. Now let us take an example. "Prepare and explain financial statement using fund flow and cash flow", okay?

Now what happens, there are two aspects in this. The financial statement, the condition is using fund flow and cash flow. The knowledge element is financial statement. Now a student is required to prepare a financial statement from the data provided. That is also necessary outcome; that needs to be attained and then having written that you want to explain the performance of the organization through the financial statement.

So both are equally important and they are related to the same object, same knowledge, okay? And preparation and explanation are equally important and both the processes are related to the same knowledge elements namely actually you should write financial statement using fund flow and cash flow, okay? So please treat using of two action verbs as an exception rather than as a matter of routine.

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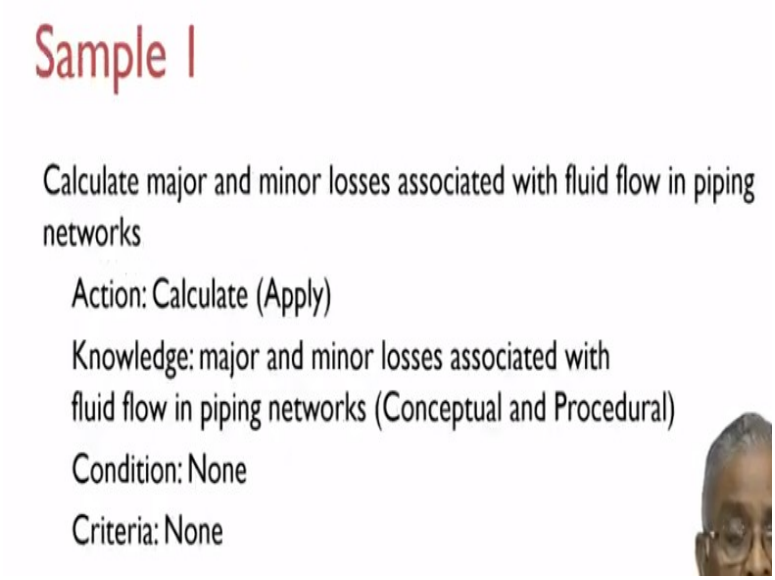

Sample. Calculate major and minor losses associated with fluid flow in piping networks. That is a CO statement. If you look at the elements in this, action is related to calculate. It belongs to the cognitive process Apply. And knowledge is major and minor losses associated with fluid flow in piping networks. Here you are computing, so there is procedural knowledge and there are concepts in that. So it is both conceptual and procedural knowledge and we have not put any conditions. We have not put any criteria.

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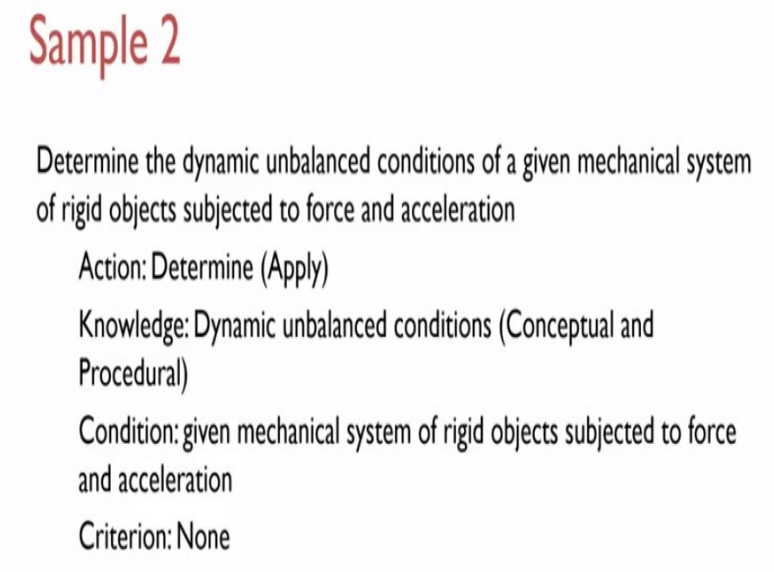

Another sample, determine the dynamic unbalanced conditions of a given mechanical system of rigid objects subjected to force and acceleration. Now action is “determine”. That is still apply. Knowledge is dynamic unbalanced conditions. Determine dynamic unbalanced conditions is the

main issue - Conceptual and procedural. The condition is given mechanical system of rigid objects subjected to force and acceleration. And there is no criterion, okay?

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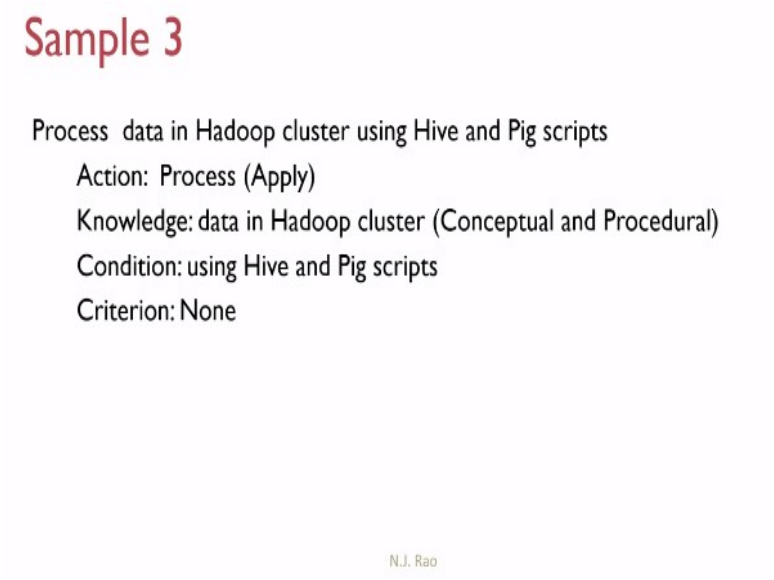

Third sample, process data in Hadoop cluster using Hive and Pig scripts. Action is a process which belongs to, you are processing the data, doing something with that data; so it is Apply. Knowledge is data in Hadoop cluster. So that is conceptual and procedural. And you are supposed to use Hive and Pig scripts. That is the condition. And criterion is none.

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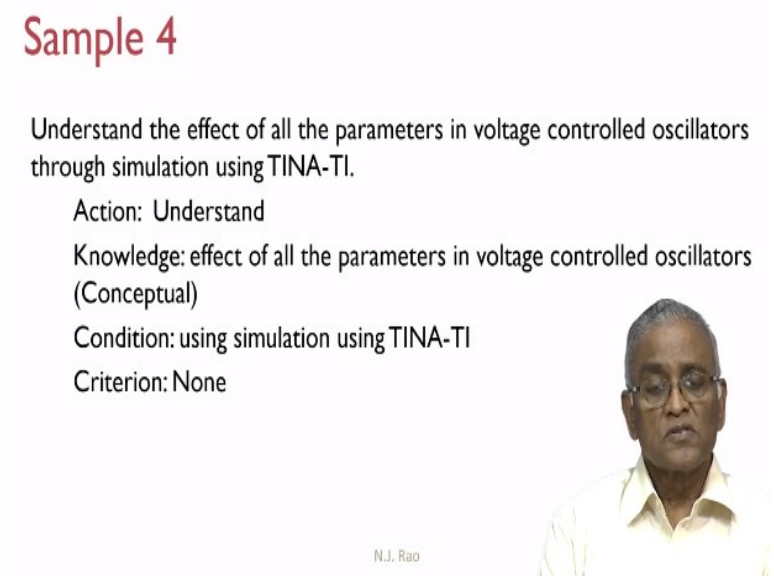

Another sample, understand the effect of all parameters in voltage controlled oscillators through simulation using TINA-TI, okay? Now action is Understand as the action verb itself says. And

knowledge is effect of all parameters in voltage controlled oscillators. Voltage controlled oscillator is a feedback network. So to that extent the main tool of studying such and that to a nonlinear circuit is simulation.

And you should use that simulation using TINA-TI which is a software package meant for simulating analog circuits. So that is sample 4. These four samples give, present you some features of course outcome statements but there is lot more which we will explore in the later unit.

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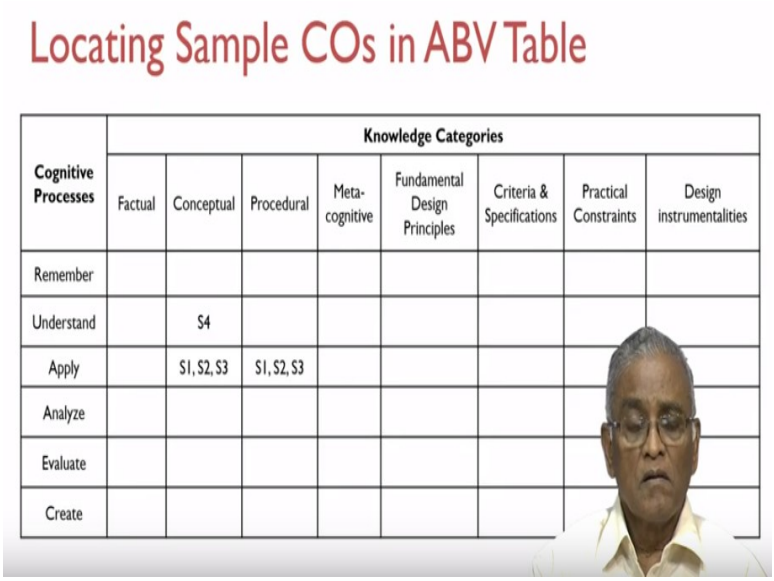

Now having written, we have to locate these COs in the ABV table. ABV we are calling it Anderson-Bloom-Vincenti taxonomy table. Now as you can see, there are two knowledge categories that we are dealing with. So the samples will come under two categories here; S1, S2, S3. Three samples are located in (Apply) Conceptual, Apply and Procedural. Whereas the sample 4 comes under Understand and Conceptual, okay? That is what, that is how you locate the COs in taxonomy table.

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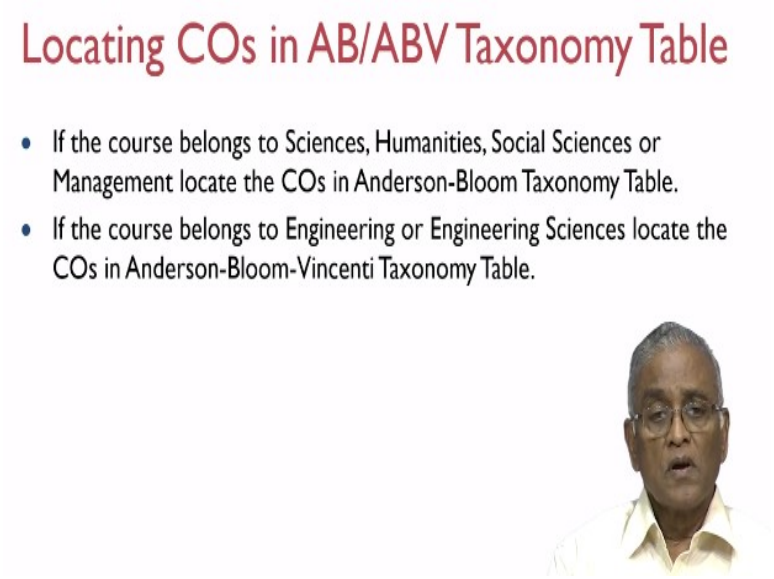

Now, how do you locate them? If the course belongs to sciences, humanities, social sciences or management locate COs in Anderson-Bloom taxonomy table that is 6 by 4 table. Whereas in courses belonging to engineering and engineering sciences locate the COs in ABV taxonomy table which has 6 by 8 table. That is the difference.

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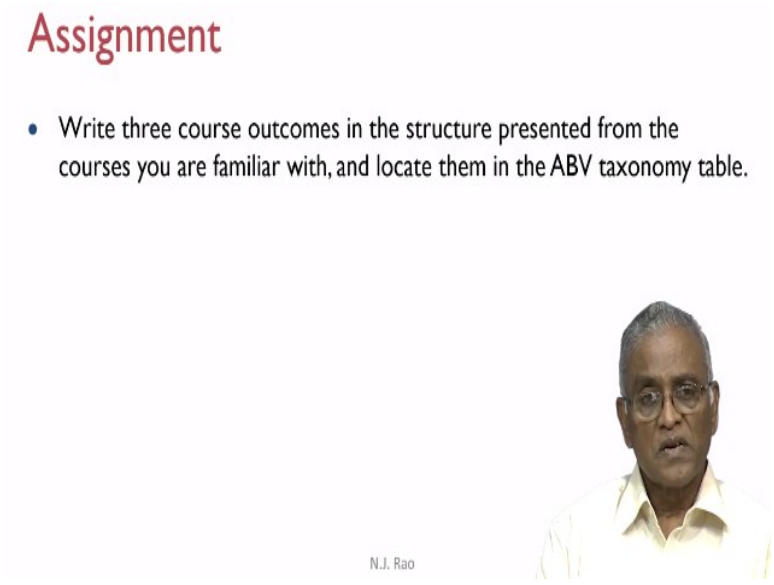

Now, based on the current understanding, though we are going to look at many more features of course outcomes, based on the present understanding of the CO or course outcome, write three course outcomes in the structure presented from the courses you are familiar with and locate them in ABV taxonomy table. As majority of you are engineering teachers, you pick the a course

or two you are familiar with or taught already and try to write three course outcomes as such. But the additional features of course outcomes we will explore in the next module, next unit actually.

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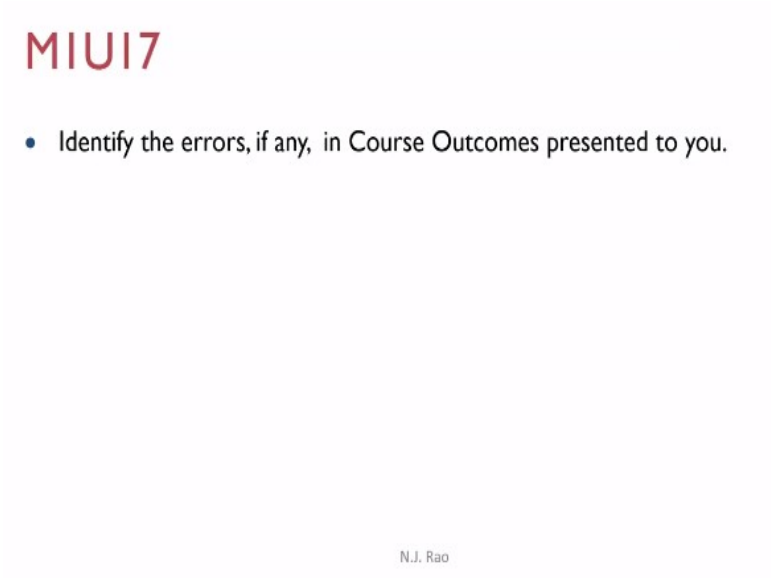

So the next unit will, the dominant aspect of it is identifying the errors if any in course outcomes presented to you because in writing course outcomes you are required to follow several operate errors specified conditions, most important one being measurability. Thank you very much for your attention.