

**Teaching and Learning in Engineering (TALE)**  
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**Lecture - 04**  
**What is OBE?**

Greetings to all of you and welcome to the Module 1 Unit 4 on Outcome Based Education.

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## Recap

- Learning is acquiring new knowledge, behaviours, skills, values, preferences or understanding, and there are several theories of learning.
- Learning is measured and facilitated through assessment.
- Instruction is planning and conducting/arranging a series of learning events to facilitate good learning.

What we looked at in unit 4 is related to learning, assessment, and instruction. We considered learning is acquiring new knowledge, behavior, skills, values, preferences or understanding and there are several theories of learning and it should be pointed out all the theories of learning are not mutually exclusive. Each theory may emphasize certain aspect of learning and in fact one can design an instruction taking features or inputs from all the theories of learning.

And we also tried to look at the centrality of assessment in terms of learning is measured and facilitated through assessment. Assessment is really a very powerful tool to facilitate good learning. And instruction is planning and conducting or arranging a series of learning events to facilitate good learning. We will be looking at both assessment and instruction in later modules.

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# Unit Outcomes

MIU4-1: Understand the origins of Outcome Based Education

MIU4-2: Understand what an outcome is and its most important features

MIU4-3: Identify the level (PEO, PO, PSO and CO) of a given outcome statement and comment on its appropriateness, observability and measurability

The outcomes of this unit include understand the origins of outcome based education. Understand what an outcome is and its most important features. We will be spending several sessions on writing and defining under various contexts the outcomes of a program or a course. Then at the end of this unit the learner should be able to identify the level of a given outcome statement and comment on its appropriateness or observability and measurability.

And we are going to talk about 4 levels of outcomes namely, we call them as PEOs, POs, PSOs, and COs. We will be elaborating on each one later.

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## How did OBE start?

- Policy makers and stakeholders in several countries have been emphasising since 1970s on the need to develop instruments to obtain comparable information on what students actually learn across schools and HEIs.
- The term Outcome Based Education was first presented by William Spady in 1994 through his book “Outcome-Based Education: Critical Issues and Answers”, American Association of School Administrators.
- ABET, in 1997, adopted Engineering Criteria 2000 (EC2000) which shifted the focus away from the inputs (what material is taught) to the outcomes (what students learned).

How did OBE start? Policy makers and stakeholders in several countries since 1970s have been emphasizing to have a kind of a grip on what exactly are the students learning - in schools or in higher education institutions so that one can kind of quantify or kind of summarize what exactly the students are learning. The term outcome based education was first used and presented by William Spady in his book in 1994.

The book is Outcome-Based Education Critical Issues and Answers. I recommend the learners to have a look at this book and it is available, it can be downloaded from the internet free. And the same exercise was continued by ABET, the accreditation board of engineering and technology of USA in 1997 adopted Engineering Criteria 2000 labelled as EC2000 which shifted the focus away from the inputs.

Inputs would mean what material is taught to the outcomes to what students have learned. So the essence of outcome-based education is, the focus shifts from the material that is taught to what the students have learned.

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## William G. Spady

- Outcome-Based Education means clearly focusing and organizing everything in an educational system around what is essential for all **students to be able to do** successfully at the end of their learning experiences.
- This means starting with a clear picture of what is important for students to be able to do, and then organizing **curriculum, instruction, and assessment** to make sure this learning ultimately happens.
- Spady's focus was School Education

A little bit about William Spady. Outcome-Based Education means clearly focusing and organizing everything in an educational system around what is “essential”. Note the focus is on essential for all students to be able to do successfully at the end of their learning experiences.

Please note that the key word is essential. That means what is desirable can be much more than what is essential.

So one should not consider the entire thing is limited to only pre-defined outcomes. What this means is starting with a clear picture of what is important for students to be able to do and then organizing curriculum, instruction, and assessment to make sure this learning ultimately happens. So the essence of OBE or outcome-based education is that the curriculum and instruction and assessment are all to be planned around what you state as outcomes.

That serves as the focus for all and it also ensures what is very common practice in academic institutes to treat each course as an independent entity unrelated to the rest of the activities in the program. Program is the focus and not necessarily the individual course and when Spady considered outcome-based education his focus was on school education. As ABET has done it has extended this outcome concept to higher education as well.

Now it is a kind of a accepted practice or at least officially accepted as the basis for designing and conducting higher education programs in India.

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## Outcomes of learning

- are referred to in the literature as
- Outcomes
  - Learning Outcomes
  - Intended Learning Outcomes
  - Instructional Objectives
  - Educational Objectives
  - Behavioral Objectives
  - Performance Objectives
  - Terminal Objectives
  - General Instructional Objectives
  - Specific Learning Outcomes
  - Subordinate Skills
  - Subordinate Objectives
  - Competencies



Now, outcomes of learning. Because outcomes of learning has been the concern of educationists, education psychologists and so many people for several decades, maybe more than 60-70 years.

Because of that several words are used to represent the same outcomes of learning. From the literature we find the following words are used.

Outcomes, learning outcomes, intended learning outcomes, instructional objectives, educational objectives, behavioral objectives, performance objectives, terminal objectives, general instructional objectives, specific learning outcomes, subordinate skills, subordinate objectives, competencies. While all of them are approximately equal to each other, but some people have differentiated some words from the others to in a very very specific context for want of other word.

For example today Competency Based Education has come to be slightly different from Outcome-Based Education in the context of USA. Let us not worry about the details right now what is competency based education. I gave that as an example to say different educationists may use these words to mean something very specific.

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## What is an Outcome?

- An outcome is what the learner will be able to do/perform as a result of some learning experience

In the context of formal education

- An outcome of an education is what the student should be able to do at the end of a program/ course/ instructional unit.
- Outcomes provide the basis for an effective interaction among stakeholders



Now what is an outcome? We will formally define it. Here, an outcome is what the learner will be able to do or perform as a result of some learning experience. I feel this is about the simplest and most what do you call complete definition of what an outcome is? One does not have to elaborate more and more on that. It is a very simple definition. What it refers to is “I am able to do something after a learning experience what I was not able to do prior to my learning

experience”. That is it. So the focus is on do or perform. Not words like know, familiar and so on.

So please note that the key words the emphasis is on doing and performing. In the context of formal education, the outcome of an education is what the student should be able to do at the end of a program which is can be a 2-year, 3-year, 4-year program or a course, course in out context is a one semester course or an instructional unit which can be part of a course may consist of anywhere from 1 to 4, 5 hours of activity.

And the another major feature of outcome is outcomes provide the basis for an effective interaction among stakeholders. Who are the stakeholders? To start with the students, faculty, the parents, industries, management, government agencies and so on. So if you want to talk about a program or a course the conversation between the stakeholders or the discussion among the stakeholders can be in terms of outcomes. One can debate, differ from each other but finally come to an agreement on what exactly the outcome that one is looking for.

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## Outcome Based Education (OBE)

- Outcome-based education is an approach to education in which decisions about the curriculum, instruction and assessment are driven by the exit learning outcomes that the students should display at the end of a program or a course.
- In outcome-based education, “product defines process”.
- It is the opposite of input-based education where the emphasis is on the educational process and where we are happy to accept whatever is the result



Now, formally defining what an Outcome-Based Education, OBE is an approach to education in which decisions about curriculum, instruction and assessment are driven by the exit learning outcomes that the student should display at the end of a program or a course. Please again note

the it is the exit learning outcomes that the student should display. Because now outcomes can be are more than one. There are many.

So you should be, the student should be able to demonstrate their attainment of these outcomes either at the end of a program or a course. Sometimes he can also apply it to an instructional unit. Now here in outcome-based education product defines the process. What does it mean? First we define the product. What is the product? The learning outcomes the student should display at the end of a program or a course.

And having defined that, all the processes that lead to the attainment of those outcomes comes as a consequence of defining the products. That means first the product has to be defined and then the process. This is also true of all industries. Whenever they want to release a product, they first do not design something and then say this is the product which the customers have to buy. You define what a product specifications and work backwards.

It is the opposite of input based education where the emphasis is on the educational process and where we are happy to accept whatever is the result. And still incidentally, it is not always undesirable, but incidentally or unfortunately the especially at higher education this is what happens. I teach what I consider important and at the end of the semester that is what you are required to accept and perform. That is it.

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## Advantages of OBE

1. Relevance—Outcome-based education promotes fitness for practice and education for capability.
2. Discourse—The process of identification of the outcomes within an institution promotes discussion of fundamental questions
3. Clarity—An explicit statement of what the educational process aims to achieve clarifies the curriculum for both students and teachers, and provides a focus for teaching and learning.
4. Provision of a Framework—Outcome-based education provides a robust framework for integration of the curriculum.

Now, let us talk about advantages of OBE. First thing is “relevance”. It makes outcome-based education promotes fitness for practice and education for capability. What is fitness for practice? Today if I look at a civil engineer, a civil engineering graduate coming out of a undergraduate program, what kind of things he should be capable of doing? It depends on the current state of the industry and the kind of knowledge and skill sets that are required or given to the graduating students.

So one is reasonably ready, it does not mean that as soon as he completes his undergraduate program he is from the next day he starts performing as required by the industry but he is ready with the knowledge and skill set and he may take a short time for him to start practicing as per the requirement of the organization. And education for capability. What it means is capability and competency they are somewhat different.

Competency is what the skills and knowledge that you already have. Capability means using your competencies to address that you have the ability to address and work on a what you call an ill-defined problem with which you are not earlier familiar with. So you are making the your graduates capable. Capable means they are capable of solving real world problems that they are not already familiar with. Okay, coming to the next advantage, “discourse”.



What happens when the very process of identification of the outcomes within institution promotes discussion of fundamental questions? That is why when you try to write the outcomes it should not be ever written by a single person even at the program level or at the course level. It is always through discussion between peers will lead to coming out with the satisfactory outcomes. This has been borne out by dozens of workshops that we have done.

Always whenever the two or three faculty are requested to write the outcomes of their course, there has been a tremendous amount of discussion among them and certainly as a result of that a much better statements, much better outcome statements will result. Then the next one is “clarity”. An explicit statement of what the educational process aims to achieve clarifies the curriculum for both the students and teachers and provide a focus for teaching and learning.

So the you have to achieve clarity. How to achieve that clarity we will talk about in a later unit how to write the outcomes, outcome statements but it is very clear to the students and teachers. So there is no ambiguity at any time and it provides both focus to students for learning and to teachers for teaching. And outcome-based education provides a robust “framework” for integration of the curriculum.

One can, in the context of outcome-based education as well as the national accreditation framework they provide an excellent robust framework for designing the entire curriculum of a program.

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## Advantages of OBE (2)

5. **Accountability**—By providing an explicit statement of what the curriculum is setting out to achieve, outcome-based education emphasizes accountability.
6. **Self-Directed Learning**—If students are clear about what they are trying to achieve, they can take more responsibility for their own learning. Outcome-based education thus promotes a student-centered approach to learning and teaching.
7. **Flexibility**—Outcome-based education does not specify educational strategies or teaching methods.

“Accountability”. By providing an explicit statement what the curriculum is setting out to achieve, outcome-based education emphasizes accountability. That means I am associated with a particular course. My course is required to attain certain outcomes, that is students who are crediting my course are required to attain certain outcomes.

These outcomes in turn address a subset of Program Outcomes and Program Specific Outcomes to the extent the accountability who is responsible for what is made very clear. And on the same count students are clear about what they are trying to achieve and they can take more responsibility for their own learning and outcome-based education thus promotes a student centered approach to learning and teaching.

Because that is one of the program outcomes as well that is self-directed learning as we call. And then “flexibility”. Outcome-based education as thought are stated by several teachers does not specify education strategies or teaching methods. It only says what should be the outcome. It does not mean how you need to achieve that, how you can achieve that is all the, the concerned teacher has all the required freedom for that.

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## Advantages of OBE (3)

8. Guide for Assessment—The outcomes provide the framework for student examinations.
9. Facilitates Curriculum Evaluation—The outcomes provide benchmarks against which the curriculum can be judged.

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And it also acts as a guide for assessment in the second module on course design that is where we strongly link assessment to the outcome. How to go about actually planning assessment in terms of the outcomes. Facilitates curriculum evaluation which is also a requirement from NBA. Outcomes provide benchmarks against which the curriculum can be judged. We will talk about that in later units that is you try to measure to what extent outcomes have been attained. So these are all the advantages of outcome-based education.

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## Reservations about OBE

- It is against the spirit of education
- It is a straight jacket



As I said reservations about OBE. Some people strongly feel it is against the spirit of education itself. There should be freedom in terms of exploration and so on but as I mentioned earlier this is the OBE only states what is essential, not what is desirable and what more can be done. So in

no way OBE, OBE guarantees some essential things and above that it is up to the teacher, it is up to the institution, it is up to the students to explore beyond that.

In no way OBE kind of goes against the spirit of education and some people because you are defining so much in detail it is considered as a straight jacket. Once again as I said it is only the outcomes are dominantly written by the teacher except in non-autonomous institutions, in all autonomous institutions around the world it is the teacher who teaches the course, writes the outcomes.

I think it is fair to say a teacher should at the beginning of the semester should declare to the students what are the expected outcomes and he has the freedom to write or decide what those outcomes he wants them to be.

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## Features of an Outcome Statement

- Should unambiguously state what the student should be able to do/perform
- What the students do or perform are observable and assessable
- Students should be able to understand what it means (comprehensible)
- Should be able to provide guidance to students in planning their learning.

And now what are the features of an outcome statement. Should first thing is it should unambiguously state what the student should be able to do. The statement should be unambiguous. And when the students do or perform whatever they do should be observable and assessable. If he merely say he should be familiar with I cannot directly observe what he is familiar with directly. So anything that you state should be observable and assessable.

Student should be able to understand what it means or the student should be able to comprehend. They are comprehensible. It cannot be written in a very complicated sentence where the student has difficulty in understanding what it really means. And they should be written in a way the student themselves should be able to plan their learning. It provides some guidance that is how clearly the outcome statements need to be written.

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## As per OBE students learn well when

- They are clear about what they should be able to do at the end of a course
- Assessment is in alignment with what they are expected to do
- Instructional activities are designed and conducted to facilitate them to acquire what they are expected to achieve

These are the three principles which may keep repeating in various units and modules. Students learn well when they are clear about what they should be able to do at the end of a course. This has been repeatedly established through extensive research the students learn lot better when they are informed very clearly about the goals of the course and here the goals are outcome statements. And assessment is in alignment with what they are expected to do.

This alignment issue will be elaborating a little later that means if I want the student to be able to solve certain problems assessment should also ask him to solve problems. It cannot be anything else. That is what is alignment. It cannot be some assessment vaguely related to the outcome statement. They should be in alignment with each other. This is valid at school education level or at higher education level.

And instructional activities are designed and conducted to facilitate them to acquire what they are expected to achieve. That means if the requirement is student should be able to solve a

certain category of problems, instructional activities should be designed to facilitate the students to solve the kind of problems you have stated that they should be able to solve. So these are the three core principles of good learning always.

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## Levels of Outcomes

- Program Educational Objectives
- Program Outcomes
- Program Specific Outcomes
- Course Outcomes



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Now, coming to our undergraduate engineering programs there are four levels of outcomes identified. These are called Program Educational Objectives. The word objective is used instead of outcome, we will explain it later. Then you have Program Outcomes, Program Specific Outcomes and Course Outcomes.

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## Program Educational Objectives (PEOs)

- PEOs are broad statements that describe the career and professional accomplishments in four to five years after graduation that the program is preparing graduates to achieve.

Sample:

- Solve problems of social relevance applying the knowledge of electrical and electronics engineering, and/or pursue higher education and research.



Program Educational Objectives. These are broad statements that describe the career and professional accomplishments in four to five years after graduation that the program is preparing the graduates to achieve. For example if I am designing a Mechanical Engineering B.E. in Mechanical Engineering, I am expecting my graduates will be working in broadly in the mechanical engineering field.

Of course I cannot legislate they have to work like that, but majority of them are going to work in the mechanical engineering field and they are able to perform certain type of activities that we consider the graduates will be able to do in four to five years after graduation. That means if everyone let us say 80% of the graduates do not work in mechanical engineering discipline but work elsewhere then the actual B.E. program has no meaning.

It is not worth giving that you waste such a lot of time and resources for that. So that means you are now looking at objectives here would mainly you are looking at what you expect your students to be doing broadly four to five years after graduation. For example, one sample is given. The graduates, graduates after four to five years will be solving problems of social relevance applying the knowledge of Electrical and Electronics Engineering and or pursue higher education and research.

It does not mean that it has to be exactly written like that but this is one sample of let us say EEE program, Electrical and Electronics Engineering B.E. program.

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## Program Outcomes (POs)

- POs are statements that describe what the knowledge, skills and attitudes students should have at the time of graduation from an engineering program.
- POs (12 in number) are identified by NBA and are applicable to all UG engineering programs.
- They address both disciplinary and professional competencies.

Coming to Program Outcomes, program outcomes are statements that describe what the knowledge, skills and attitudes students should have at the time of graduation from an engineering program. That means just at the end of 4 years these represent what is the knowledge, skills and attitudes they should have. And at present POs are 12 in number and they are identified by NBA and are applicable to all engineering programs.

They are discipline agnostic, they are not dependent on the particular discipline. That means all graduates will have to attain these 12 Program Outcomes. And when you look at these 12 outcomes as we spend considerable time on that, they address both disciplinary and professional competencies. Disciplinary would mean specific to the particular subject and professional would mean the kind of competencies any person should have in any kind of engineering profession.

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## Sample NBA PO

PO3. Design/Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal and environmental considerations.



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One sample, this is directly taken from the list of POs as given by NBA. PO3 states that design, development of solutions that is the title of this. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety and the cultural, societal and environmental considerations.

As you can see there are several keywords in this and we will be trying to look at each one of the features of such statements in the later units and that is how NBA at present stated.

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## Program Specific Outcomes (PSOs)

- Program Specific Outcomes (PSOs) are outcomes that are specific to a program.
- PSOs characterise the specificity of the core (core courses) of a program.
- PSOs of an engineering program can only be two to four in number.

Sample

PSO1. Survey, map and plan layouts for buildings, structures and alignments for canals and roads

Now, coming to Program Specific Outcomes, after all mechanical engineering program would mean they should be able to do something in mechanical engineering in the discipline but then each program may specialize or make certain choices or the weightage given to different aspects of mechanical engineering and these all will have to somehow get translated into two to four statements which capture the specificity of your own program.

For example a sample if you look at, survey map and plan layouts for buildings, structures and alignments for canals and roads. This is one Program Specific Outcome of a civil engineering program and a particular program may or may not want to address let us say building structures, alignments for canals and roads or they may add some more features to that depending on the kind of resources and faculty they have.

So one can use the Program Specific Outcomes to differentiate a program from other similar programs.

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## Course Outcomes (COs)

- Course Outcomes are what students are required to attain at the end of a course
- COs should be observable and measurable
- A course outcome addresses a subset of POs and PSOs

Sample

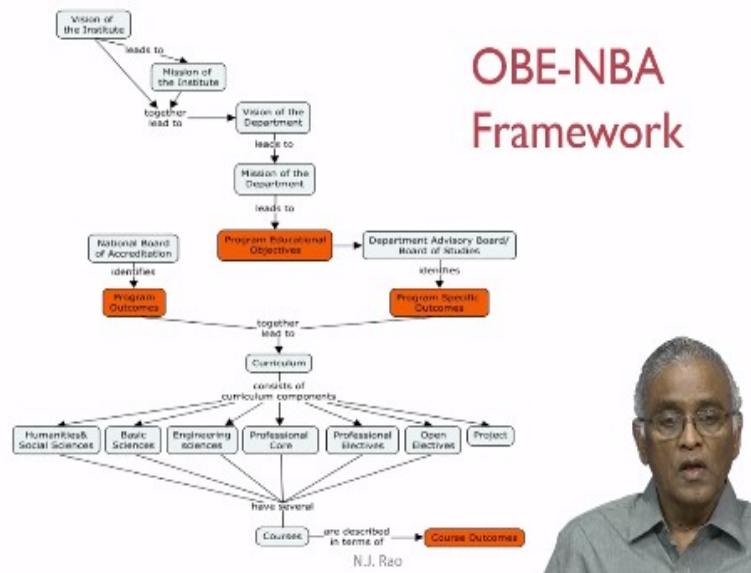
Understand the Divide and Conquer strategy for designing algorithms including Merge sort, Quick sort, and Selection sort.

Coming to Course Outcomes, Course Outcomes are what students are required to attain at the end of a course. Again, COs should be observable and measurable. A course outcome addresses a subset of POs and PSOs. After all POs and PSOs have to be dominantly be attained through courses. So to that extent I need to relate my or connect my COs to POs and PSOs. Here a

sample from computer science course one understand the divide and conquer strategy for designing algorithms including Merge sort, Quick sort, and Selection sort.

So it is very specific. The goal is very clear. It is related to understand.

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Now all this can be captured in a pictorial form, the OBE network. If you look at now all in higher education institution should have a vision statement, vision of the institute. It leads to mission of the institute together lead to vision of the department which is offering the program and that leads to a mission of the department and this leads to Program Educational Objectives.

And these are generally are identified by a department advisory board or a Board of Studies and this Board of Studies identifies the Program Specific Outcomes and whereas NBA has identifies the Program Outcomes. These may change maybe from time to time. They will not be permanent as the outside context changes based on the feedback given by institute across the country. NBA may decide to slightly modify the statements here.

And these POs and PSOs together design the curriculum and these are the curriculum components and all of them will have or will have several courses and each course is described by a set of course outcomes. That is broadly the relationship among all the outcomes. The ones marked in red are the four levels of outcomes we are talking about.

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## Assignments

- Give two examples of outcomes of your own undergraduate **program** paying attention to all the features of an outcome.
- Give two examples of outcomes of an undergraduate **course** offered by you paying attention to all the features of an outcome.

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Now, we to understand the important features of outcome-based education we expect all the participants to do these assignments. Give two examples of outcomes of your own undergraduate program paying attention to the features of an outcome. Okay, what are your Program Outcomes, here we mean Program Specific Outcomes. Give two examples of outcomes of an undergraduate course offered by you paying attention to all the features of an outcome.

So two statements, two PSO statements and two CO statements have to be written.

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## Assignments (2)

Identify the level of Outcome and comment on its appropriateness with respect to observability and measurability

1. Apply the knowledge of electrical and electronics engineering to solve problems of social relevance, and/or pursue higher education and research
2. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.



And then here we have given a list of statements, several of them about 12 of them, identify the level of outcome and comment on its appropriateness with respect to observability and measurability of this statement of the outcome.

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## Assignments (3)

3. Study a variety of advanced abstract data type (ADT) and data structures and their Implementations.
4. Be familiar with ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
5. Know the stress strain relation for a body subjected to loading within elastic limit.
6. Specify, select and formulate environmental engineering systems



## Assignment (4)

7. Know the principles and construction of electrical machines and determine their performance through testing.
8. Design mechanical components and systems as per given specifications using CAD tools.
9. Work effectively as individuals and as team members in multidisciplinary projects.
10. Determine and optimize the performance of a given algorithm on a computing platform
11. Understand the behaviour of two-port networks, and active devices including amplifiers, Op Amps, comparators, multipliers, BJTs and FETs.
12. Apply problem solving techniques to find solutions to problems.

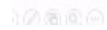


So please do that. Some are good statements some are bad statements. They can be improved. So we expect you to kind of comment on the appropriateness.

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## MIU5

- Understand the role of Accreditation and the criteria according to which NBA conducts accreditation.
- Understand the centrality of closing the quality loop at attainment of outcomes at the levels of COs, POs and PSOs.



Coming to the next unit, MIU5 which will attempt to facilitate understanding of the role of accreditation and the criteria according to which NBA conducts accreditation. And understand the centrality of closing the quality loop at the attainment of outcomes at the levels of COs, POs, and PSOs. That will be the expected learning outcomes of the next unit. Thank you very much.