Teaching and Learning in Engineering (TALE)
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Lecture - 08
Program Outcomes 2

Greetings and welcome to the Module 1 and Unit 8. This unit is related to the Program Outcomes again like the earlier unit.

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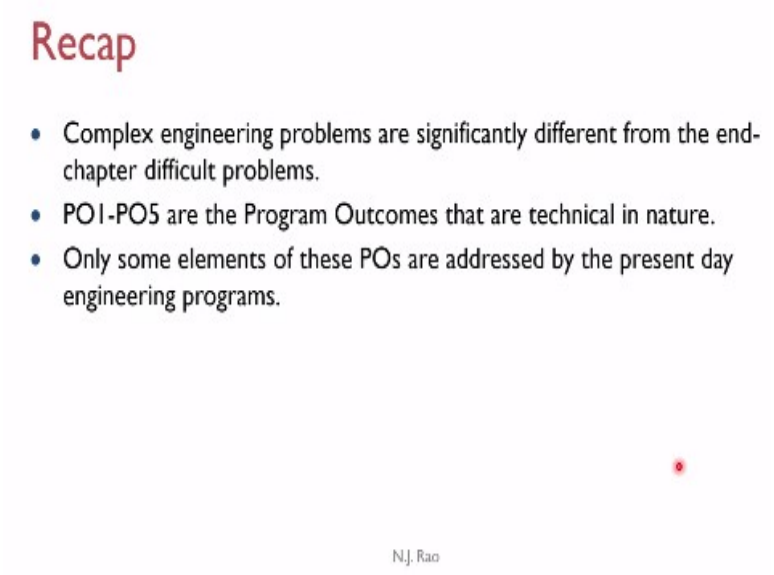

And in the earlier unit we looked at what is the nature of complex engineering problems and we noted that they are significantly different from the end chapter difficult problems because problems can be simple and difficult but a difficult problem does not become a complex engineering problem. That is one thing as an instructor one has to remember that. And out of the 12 Program Outcomes identified by NBA, the first 5 are dominantly technical in nature.

And that is why we grouped them as the first 5 into one group, technical in nature. And even in this technical outcomes, we further noted that only some elements of these POs are addressed by the present day engineering programs. It might not be intentional but it somehow over the period the entire system has adjusted itself to kind of ignore many dominant elements of even these 5 POs. So that is what we noted in the previous module, previous unit in fact.

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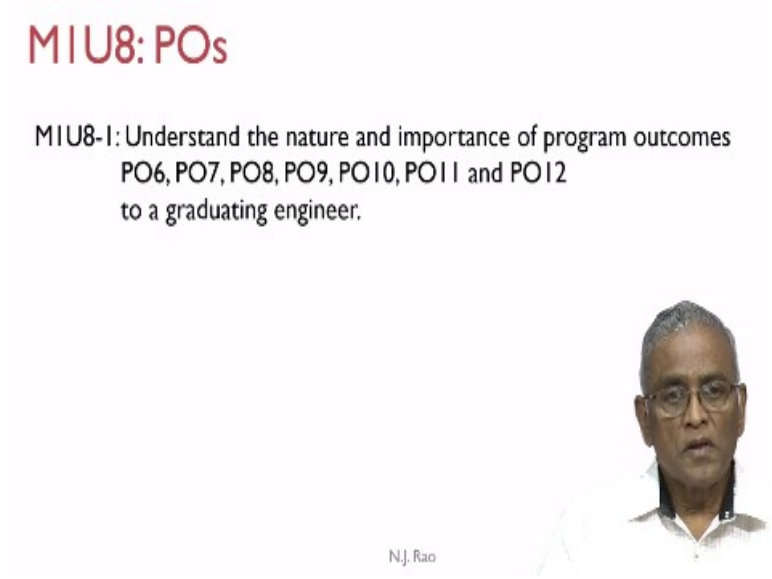

Now the present unit, the outcome is to understand the nature and importance of program outcomes starting from PO6 to PO12 in what way they are relevant to a graduating engineer. That is the goal of this particular unit.

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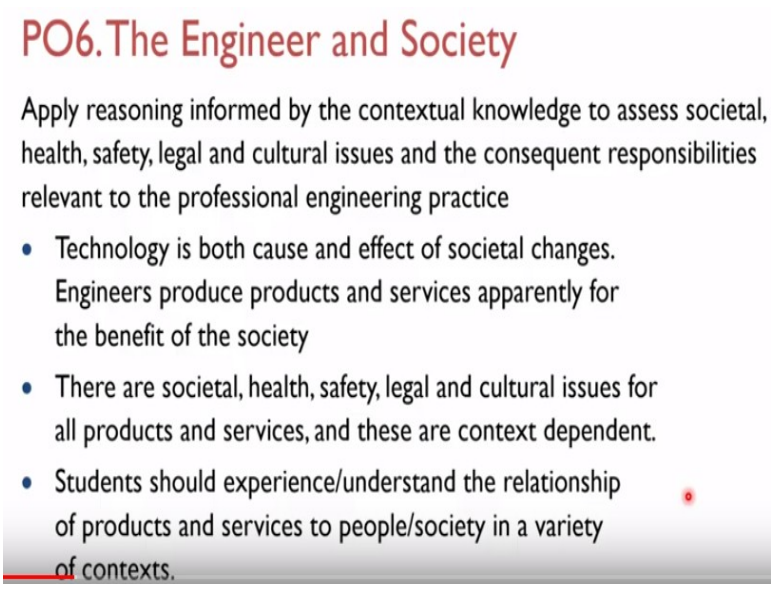

Now, PO6 is labeled as Engineer and Society. The statement says apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and consequent responsibilities relevant to the professional engineering practice. There are several elements into this. If you look at contextual knowledge, what does it mean we need to understand.

And we have other elements like societal health, safety, legal and cultural issues and the responsibilities are to the professional engineering practice. So there are several keywords in this. Now why is it relevant to the engineering student? If you note, technology is both cause and effect of societal changes. That means a technology can cause a societal change and a societal change can encourage or bring new technology into existence.

And the persons who bring technology into societal use are engineers. Engineers produce products and services apparently for the benefit of the society. And with every product you have all the issues namely societal, health, safety, legal and cultural issues. For all products and services and on top of that they are context dependent. They are not universal. And to that extent when to apply, when they become important an engineer needs to understand, because they are context dependent.

So, the students need to experience or understand the relationship of products and services to people, society in a variety of contexts. In the case of electronics you can see earlier radio was a dominant thing. Subsequently TV was a dominant thing. Now a cellphone is a dominant thing. And if you look at one can trace the, what do you call the cause and effect relationship, interchangeable relationship between let us say cellphone and society. And that is what an engineer needs to at least feel sensitized to that.

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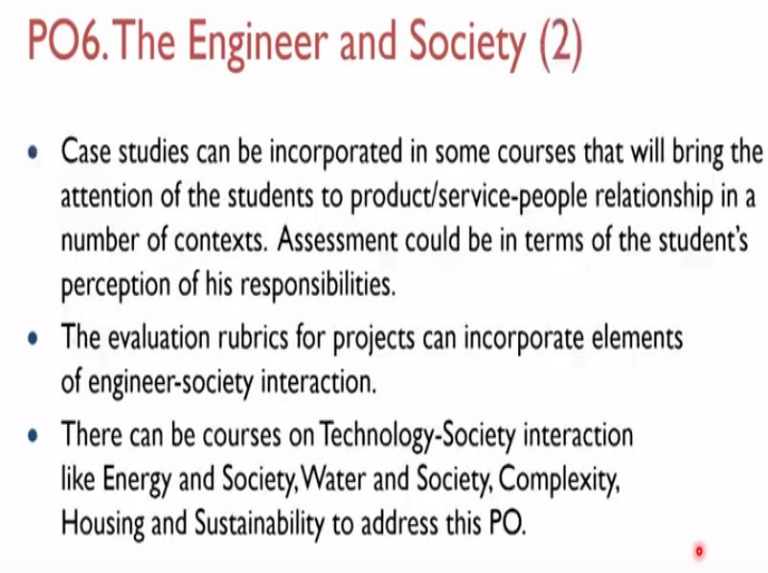

Further the how can we even address this? One of the ways is case studies can be incorporated in some courses that will bring the attention of students to products-service-people relationship in a number of contexts. And assessment could be in terms of the student's perception of his responsibilities. Because it is easy to present the case study but how do you know that he has been sensitized, so you have to design assessment that could be in terms of student's perception of his responsibility.

The evaluation rubrics for projects can incorporate elements of engineer-society interaction. If you do not incorporate evaluation rubrics you can be sure that this engineer society interaction would not be addressed through the project and there can be courses on technology society interaction.

And again it brings it back to curriculum design and who will design these courses and who will offer these courses is a fairly difficult issue to address. Some courses like energy and society, water and society or merely complexity, housing, sustainability are some examples that can address this particular PO.

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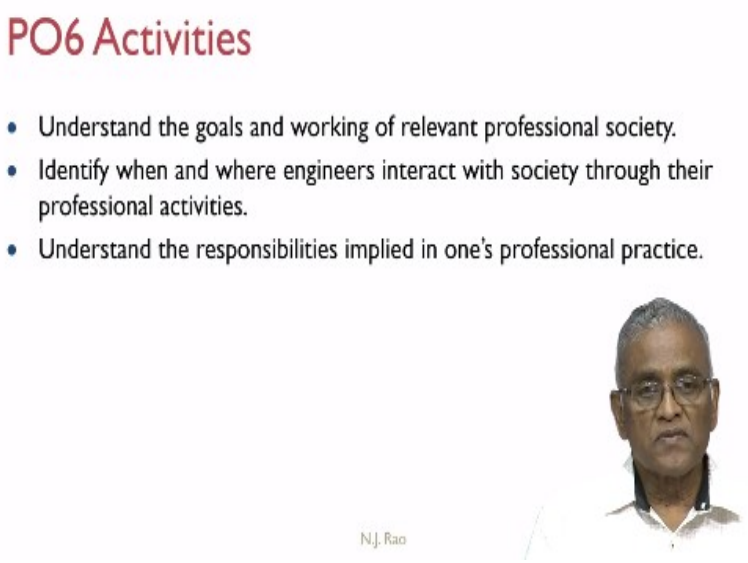

And the specific activities by which PO6 can be addressed: understand the goals and working of relevant professional society because their professional society can generally talks about the professional and ethical manner in which the practitioner will have to practice at least if you are

familiar with the goals and working of relevant professional society one can understand some dimensions of this PO.

Identify when and where engineers interact with society through their professional activities. You can give a particular example and ask them, ask the students to do an exercise of this nature. Understand the responsibilities implied by one's professional practice. These are some activities. One can come with many more activities that will address some elements of this PO6.

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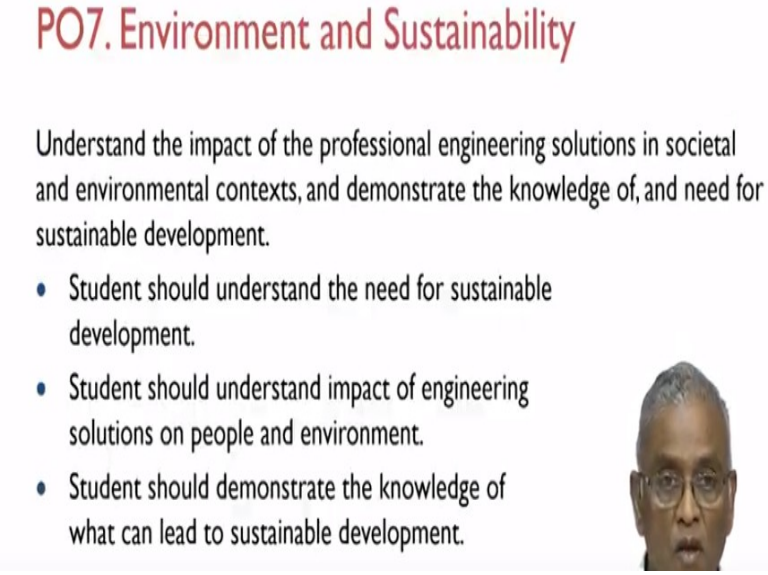

Now coming to PO7, this is a little more easily understandable; particularly at present. Environment and sustainability. Understand the impact of professional engineering solutions in societal and environmental contexts and demonstrate the knowledge of, and the need for sustainable development. So the keywords are environment and sustainability. In some sense both are related to each other.

But still student should understand the need for sustainable development first. In a world that this is a fast growing population with resources being limited, so the current way of living and current way of doing business is not sustainable as it is being repeatedly stated by so many people. But are we sensitized to that? Which can have some impact on what we are doing both in our profession as well as in our life.

And student should understand the impact of engineering solutions on people and environment. Both are required. Student should demonstrate the knowledge of what can lead to sustainable development. These are the elements. For example, around these three requirements one can build some activities.

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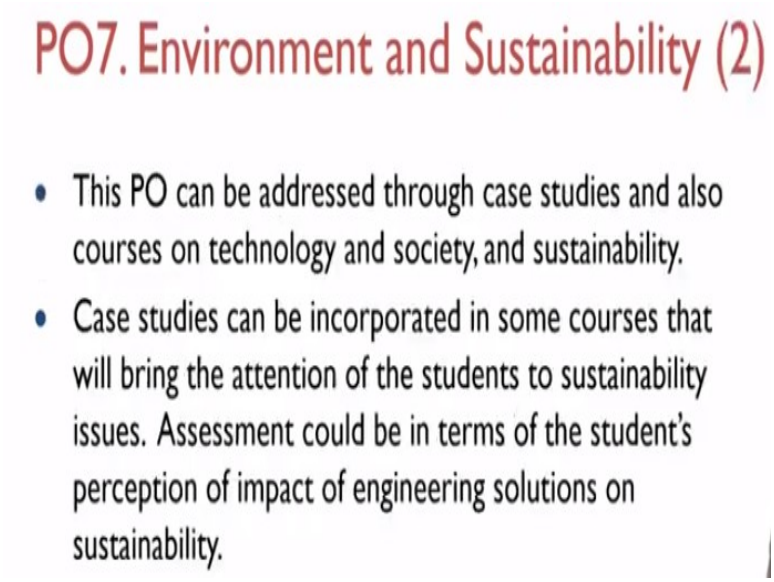

So this PO can be addressed through once again case studies. Also courses on technology and society and there can be course on sustainability. Case studies can be incorporated in some courses that will bring the attention of the students to sustainability issues. Assessment could be in the form of student's perception of impact of engineering solutions on sustainability.

So like the earlier PO, here also through case studies you can present the case study and ask the student to do what do you call ask his perception of the impact of engineering solutions on sustainability.

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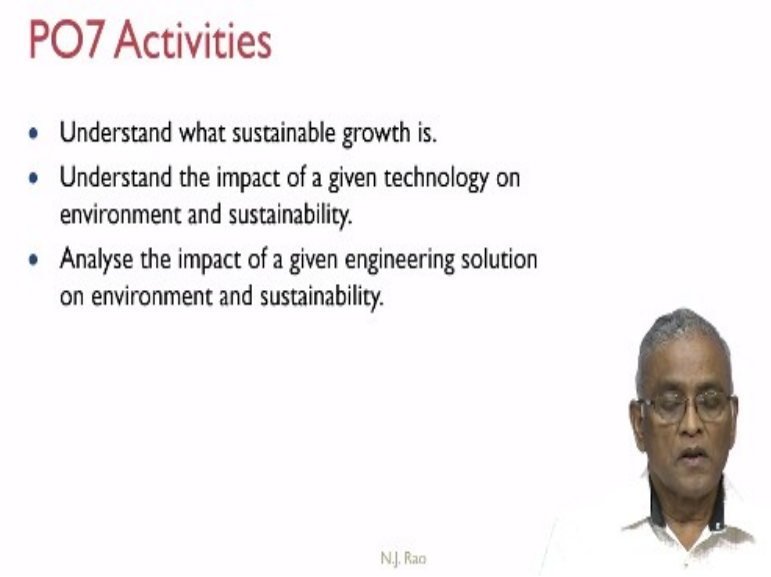

Now what are type of activities you can do? Understand what sustainable growth is. Understand the impact of a given technology on environment and sustainability. Analyze the impact of a given engineering solution on environment and sustainability. One can talk about either bigger ones or smaller engineering solutions we can talk about and then and then talk about their impact on environment and sustainability.

This can be, that kind of exercises can be irritating to an young student when they are talking about the impact on environment and sustainability. But that is the way one can sensitize.

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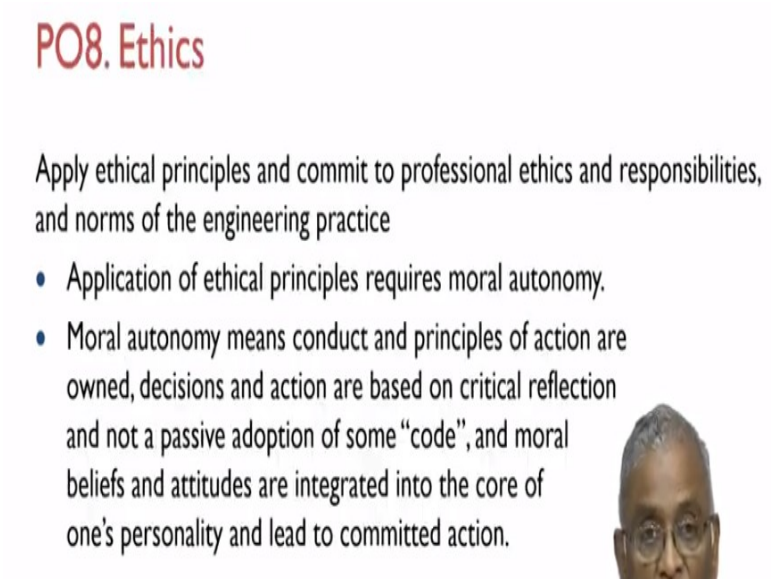

Now, the PO8 is related to Ethics. As you see the PO6 also talks about Ethics and PO8 is exclusively on Ethics. What is the PO statement? Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice. Well, it comes to ethics, it will always looks like sermonizing. But in real world, if you want to apply ethical principles, if you want someone to really be able to apply ethical principles it requires what we call moral autonomy. What is moral autonomy?

It means the conduct and principles of action are owned by the individual. That it is not responsibility of somebody else. We cannot wave our hands and say it is a system, the company that I am working for and so on. But the fact that you are working in a certain place and you are taking some actions, you have to own them. That is what we call moral autonomy. That means decisions and action are based on critical reflection and not a passive adoption of some code.

And moral beliefs and attitudes are integrated into the core of one's personality and lead to committed action. This is a tall order we agree, and that too in a present day complex society but at least one should make an attempt to inspect, to introspect on one's own believes and attitudes and see whether it can be incorporated into one's own personality. That is, this is the way I wish to behave. This is the kind of jobs that I would like to, I wish to work on.

I am sure you will have plenty of examples in the society and many times lots of interesting reports are published in the newspapers where people have taken such considered stand and they change their careers to work like that.

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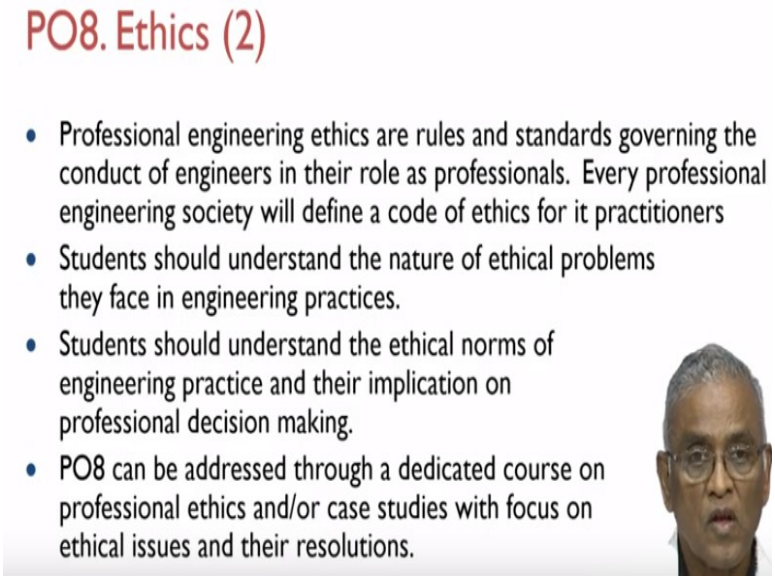

Now, what are Professional Engineering Ethics? They are rules and standards governing the conduct of engineers in their role as professionals. Every professional engineering society will define a code of ethics for its practitioners. Students should understand the nature of ethical problems they face in engineering practices. This can be given as some kind of case study.

Students should understand the ethical norms of engineering practice and their implication and professional decision making. When do you under what conditions do you agree to work as per the customer's requirements. PO8 can be, this particular PO can be addressed through a dedicated course on professional ethics. Some colleges already offer such a course, professional ethics and or case studies with focus on ethical issues and their resolutions into in some courses, relevant courses.

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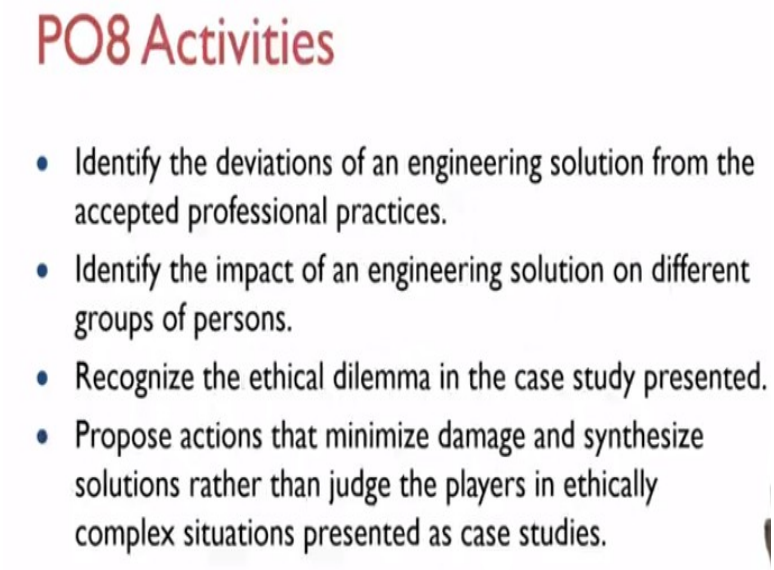

Now what are the type of activities that you can plan? Identify the deviations of an engineering solution from the accepted professional practice. That is one can inspect for example you can look at the recent Kerala floods and the kind of final engineering solution that is produced was against the report of the concerned committees and one can see the amount of for example the impact of the deviations from of implemented solution to the suggested solution. One can look at that.

Identify the impact of an engineering solution on different groups of persons. Once again, Kerala floods or floods in Karnataka do provide excellent examples where the impact of a particular engineering solution is different on different groups of persons because of economic conditions or particular societies the way they are operating. Recognize the ethical dilemma in a case study presented.

So the ethical dilemma is always development versus sustainability. It is always the dilemma would be there and there may not be very clear answers. Case studies and discussions are the best examples. Propose actions that minimize damage and synthesize solutions rather than judge the players in ethically complex situations presented as case studies.

So if a particular, this dilemma that exist between development and sustainability the students can participate in a debate and see whether they can come with a solution that creates the best

compromise between the two requirements. These are possibilities. These are the activities that can be built into the program. But of course that requires the curriculum redesigned.

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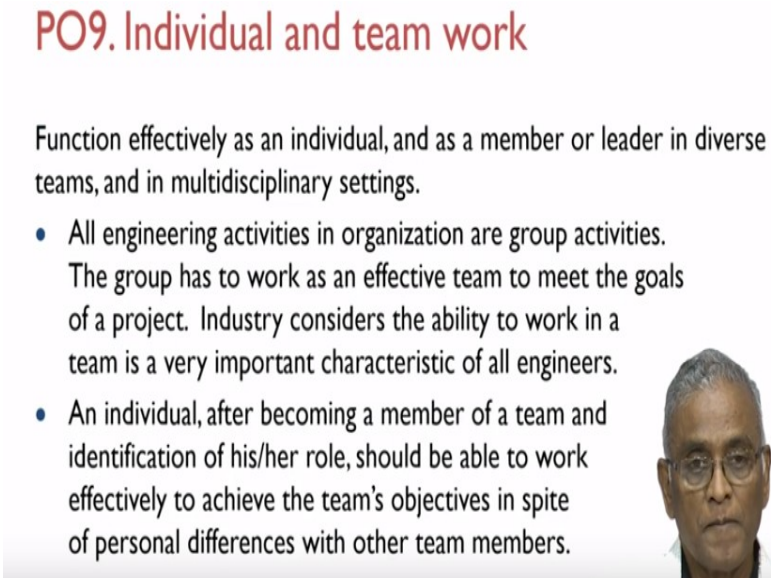

Now come PO9. This is where these days at least fairly easy to understand individual and team work. What is the statement? Function effectively as an individual and as a member or leader in diverse teams and in multidisciplinary settings. First thing is as we said all engineering activities are group activities when you work in an organization. To that extent sometimes depending on a particular activity you are a member of a team or sometimes you are a leader of a small team.

So both ways you have to work effectively. And then these activities may change from time to time. So you are working in diverse teams. But the second part while in an organization, generally by and large it will be a multidisciplinary activity, any product or system that you look at. But to create such multidisciplinary settings in a within a 4-year undergraduate program can be difficult but it can be attempted.

It is possible to do so but provided all the concern people do believe that is an important feature of undergraduate engineering program. Now an individual after becoming a member of a team and his role is identified, his or her role are identified, he should be able to, what does it mean ability to work in a team? Is having a identified role, he should be able to work effectively to achieve the team's objectives in spite of personal differences with the other team members.

That is the one of the toughest things to do and some people learn and those who learn fast will move up in the ladder. Those who refuse, say always the fault lies with the other person, they will pay a heavy price for that, okay? Industry considers this particular ability to work in a team as one of the very very important characteristic of an engineer.

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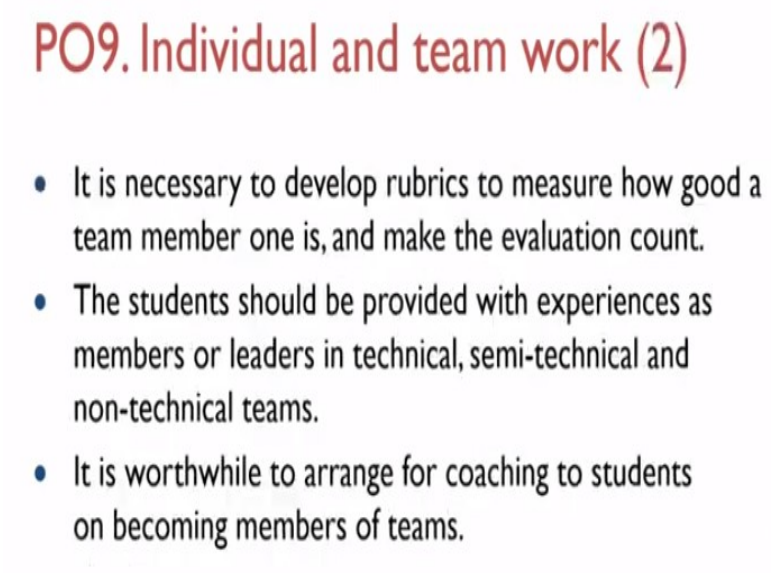

And but how do we measure the individual's ability to work in a team? It is necessary to develop rubrics to measure how good a team member one is and make the evaluation count. Evaluation count means what? Once you have a rubric for that the marks that he gain should finally get added to the grade that he gets in that course in which such an exercise is included.

You cannot just merely announce that we will measure, he is a good team member, not so good team member and forget about this the grade has nothing to do with this ability. Then only all the students will take it seriously. Student should be provided with experiences as members or leaders in technical, semi-technical and non-technical teams. And many times semi-technical and non-technical teams do happen in undergraduate program like professional societies or outside extracurricular activities and festivals.

Whenever they are organized it is always by a team of people. But only a selected, some interested people only will participate where all students are not likely to get these experiences.

So a department should plan activities in which every student will somehow find part of such teams during the 4 years' period. It is worthwhile to arrange for coaching to students on becoming members of teams.

Such coaching is available because the HR people of various organizations are equipped for coaching people to be effective team members. Such coaching can be organized for all the students.

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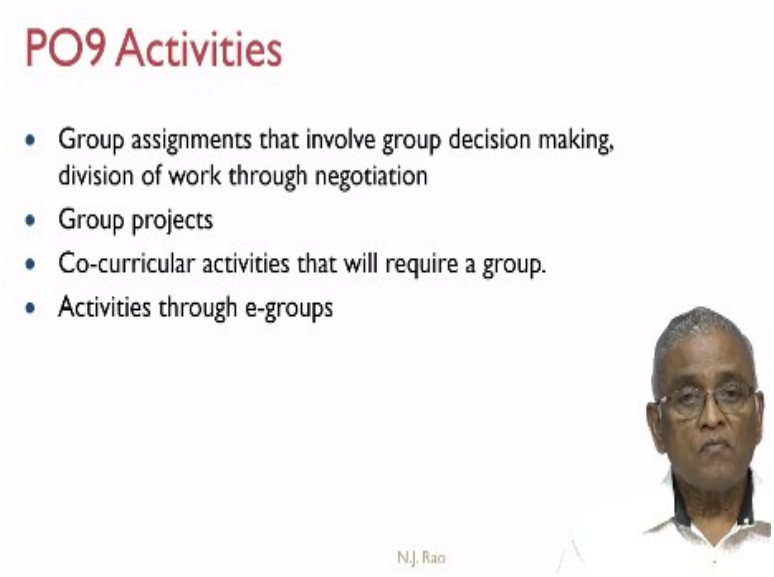

What are the activities? Group assignments that involve group decision making, division of work through negotiations. This can be, group assignment could be strictly technical and yet they have to work as a team. Group projects which is slightly bigger than group assignments which will require maybe equivalent of one man month or two man month activity. Co-curricular activities that will require a group. Activities through e-groups.

This is a new dimension that has been coming of late where groups are formed over the internet. They are not operating face to face. The present day engineers will have to learn to work with people who are not on day to day basis you are not meeting across the table and you are only interacting over the internet.

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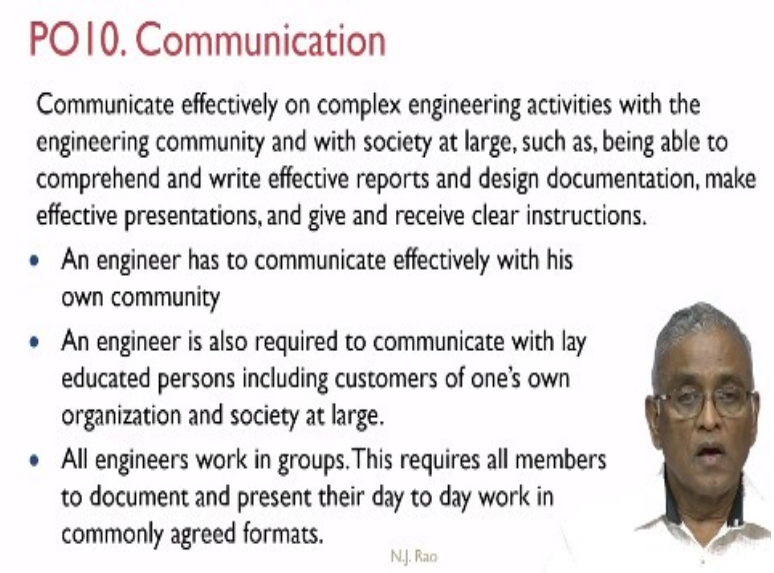

Now, PO 10 is Communication. Once again like the earlier PO9, ability to work in a team, communication is also considered very very crucial by industry, is a very essential skill. Communicate effectively on complex engineering activities with the engineering community and with society at large such as being able to comprehend and write effective reports and design documentation, make effective presentations and give and receive clear instructions.

As you can see it is very, it is written in a great detail. There are several things in this. That is you should be able to communicate effective with engineering community. That means the language that you use to communicate is known to the other person. A group of, in a project if you are working as a group, then the language the acronyms that you use for communicating they are known to all the persons in the group. That is communicating with peers.

And also sometime you have to communicate with society at large. Society at large would mean people who do not speak your technical language in the same acronym, same way. It could be a customer or it could be a group of public persons who are literate alright but they do not know this specific technical language. One should be able to communicate to them what exactly your group is doing. These are the two.

That is communicating with your peers and communicating with society at large. And on top of that you should be able to write effective reports. Whatever you do you need to write, you should

be able to write technical reports or reports which are also include design documentations and make effective presentations. That is you should not only write reports and design documentation and make effective presentations to again your customers or within your own group.

For example if you are asked to make a 5-minute presentation every week to the group what exactly that you have done during that week, you should be able to make the corresponding technical presentation. These days it is mainly through PowerPoint presentations. And they should be simple and very clear. And then further you should be able to give and receive clear instructions. This is somehow as Indians, I find that we do not have this particular skill.

We do not clearly give instructions nor receive clear instructions. Receive clear instructions means somehow Indians seem to be operating in a menu card mode. That is a menu card is given and then you pick what you want. So same way, instructions are given and you implement what you like within that. That is not the way engineer need to work, okay? So there are several dimensions to this, to this PO.

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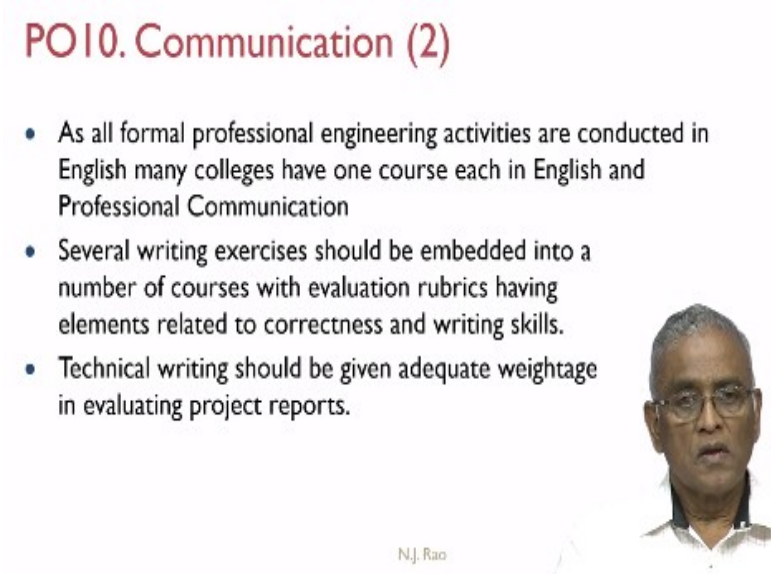

And on top of that the all formal professional engineering activities in India are conducted in English and English is not mother tongue for any one of us and to that extent one has to get adequate proficiency for both writing reports as well as making presentations and many colleges

as of now they do have a course in English and Professional Communication. And the more emphasis need to be given on making written, rather writing professionally.

Several writing exercises should be embedded into a number of courses with evaluation rubrics having elements related to correctness, technical correctness and writing skills. You must have some rubrics and give marks to that. It should get reflected finally into your grade. And similarly technical writing should be given adequate weightage in evaluating project reports.

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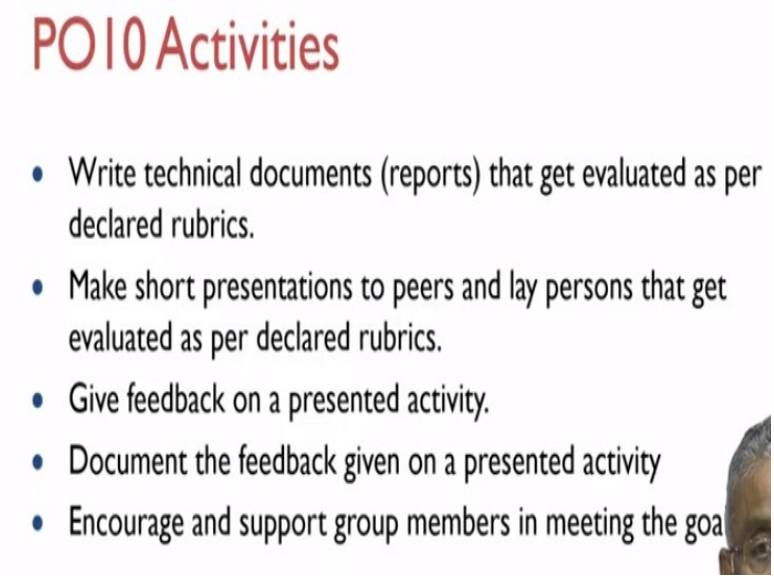

So there are several activities one can do like write technical activities reports and get evaluated as per declared rubrics. Make short presentations to peers and lay persons that get evaluated as per declared rubrics. This is something that is practiced by several colleges like for making short presentations. Give feedback on a presented activity. That can be brought into action. Document the feedback given on a presented activity.

Encourage and support group members in meeting the goals. This is where once again how do you support the group members? That requires adequate communication between the group members, the right kind of communication.

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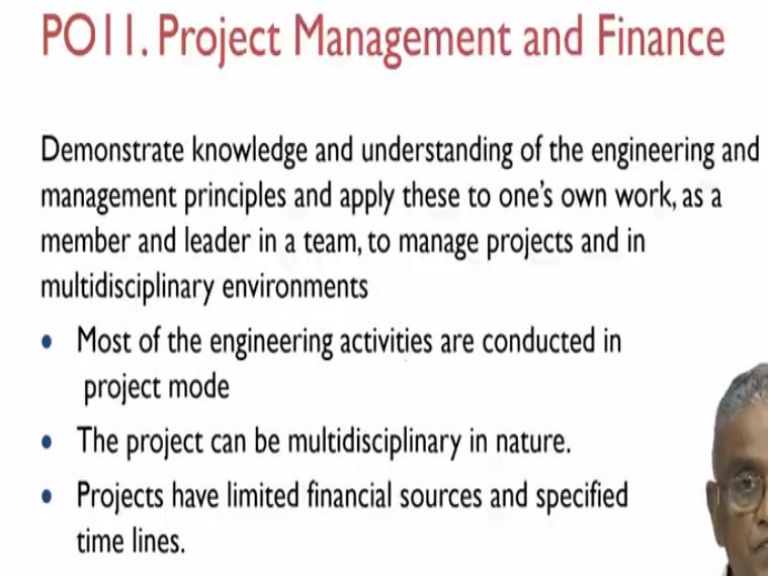

Now coming to PO11 which is related to project management and finance, what does it say? Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and a leader in a team to manage projects and in multidisciplinary environments. It is a tall order. First of all, most of the engineering activities if you look at, they are conducted in a project mode.

What is project mode? There is a time duration over which something has to be completed. There are identified financial and human resources and it has to be completed within that and any project what will happen is, it has to have a plan from one point to the other and what are the milestones and how do we evaluate whether we are near the milestones and then if there are deviation how do we, how can we, what exactly is to be done to do that.

And for example to even monitor, are there adequate tools available. These are all the concerns of when you operate in project mode. And a project can be also be multidisciplinary in nature. There could be when you are developing a product there could be mechanical dimension, there could be manufacturing dimension, there could be electronics dimension and so on. When multiple teams are working on such a project it becomes multidisciplinary in nature.

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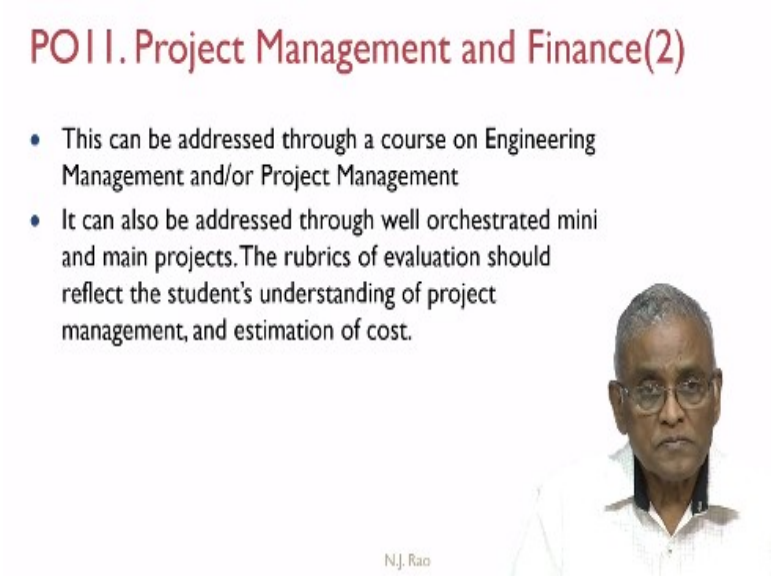

And this particular PO can be addressed through a course on engineering management and or project management. There are courses available and it can be included and it can also be addressed through well-orchestrated mini and main projects. The rubrics of evaluation should reflect the student's understanding of the project management and estimation of cost. So through all this we are bringing lot of load on the project itself.

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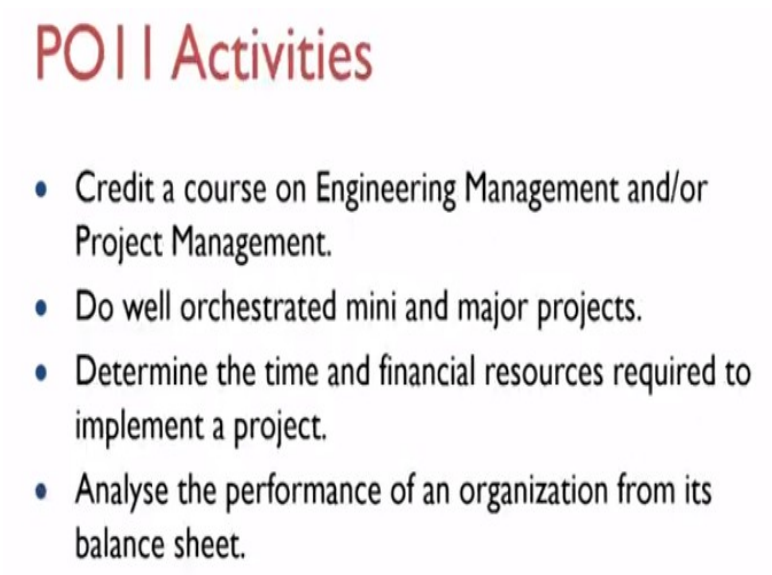

And PO11 activities. Credit a course on engineering management and or project management. Do well orchestrated mini and major projects. Determine the time and financial resources required to implement a project. Analyze the performance of an organization from its balance sheet. That also is a part of, can be part of addressing PO11.

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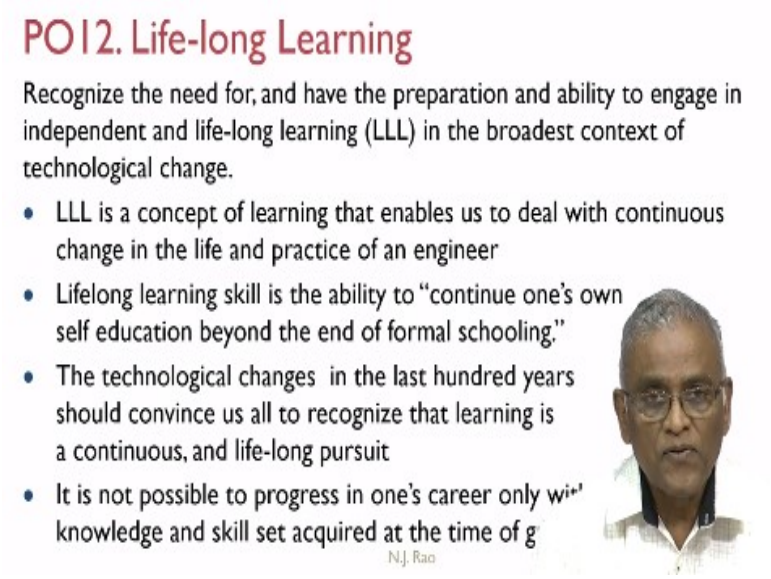

Coming to PO12, life-long learning. What does the statement say? Recognize the need for and have the preparation and ability to engage in a independent and life-long learning LLL as we call it in the broadest context of technological change. Now this is not anything new. As we know in the last two or three decades, the rate of change of technology has been very significant and what you know today, may become outdated in two or three years and also sometimes irrelevant.

The knowledge is irrelevant. So for you to work in one's own let us say professional period, career period like 30-35 years, you may have to overhaul your knowledge base many times. So one of the key skills that is required is any engineer should be able to, should have the ability to continue one's own self education beyond the end of formal schooling. That is our learning actually does not stop with when you write your final year examination.

It possibly starts at that time. And it is not possible to progress in one's career only with the knowledge and skill set required at the time of graduation. That is very clear as we have already stated.

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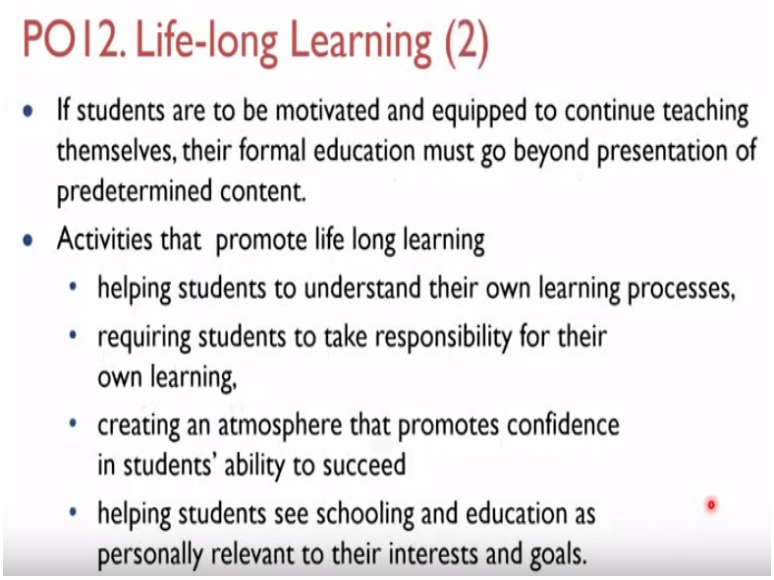

If students are to be motivated and equipped to continue teaching themselves their formal education must go beyond presentation of predetermined content. See right now dominantly we have the predetermined content and our tests are done, or entire assessments is based on this presentation of predetermined content and that is where the problem comes. So your assessment should include something which is beyond the predetermined content.

Activities that promote life-long learning include helping students to understand their own learning process. This we found in our experience especially in some of the regional or local what do you call it tier 2 or tier 3 institutions one of the problems is their understanding of their own learning processes can be seriously what requires attention. And this we are going to address what we call metacognitive knowledge.

That is, one should know how much he knew and how much he has to learn. That knowledge will have to be presented to him, okay? So there are several exercises that would be, could help students to understand their own learning process and the student should also take responsibility for their own learning. And creating an atmosphere that promotes confidence in student's ability to succeed.

Helping students see schooling and education as personally relevant to their interests and goals. These things will have to get reflected in the instruction, the way the teachers handle and

instruction will be our third module where these activities will be taken up for more detailed considerations.

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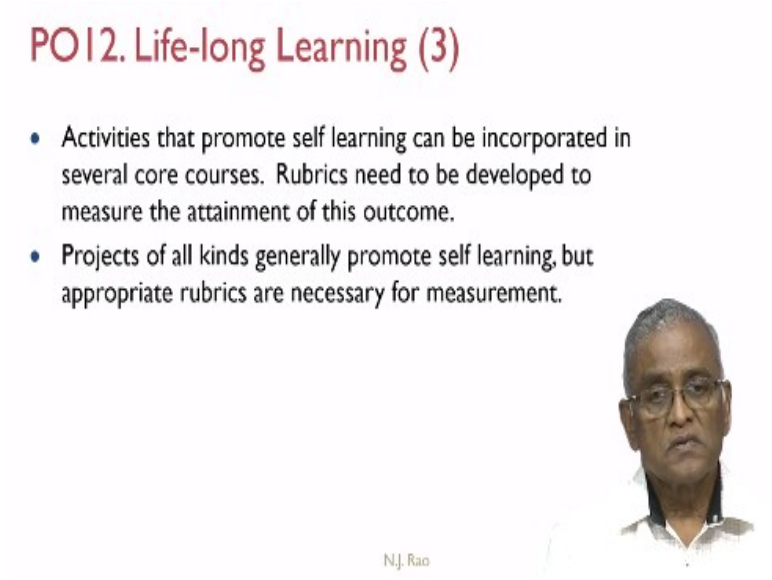

Activities that promote self-learning can be incorporated in several core courses. Rubrics need to be developed to measure the attainment of this outcome, okay? They can be, that I,s you can incorporate some kind of your assignment or a reading exercise that goes beyond the predetermined content and then you can have rubrics to measure that to what extent he has done. Projects of all kinds generally promote self-learning, projects of all kinds generally promote self-learning, but appropriate rubrics are necessary for measurement.

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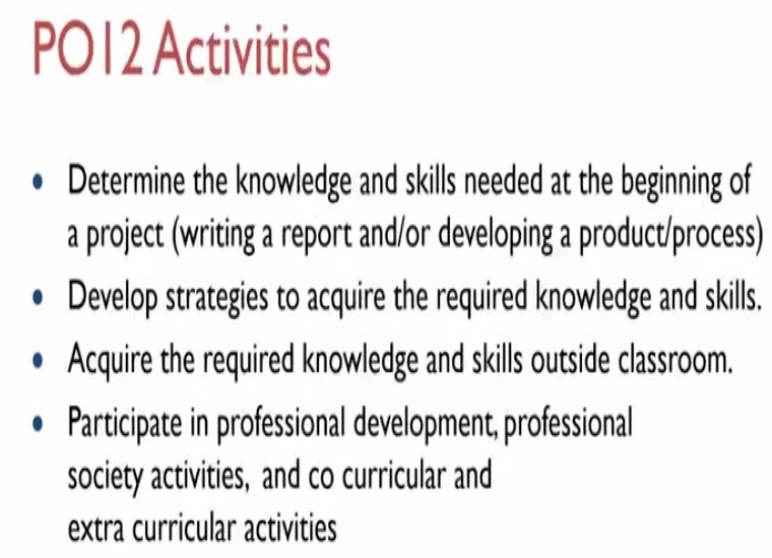

So the activities of PO12 include determine the knowledge and skill needed at the beginning of a project. Writing a report and or developing a product or process. Develop strategies to acquire the required knowledge and skills. So you can ask what is the strategy that he is going to follow when he is working on a project? That itself, writing that itself will bring the attention of the student to what exactly he needs to do and he can write down that particular strategy.

Acquire the required knowledge and skills outside classroom. Do not depend on teacher making the presentation solving problems on the board, but he should be able to work something outside the classroom. Participate in professional development, professional society activities and co-curricular and extra-curricular activities. All of them are likely to promote or will promote the life-long learning.

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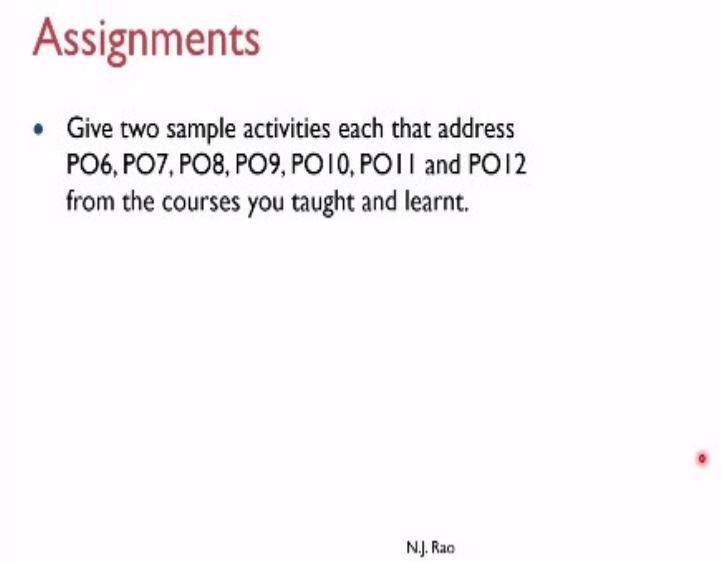

Now coming to the assignments, please give two example activities each that address these 7 POs from the courses you taught and learnt. So do not relate to the projects. From the courses that you have taught or learnt, try to give some sample activities. That would be a really a great contribution as well as it will bring it to your attention to these 7 POs.

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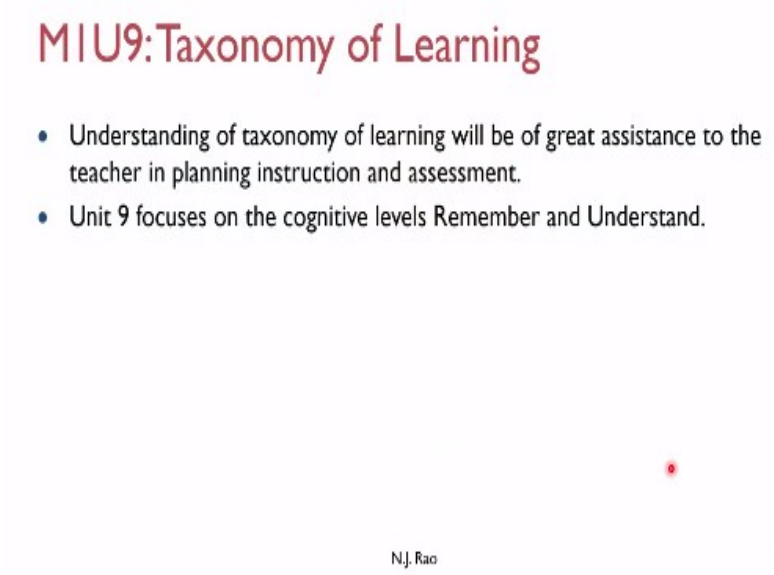

And the next unit we will move on to the Taxonomy of Learning. Understanding taxonomy of learning will be great assistance to the teacher in planning instruction and assessment because one has to, teachers will have to communicate with other teachers or along with the students who require a precise language for that to communicate and taxonomy of learning will provide that and Unit 9 focuses on mainly two cognitive levels that is Remember and Understand, okay. So that will be the goal of next unit. Thank you very much for your attention.