Program Outcomes

- POs are statements about the knowledge, skills and attitudes (attributes) the graduate of a formal engineering program should have.
- Profile of the Graduates reached through POs - Target
- POs are defined by Accreditation Agencies of the country (NBA in India)
- Defining these is the Starting Point

Program Outcomes (POs)

1. **Engineering Knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2. **Problem Analysis**: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3. **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
4. **Conduct Investigations of Complex Problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

Conti…

5. **Modern Tool Usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
6. **The Engineer and Society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
7. **Environment and Sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
8. **Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

9. **Individual and Team Work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
10. **Communication:** 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.
11. **Project Management and Finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
12. **Life-long Learning:** Recognize the need for, and have the preparation and ability to engage in independent and lifelong learning in the broadest context of technological change.

Attainment of PO1 to P05

PO 1-5

- POl. Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and engineering. specialization to the solution of complex engineering problems.

- PO2. Problem analysis: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

- PO 3 Design/development of solutions: Design solutions for complex engineering problems and design system components, processes to meet the specifications with consideration for the public health and safety, and the cultural, societal, and environmental considerations.

- **Conduct Investigations of Complex Problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
- **Modern Tool Usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

Why place these POs in one Basket?

- The Statements show that one part *{That of (complex) Engineering Problem CEP} is common to all.*

- *Though, individually each PO deals with a different aspect of CEP. Recognizing this commonality makes the discussion easier.*

Source: NBA learning resources

Complex Engineering Problem-CEP

1. Problems not the kind generally encountered at the ends of text book chapters. (These often test if the contents of the chapter have been understood)

2. These are problems that have not been completely framed and leave at least a few* choices for the student to make.

3. Problems may require use of laws of physics, or bring in some mathematical tools in which the problem can be framed.

Course Outcomes (COs)

- "Statements of observable student actions that serve as evidence of the Knowledge, Skills and Attitudes acquired in a course".
- Each course is designed to meet (about 6) Course Outcomes
- The Course Outcomes are stated in such a way that they can be actually measured.
- POs are attained through program specific Core Courses

Course Outcomes

Engineering Physics (Not a Good Example)

CO1: Understand the knowledge of basic quantum mechanics, to set up one-dimensional Schrodinger's wave equations and its application to few physical problems.

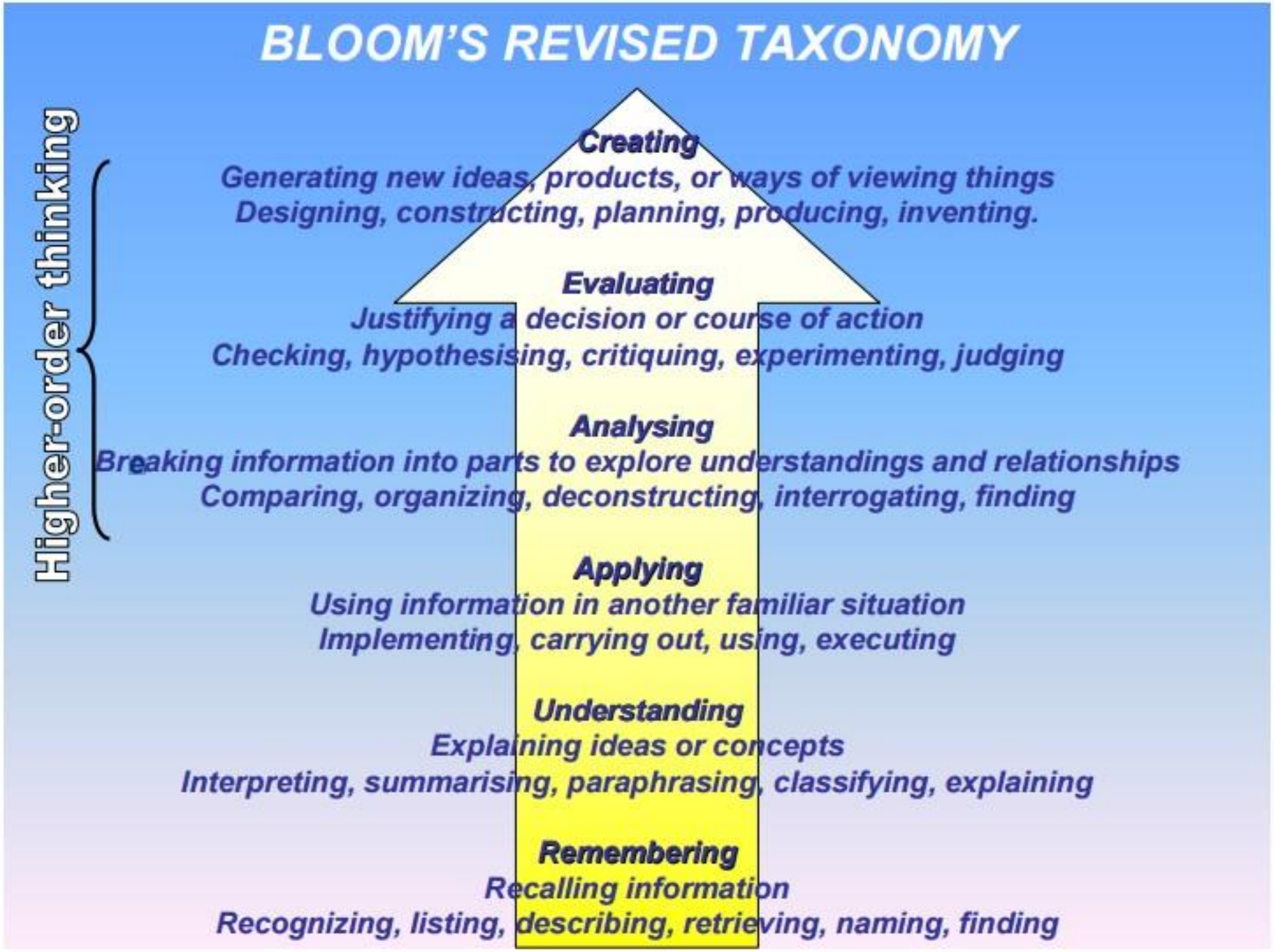
CO2: Understand the fundamental aspects of crystallography, able to recognize various planes in a crystal and have knowledge of structure determination using x-rays.

CO3: Understand the role of free electrons in determining the properties of metals, the concept of Fermi energy, and the domain formation in ferromagnetic materials.

CO4: Understand the basic laser physics, working of lasers, holography and principle of propagation of light in optical fibers.

CO5: Understand the theory of free, damped and forced vibrations of a particle and also the concept of resonance and its applications in ESR & NMR.

What level of BLOOM,s Taxonomy you want your students to achieve?



Retrieved from: http://www.kurwongbss.qld.edu.au/thinking/Bloom/blooms.htm

Comparison

Bloom's Levels	Program Outcomes	
Remember (K1)		
Understand (K2)		
Apply (K3)	Apply Knowledge	**Engineering Knowledge**: ***Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems***
Analyze (K4)	Problem Analysis	**Problem Analysis:** ***Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences***
Evaluate (K5)	Design/Development of Solutions	**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.**

Structure of Course Outcomes:

Course Outcome statement may be broken down into two main components:

- **An action word** that identifies the performance to be demonstrated;
- **Learning statement** that specifies what learning will be demonstrated in the performance;

Examples of good action words to include in course outcome statements:

- Compile, identify, create, plan, revise, analyze, design, select, utilize, apply, demonstrate, prepare, use, compute, discuss, predict, assess, compare, rate, critique, outline, or evaluate

Course Title: Strength of Materials

Course Outcomes: Example

At the end of the course, student is able to:

Action Verb

1. **Apply** laws of physics (eg..Hook's law, etc.,) to compute different types of response (stress and deformation) in the given materials. (PO 1)

Learning Statement

2. **Analyse** structural elements for different force systems to compute design parameters (BM and SF) (PO2)
3. **Design** compression elements using engineering principles to resist any given loads. (PO3)
4. **Conduct** experiments to validate physical behaviour of materials/components.(PO4)
5. **Prepare** laboratory reports on interpretation of experimental results (P10)

Assessment:

It is one or more processes that identify, collect, and prepare data to evaluate the achievement of Course Outcomes and Program Outcomes

PO/Course Assessment Tool Types	PO/ Course Assessment Tool	1	2	3	4	5	6	7	8	9	10	11	12
Direct Tools	Tests	√	√	√	√								
	Assignments	√	√	√	√		√		√			√	√
	Lab/Seminars/Industrial Training/ Projects (Rubrics)	√	√	√	√	√		√	√	√	√	√	√
Indirect Tools	Course End Survey	√	√	√	√	√	√	√	√	√	√	√	√
	Exit Survey	√	√	√	√	√	√	√	√	√	√	√	√
	Faculty Survey	√	√	√	√	√	√	√	√	√	√	√	√
	Alumni Survey		√			√					√		
	Programme Statistics	√	√					√		√		√	√

CO-PO Relationship

- Each CO can be identified to address a subset of POs
- Based on the number of COs and the sessions dedicated to them it is possible to identify the strength of mapping (1, 2 or 3) to POs
- Based on these strengths of selected POs a CO matrix can be established.

CO-PO Relationship

COURSE	COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
Problem solving and programming	CO1	3	3	-	-	-	-	-	-	-	-	-	-
	CO2	3	3	-	-	-	-	-	-	-	-	-	-
Data Str4uctures	CO1	3	2	-	3	-	3	3	-	-	-	-	-
	CO2	3	3	-	-	-	3	3	-	-	3	-	-
	CO3	-	-	3	-	-	-	3	3	-	3	-	-
Operating systems	CO1	3	3	-	-	-	-	-	-	-	-	-	-
	CO2	3	3	-	-	-	-	-	-	-	-	-	-
	CO3	3	3	-	-	-	-	-	-	-	-	-	-
	CO4	3	3	2	-	-	3	-	-	-	-	-	-
Unix	CO1	3	-	-	-	-	-	-	-	-	-	-	-
	CO2	-	3	3	-	-	-	-	-	-	-	-	-
	CO3	-	3	3	-	-	-	-	-	-	-	-	-
	CO4	-	-	-	-	-	-	-	3	3	-	-	-
DBMS	CO1	3	3	-	-	-	-	-	-	-	-	-	-
	CO2	3	3	-	-	-	-	-	-	-	-	-	-
	CO3	3	3	3	-	-	-	-	3	-	-	-	-
Digital Electronics	CO1	3	3	-	1	-	-	-	-	-	-	-	-
	CO2	3	3	-	-	2	2	-	-	-	-	-	-
	CO3	3	3	-	-	-	-	-	-	-	-	-	-
	CO4	2	3	2	-	-	3	-	-	-	-	-	-
Computer organization	CO1	3	-	-	-	-	-	3		-	-	-	1
	CO2		3	-		-	-	3		-	-	-	3
	CO3		-	-	-		-	3		-	-	-	2
	CO4			3	-	2	-	2	3	-	-	-	-
Minor Project Phase I	CO1	-	-	-	-	-	-	3	-	3	-	-	-
	CO2	3	3	3	3	-	-	-	3	3	-	-	3
	CO3	-	-	-	-	3	-	-	-	3	-	-	-
	CO4	-	-	-	-	-	-	-	-	3	3	2	-

Alignment of Assessment to COs and hence to POs…Example.

Topic: STACK

Stack is a linear data structure in which data can be inserted(PUSH) and can deleted(POP) on the basis of First in First out.

When we are discussing about stack, students must be made familiar about following topics

1. Abstract data type
2. Domain
3. Operations
4. Axioms

Contd.,

- To introduce complexity, students can be asked to write a program to visualise the operations of stack.
- Students can be asked to list out various real time applications of stack
- Student can be asked to list out differences between array and stack

PO1: **Engineering Knowledge**: ***Apply*** ***the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems***

Example Situation 1:

CO3: Able to understand stack and its operations, applications.

Assessment for CO3: (Question in Tests)

Briefly explain the various methods of creating stack

• ***Does this CO reflects the intended measurement from PO1?*** • ***Does the assessment correlates well with the CO?***	Mapping: CO3- PO1.

- ***In this case, CO does not reflect the intention of measuring application of either science, maths or engineering principles. It can measure only remembrance in this topic.***
- ***Further, the assessment, does not test the requirement of application of engineering principles used in creating stack as per PO1. Hence, the correlation between CO-PO is weak.***

PO2:Problem Analysis: *Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.*

Example Situation 2:

CO3: Able to apply pointers to create stack.

Assessment for CO3: (Question in Tests)

Specific application is given and student is asked to create stack for it.

• ***Is CO reflects the intended measurement from PO2?*** • ***Does the assessment correlates well with the CO?***	Mapping: CO3 - PO2

- In this case, the assessment does not test the students ability to identify, formulate and do some research for arriving at a suitable stack for a given situation since many variables of the design have already been identified in the problem and hence the strength of mapping of CO3 for PO2 in the above example can not be considered good. At best it can map well for PO1 as it involves application of engineering fundamentals.

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.**

Example Situation 3:

CO3: Able to analyse characteristics of stack used in different applications.

Assessment: Study about stacks used in different operating systems and how they are used.

• ***Is CO reflects the intended measurement from PO2, PO3 ?*** • ***Does the assessment correlates well with the CO?***	Remarks: CO3 –PO2, PO3

In this case, students are expected to identify and formulate various operating systems and how the stack in their architecture work.

The assessment correlates well with the CO and hence maps strongly for PO2 and PO3.

COs (Summary)

Example Situation 1:

- **Able to understand stack for different applications.**

Example Situation 2:

- **Able to <u>apply</u> different methods to <u>design</u> a stack.**

Example Situation 3:

- **Able to <u>analyse</u> characteristics of stacks used in different operating systems**
- ***(Choice of writing an appropriate CO and choosing the right assessment to map corresponding PO remains with the course instructor)***

Example of CO-attainment for a course

Course Name :	**Data structures**
Course Code :	CSE201
Session of Course	Batch-2013, Sep-Dec'2013
L : T : P -	
Semester :	I
Credits :	4
Batch :	2013
Faculty :	R V Ranganath

	Grading Scale	
50%	SCORE : < 50%	1
	50% - < 70%	2
70%	> =70%	3

75% **Percent of Students should score > 70% of marks for Attainment**

CO	CO Decription	T1	T2	A1	A2		LAB
CO1	**Identify** stacks that are used in unix, windows etc operating systems. [K 2](PO1)	Q1.a, b, Q2 a,b		-	-	-	-
CO2	**Compare behaviour of and design of these stack in different applications**(PO2, PO3)			A1	-	-	-
CO3	**Analyse different stacks and design new stack wth new characteristics of applications.** { PO2, PO3)		Q1, Q2	-	A2 -	-	
CO4	**Prepare** a comprehensive report on new knowledge in any one of the topic related to c data structures [K5] (PO8, PO9)			-		-	lab-

CO Attainment

- The assessments should be in alignment with the COs
- Question paper should be so set to assess all COs
- The average marks obtained in assessments against items for each CO will indicate the CO attainment.
- Instructors can set targets for each CO of his/her course.
- Attainment gaps can therefore be identified.
- Instructor can plan to reduce the attainment gaps or enhance attainment targets.

PO Attainment

- All POs can be adequately addressed through the selection of core courses and their COs
- Attainable targets can be selected for each of the CO.
- If assessment is in alignment with COs the performance of the students indicates the CO attainment.
- These measurements provide the basis for continuous improvement in the quality of learning.

Continuous Improvement

- Closing the loop at course level, programme level and Institute level ensures quality assurance for stake holders.
- All attainment analysis is made to provide continuous improvement through either in course delivery, Assessment and curriculum (Essence of OBE)