



G. K. Gujar Memorial Charitable Trust's

DR. ASHOK GUJAR TECHNICAL INSTITUTE'S DR. DAULATRAO AHER COLLEGE OF ENGINEERING, KARAD

Approved by AICTE, DTE Mumbai Maharashtra & Affiliated to Shivaji University, Kolhapur

OUTCOME BASED EDUCATION MANUAL

- ALGORITHM
- ANALYSIS
- STRATEGY
- INNOVATION
- BUILDING
- STRUCTURE
- PROCESS
- VISITIN



(CGPA 3.23)



OUTCOME BASED EDUCATION

Preamble:

Outcome means Net Result. Outcome-Based Education (OBE) is a student-centric teaching and learning methodology in which the course delivery, assessment are planned to achieve stated objectives and outcomes. It focuses on measuring student performance i.e. outcomes at different levels. The purpose of OBE is to ensure that all students are equipped with the knowledge, competence, and attributes needed to be successful with reference to placement, higher studies and entrepreneurship when they exit the educational system after obtaining the Engineering degree.

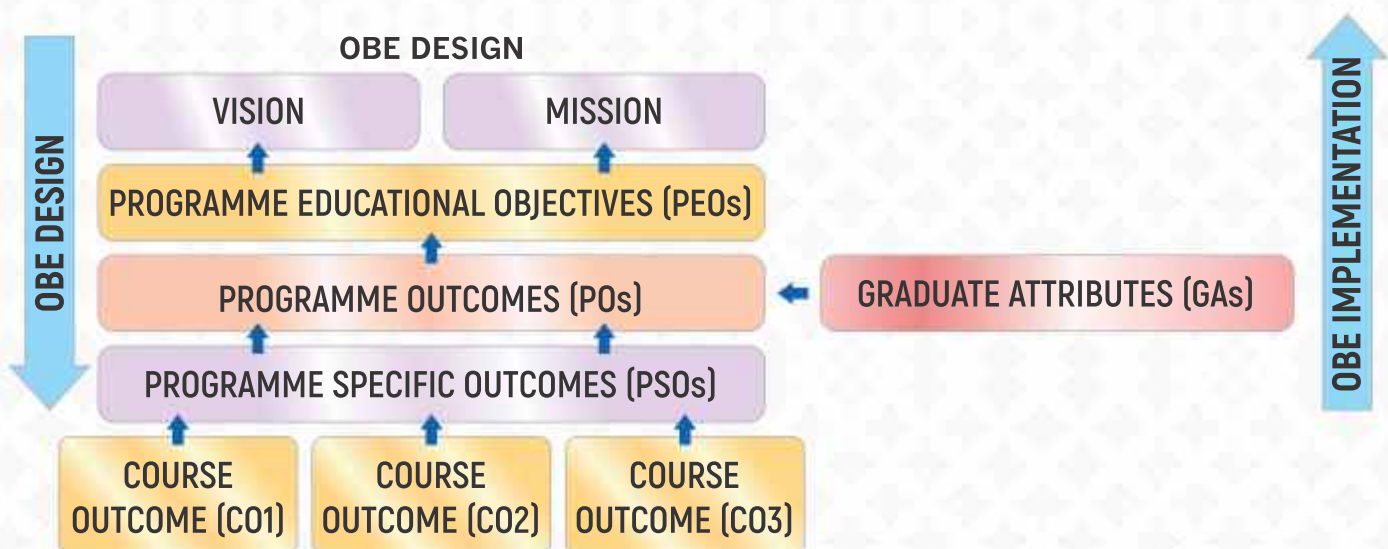
In current scenario, many higher and technical education institutions moved attention towards implementation of the OBE system. It is due to reaction to the need for standardization of education systems and processes. OBE has been encouraged primarily because of its acceptance as a framework by national as well as international academic accreditation organizations.

In our country also the implementation of OBE has been started in higher and technical education institutes. The National Assessment and Accreditation Council (NAAC) and the National Board of Accreditation (NBA) are established as autonomous bodies to promote and recognize excellence in higher and technical education in colleges and universities - at both the undergraduate and post graduate levels. Institutions, students, employers, and the public at large all benefit from the external verification of quality provided through the NBA accreditation process. Since 2013, NBA has started accrediting only the programs which implements OBE. A culture of outcome-based education (OBE) in technical institutions is established by NBA.

Outcomes-based Education as defined by Spady (1994, p. 12) 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 experience.”

OBE is an educational theory which moves the focus from teaching to learning, by making use of knowledge, skills and attitudes that students are expected to learn and be able to demonstrate upon completion of a program.

Key Constituents of the OBE :



OBE Implementation

Outcome-Based Education (OBE) is a student-centric learning model that helps teachers to plan the course delivery and assessment. It is implemented as per the following steps:

- Define Vision statements, Mission statements for the Institute and department
- Define Program Educational Objectives
- PO & PSO Statements
- Identify Gaps in the Curriculum and adopt suitable measures to bridge the Gap
- Define Course Objectives
- Define Course Outcomes with Bloom's Taxonomy for each course
- Map Course Outcomes with Program Outcomes at suitable levels.
- Prepare lecture-wise Course Lesson Plan
- Define pedagogical tools for Course delivery to achieve desired Outcomes
- Define Rubrics for Seminar, Field Training, Mini Project, Final year Projects.
- Measure the attainment of each CO through well-defined Assessment methods.
- Measure the attainment of each PO and PSO through Direct and Indirect Assessment methods.
- Track Students performance by observing attainment values.
- Compare PO/PSO attainment for last 3 academic years and propose remedial actions.

Vision and Mission Statement of the Institute :

Defining the vision and mission statement of institute is the initial step when we start implementing OBE.

Defining Vision Statement of the Institute :

- Vision is a futuristic statement that the institute/departmentt would like to achieve over a longer period of time
- Where you “see” your institute/departmentt down the road
- Typically one sentence..!
- Vision of the department should be in line with institutes Vision.



Vision of the DACOE :

- To be a Competent Engineering Knowledge Centre for Socio-Economic Development.

Defining Mission statements of the Institute :

- Mission statements are essentially means to achieve the Vision.
- What you “do” to go there? Typically, 2-3 sentences.
- Department Vision mission statements must in line with Vision and Mission of the Institute
- Must be shared with all stake holders
- Must result from a well-defined and recorded process



Mission of the DACOE :

- 1: By empowering students with knowledge, essential technical skills & ethical values.
- 2: By fostering effective interaction & networking with all stakeholders for the benefit & continuous Development of the profession and society.
- 3: By creating professional and responsible engineers for research, entrepreneurship and leadership.

Vision and Mission statements of the Department :

Vision of the Computer Science & Engineering Department :

To produce competent engineers employable in the Computer Science and Engineering profession for socio-economic and sustainable development.

Mission of the Computer Science & Engineering Department :

- M1 : Inducing learning practices for problem solving and technical skills to meet emerging trends in Computer Science and Engineering
- M2 : Collaborative work developing conducive relationship with stakeholders for continuous improvement and enhancing employability skill
- M3 : Grooming computer professionals with ethical values for inculcating research, entrepreneurship and leadership to serve the society in sustainable way

Vision of the Civil Department :

To produce globally competent civil engineers for the sustainable development of society.

Mission of the Civil Department :

- M1 : Empowering the student with sound technical knowledge and professional skills.
- M2 : Creating ecosystem for the research, development, entrepreneurship for sustainable development.
- M3 : Applying the technical knowledge for serving the society and nation for its overall development.

Vision of the Electronics & Telecommunication Department :

To produce professionally competent Electronics & Telecommunication Engineers for Socio Economic Development

Mission of the Electronics & Telecommunication Department:

- M1 : By inculcating in-depth knowledge and skills in both fundamental and applied areas of science and technology with ethics.
- M2 : By developing competencies of the students to meet social and industrial needs.
- M3 : By mentoring students to develop professional skills, leadership and team building qualities.

Vision of the Mechanical Engineering Department:

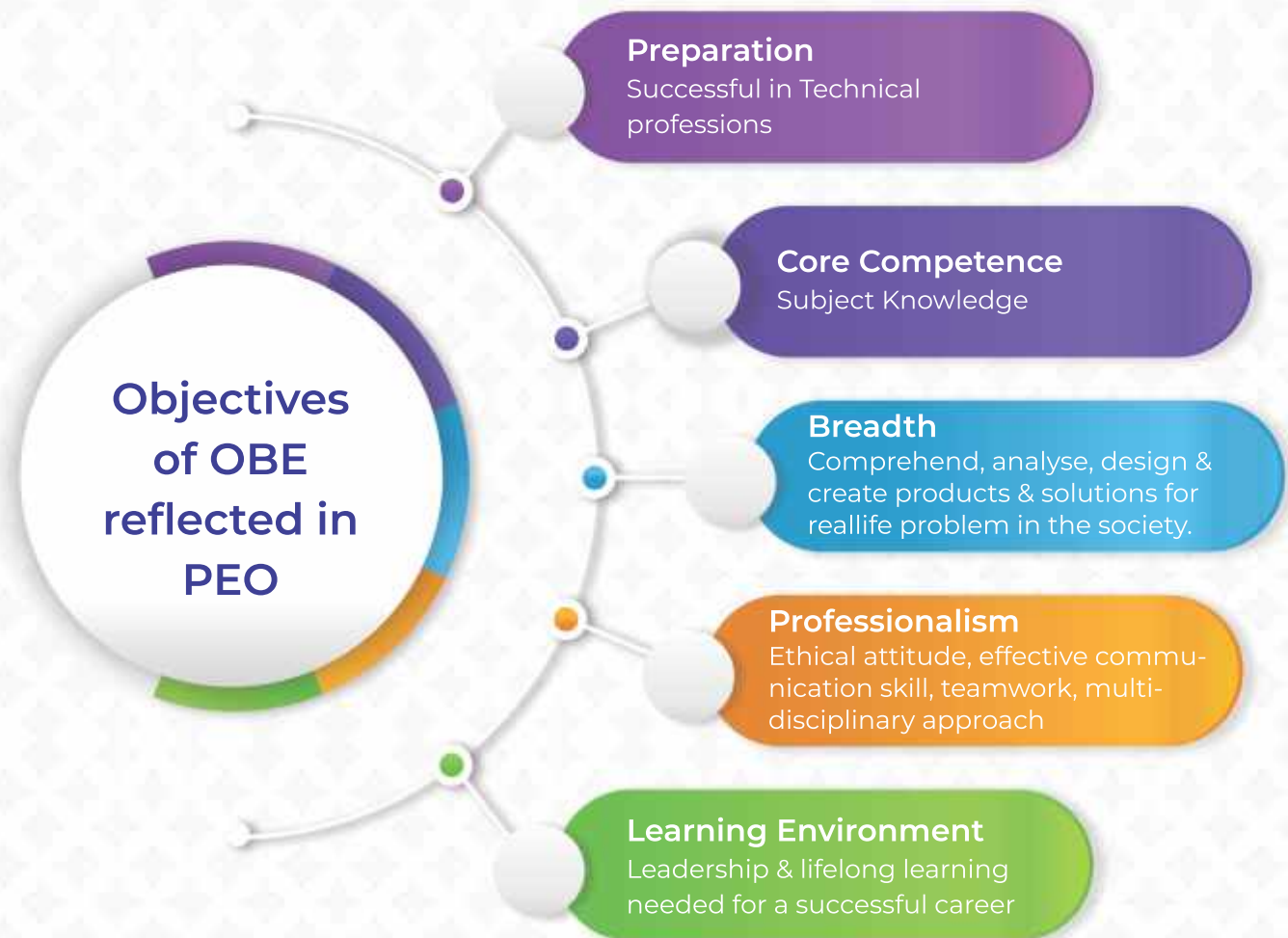
To produce professionally competent Mechanical Engineers for socioeconomical development.

Mission of the Mechanical Engineering Department:

- M1 : Providing quality education to the students and improving their skills to make them professionally competent.
- M2 : Providing the students with conducive academic environment and ethical values for social needs and career development.
- M3 : Liaising with industry and esteemed educational organizations to motivate students for research and entrepreneurship.

Program Educational Objectives :

- Program Educational Objectives (PEOs) are broader statements that describe the career and professional accomplishments in 3 to 5 years after graduation of the students
- PEOs should be consistent with Mission statements
- PEOs should be measurable and achievable by the Program
- Program should follow established process of defining statements
- Typically, the process is similar as that for Vision and Mission
- Must be published and shared with all stake holders
- Key elements (generally): – Professional success – Life-long learning, Higher Education, Research – Ethical professional practice – Communication skills – Team work – Leadership.



Process of defining PEOs of the Department



PEOs of CSE Program :

PEO-1: Embed with core competencies to solve real world problems for career enhancement.

PEO-2: Enhance the ability to think logically, analyse and design effective solutions with state of art tools

PEO-3: Utilize their technical, behavioural skills and teamwork for multidisciplinary projects related to industry and community welfare

PEO-4: Prioritize effective communication for professional, social and environmental concern.

Program Outcomes & Program Specific Outcomes

Program Outcomes (POs):

- Program Outcomes are narrower statements that describe what students are expected to know and be able to do by the time of graduation
- POs basically describe knowledge, skill and attitude/behaviour (KSA) of students as they progress through the program as well as by the time of graduation
- POs are expected to be aligned closely with Graduate Attributes.
- They must reflect all the Graduate Attributes

Program Outcomes (POs) defined by NBA

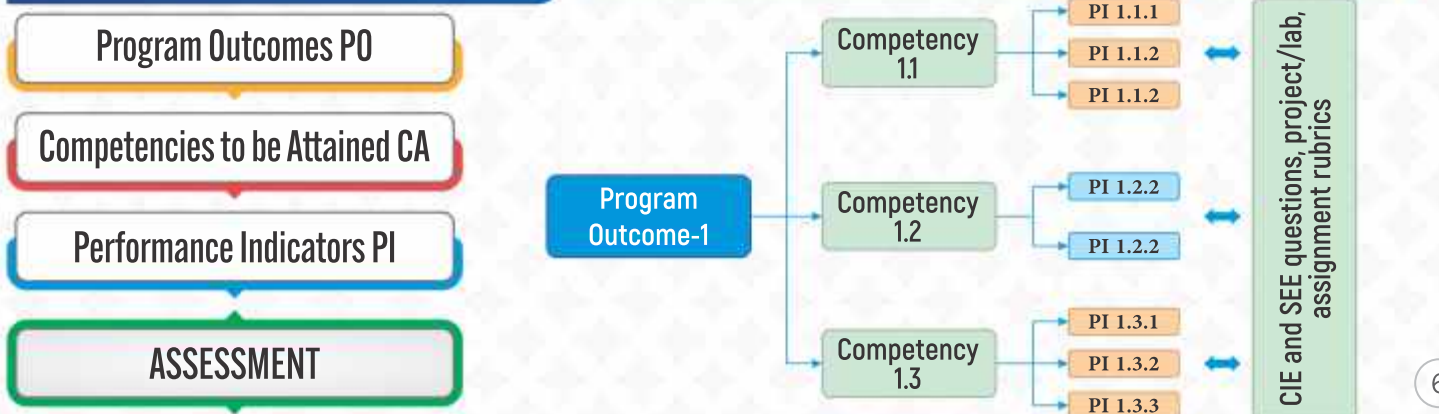
- PO1. **Engineering Knowledge** : Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
- PO2. **Problem Analysis** : Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
- 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.

- P04. **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.
- P05. **Modern Tool Usage** : 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.
- P06. **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.
- P07. **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.
- P08. **Ethics** : Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
- P09. **Individual and Team Work** : Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
- P010. **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.
- P011. **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.
- P012. **Life-Long Learning** : Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Program Specific Outcomes (PSOs)

- Beyond POs
- Specific to particular Program
- 2 to 4 in number
- Must be realistic and have process to measure them
- Program curriculum and other activities during the program must help the achievement of PSOs as with the POs

Connecting PO's to Assessment



POs – Competencies – Performance Indicator

Sr.No.	1	2	3	4	5	6	7	8	9	10	11	12	12 POs
POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	Total
Competencies	4	4	4	3	3	2	2	2	2	3	3	3	36
Performance Indicators	05	14	14	08	06	02	04	03	07	07	05	06	81

PO 5: Modern tool usage: 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.

Competency	Indicators
5.4 Demonstrate an ability to identify/create modern engineering tools, techniques and resources	5.4.1 Identify modern engineering tools, techniques and resources for engineering activities 5.4.2 Create/adapt/modify/extend tools and techniques to solve engineering problems
5.5 Demonstrate an ability to select and apply discipline-specific tools, techniques and resources	5.5.1 Identify the strengths and limitations of tools for (i) acquiring information, (ii) modeling and simulating, (iii) monitoring system performance, and (iv) creating engineering designs. 5.5.2 Demonstrate proficiency in using discipline-specific tools
5.6 Demonstrate an ability to evaluate the suitability and limitations of tools used to solve an engineering problem	5.6.1 Discuss limitations and validate tools, techniques and resources 5.6.2 Verify the credibility of results from tool use with reference to the accuracy and limitations, and the assumptions inherent in their use.

PO 12: Life-long learning: Recognise the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Competency	Indicators
12.4 Demonstrate an ability to identify gaps in knowledge and a strategy to close these gaps	12.4.1 Describe the rationale for the requirement for continuing professional development 12.4.2 Identify deficiencies or gaps in knowledge and demonstrate an ability to source information to close this gap
12.5 Demonstrate an ability to identify changing trends in engineering knowledge and practice	12.5.1 Identify historic points of technological advance in engineering that required practitioners to seek education in order to stay current 12.5.2 Recognize the need and be able to clearly explain why it is vitally important to keep current regarding new developments in your field
12.6 Demonstrate an ability to identify and access sources for new information	12.6.1 Source and comprehend technical literature and other credible sources of information 12.6.2 Analyze sourced technical and popular information for feasibility, viability, sustainability, etc.

Course Outcomes (COs) :

- Course Outcomes (COs) are statements clearly describing the meaningful, observable and measurable knowledge, skills and attitudes that constitute the basic learning needed by a graduate of the course.
- These are major domain specific outcomes written using action verbs which are specific, measurable, achievable, realistic and time-bound (SMART) and can be demonstrated by students on completion of each course.
- A well written CO facilitates teachers in measuring the achievement of the CO at the end of each course which is referred as attainment of Course Outcome
- They are limited in number (4-6) for each course and specific enough to be measurable.

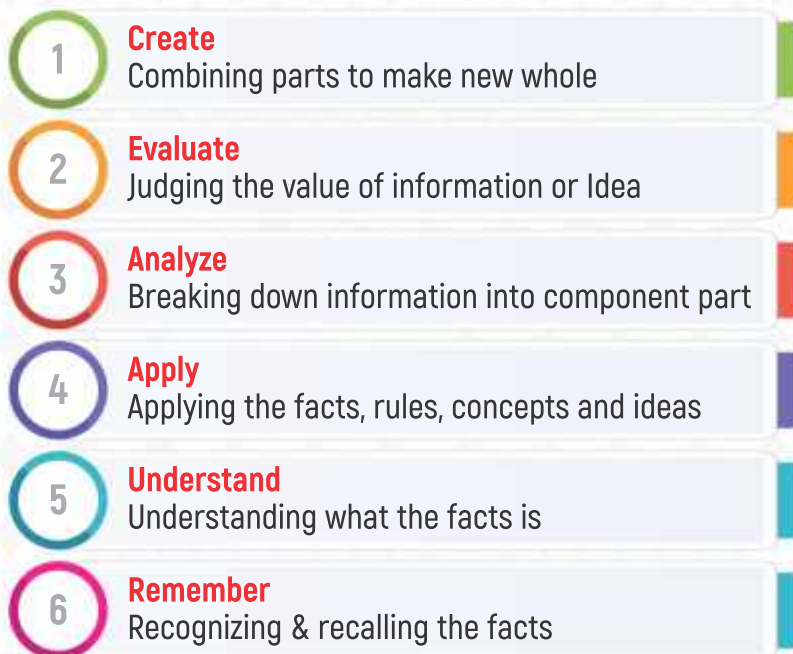
SMART Technique of defining COs :



- » **Specific** : Course Outcomes should be precise, concrete, focused and detailed.
- » **Measurable** : Course Outcomes must be observed and measured by some means.
- » **Achievable** : Course Outcomes must be achieved by using reasonable amount of effort.
- » **Realistic** : Outcomes must be appropriate for the student and the situation.
- » **Time bounded** : Must be clearly stated with a time limit for the attainment.

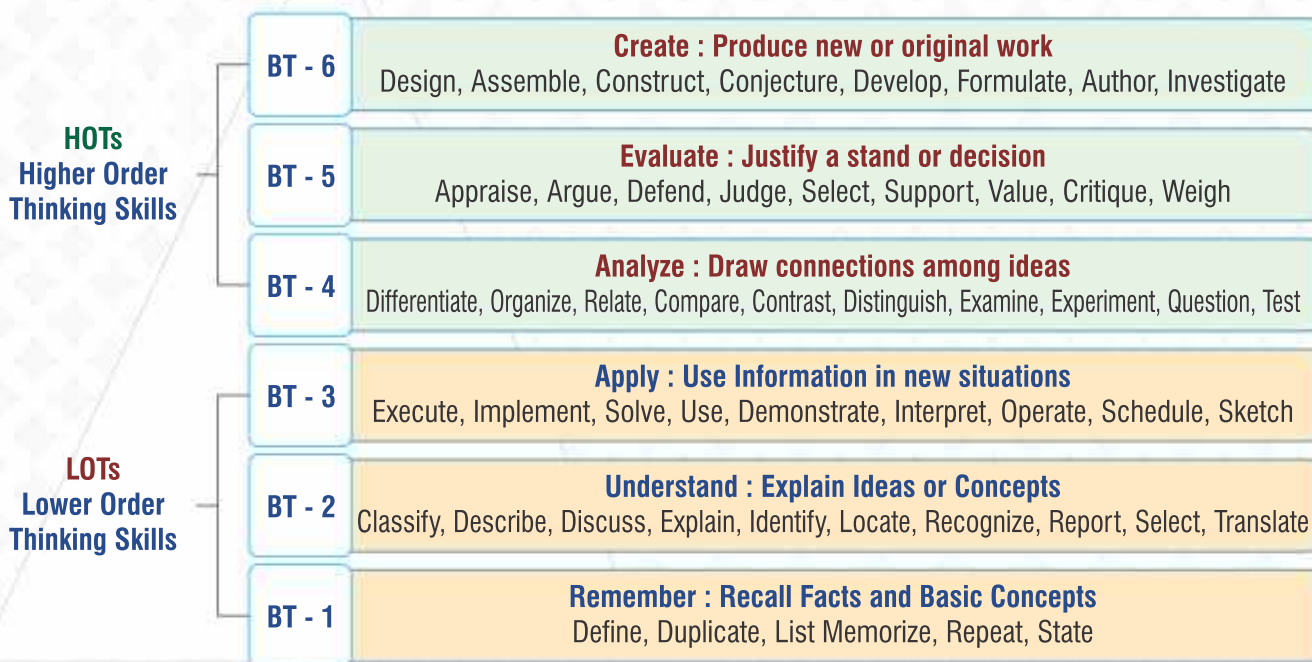
Blooms Taxonomy :

Bloom's taxonomy is considered as the global language for education. Bloom's Taxonomy is usually referred by course teachers in writing the course outcomes as it provides a readymade structure and list of action verbs. A summary of Anderson and Krathwohl's revised version of Bloom's taxonomy of critical thinking is provided in below Figure.



Bloom's Taxonomy : Taxonomy-Scheme of Classification, Students Learning Levels-6

Employability Skills of Engineering Students



The sample list of Action words that can be used when creating the expected student learning outcomes related to critical thinking skills in a course :

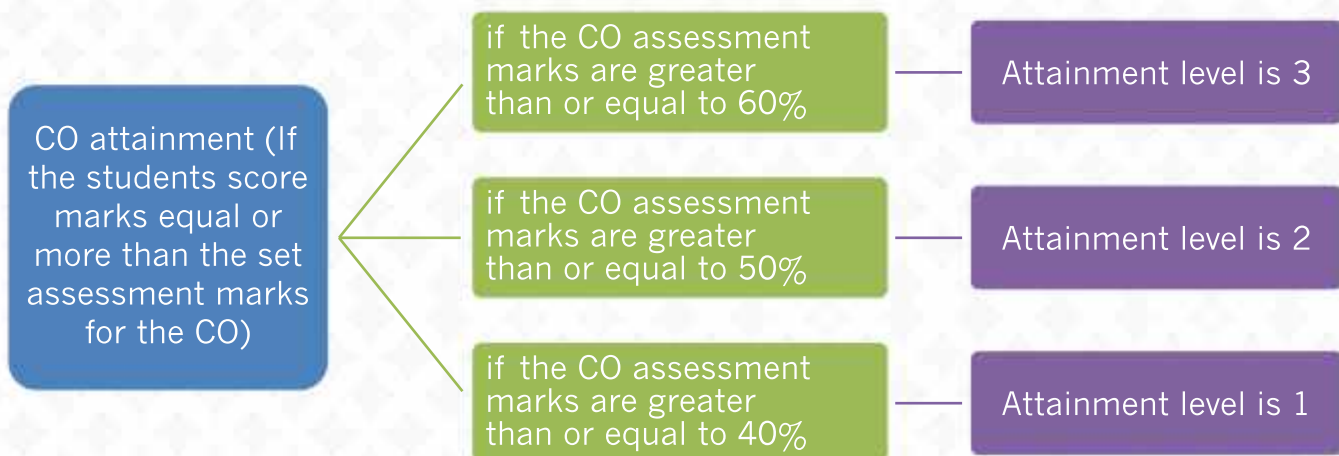
Lower Order of Thinking (LOT)			Higher Order of Thinking (HOT)		
Remember	Understand	Apply	Analyze	Evaluate	Create
Define	Explain	Solve	Analyze	Reframe	Design
Describe	Describe	Apply	Compare	Criticize	Create
List	Interpret	Illustrate	Classify	Judge	Plan
State	Summarize	Calculate	Distinguish	Recommend	Formulate
Match	Compare	Sketch	Explain	Grade	Invent
Tabulate	Discuss	Prepare	Differentiate	Measure	Develop
Record	Estimate	Chart	Appraise	Test	Organize
Label	Express	Choose	Conclude	Evaluate	Produce
Choose	Illustrate	Make use of	Discover	Choose	Compile

Sample of CO-PO Mapping: Course Articulation Matrix :

CO	Statement		PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CS704.1	Examine basic Artificial Intelligence (AI) methods with their foundations.	2	3		2			1						2	2
CS704.2	Apply basic principles of AI in solutions that require problem solving, inference, perception, knowledge representation and learning.	2	3	3		2	1							2	2
CS704.3	Demonstrate knowledge of reasoning and knowledge representation for solving real world problems.	2	2	3	2	2	1		1	1	1	1	1	2	3
CS704.4	Illustrate how search algorithms play vital role in problem solving.	2	2	2	2	2	1	2			2			2	2
CS704.5	Illustrate the construction of learning and expert system.	2	2	2		2	1			1				2	2
CS704.6	Discuss current scope and limitations of AI and societal implications.	2	2	2	2			2					3	2	2

Level of attainment

Here 3 levels of attainment are taken as 1-Low; 2-Medium; 3- High. These 3 levels of attainment can be defined as :



Setting Target Marks for CO Attainment

- » Target level for attainment of COs can be set initially based on average marks of that course in the last three previous academic years.
- » However, it can also be based on some threshold (minimum passing criteria or some other threshold level) i.e. 60 % or maximum marks allocated to CO etc.

Targets can be set for each CO of a course separately

CO	CO1	CO2	CO3	CO4	CO5	CO6
Threshold Target	60%	70%	65%	80%	70%	75%

Procedure for computation of CO attainment

Course outcomes will be attained through direct and indirect methods.

Direct Attainment:

The following criteria are considered in the direct attainment

- Conduction of Two Mid Semester Examination (MSE) based on COs
- Class performance activities
 - » Assignments
 - » Tutorials
 - » Mini Projects
 - » Term work
 - » Quizzes etc
- End Term Examinations

The proportional weightages of the above criteria are as per the institute academic regulations.

Direct Assessment tools

- » The various internal assessment tools should be in alignment with the COs for different subjects. All the assessment are mapped to action verbs so that they help to measure the performance of students.
- » Question paper should be so set to assess all CO. The marks obtained in assessments against items for each CO will indicate the CO attainment.
- » Course Teacher set targets for each CO of his/her course and take actions accordingly for improvement in the students learning.

A common format of programmed excel sheet, prepared in the Institute, is initially being used for calculating the attainment of COs. Each course teacher computes the attainment as per the appropriate assessment tools considered. Once the marks of each student in internal assessment tests and assignments and other internal evaluation metrics are entered, the CO attainment can be measured for each class.

Measurement CO Attainment :

The Course Outcome (CO) is measured through the performance of students in the various assessment tools for the particular course. The first step is to collect the marks obtained by the students in each assessment tool. Also mapping of CO to the question ask is done shown in the sample sheet given below.

Academic Year			2020-21			
Course Name			Operating System II			
Course Code						
Class and Semester			T. Y. B. Tech, Sem. VI			
Name of the faculty member			Mrs. S. P. Kakade			
Set Attainment Level:						
Student scoring more than or equal to 70% Marks			1			
Student scoring more than or equal to 80% Marks			2			
Student scoring more than or equal to 90% Marks			3			
Course Outcome	CO1	CO2	CO3	CO4	CO5	CO6
Average Percentage Assessment marks	81	81	82	82	80	80
Average Attainment	2.56	2.56	2.65	2.58	2.46	2.44
Percentage Dissemination of CO among students	85.33%	85.33%	88.33%	86%	82%	81%

The Assessment marks of Course Outcome is done by using below formula :

$$\begin{aligned}
 \text{CO}(i)\text{Assessment} = & \frac{\text{Obtained Marks in MSE}}{\text{Maximum Marks in MSE}} \times \text{Marks assigned to CO}(i) \text{ in MSE} \\
 & + \frac{\text{Obtained Marks in TW}}{\text{Maximum Marks in TW}} \times \text{Marks assigned to CO}(i) \text{ in TW} \\
 & + \frac{\text{Obtained Marks in ESE}}{\text{Maximum Marks in ESE}} \times \text{Marks assigned to CO}(i) \text{ in ESE}
 \end{aligned}$$

The Course Outcome Attainment is determined by using below formula :

$$\begin{aligned}
 \text{CO}(i) \text{ Attainment} = & 3, \text{ if } (\text{CO}(i) \text{ Assessment} \geq \text{Threshold1}) \\
 & + 2, \text{ if } (\text{Threshold1} > \text{CO}(i) \text{ attainment} \geq \text{Threshold2}) \\
 & = 1, \text{ if } (\text{Threshold2} > \text{CO}(i) \text{ attainment} \geq \text{Threshold3}) \\
 & = 0, \text{ if } (\text{CO}(i) \text{ attainment is } < \text{Threshold3})
 \end{aligned}$$

Threshold 3 is normally set to Minimum Passing Marks.

Sample Rubrics for Assessment of Final Year Projects:

Rubrics can also be used effectively to design the continuous assessment of the student projects. In the following example, we can refer the Rubrics of the students projects.

PI Code	PI	Marks	Very Poor Up to 20%	Poor Up to 40%	Average Up to 60%	Good Up to 80%	Very good Up to 100%
3.4.2	Generate information through appropriate tests to improve or revise design - GA	02	Not able to identify suitable tests to be done	Able to identify but not able to follow testing procedure	Able to follow testing procedures but not able to collect information	Able to collect information but not able to apply it for improvement	Able to apply information for the improvement
4.3.1	Use appropriate procedures, tools and techniques to conduct experiments and collect data - GA	04	Not able to identify tools, techniques and procedures	Able to identify but not able to conduct experiments	Able to conduct experiments but not able to follow procedure	Able to follow procedure but not able to collect data	Able to collect data as per the standards
4.3.2	Analyze data for trends and correlations, stating possible errors and limitations - GA	03	Not able to understand data	Able to understand but not able to analyze data	Able to analyze data but not able to correlate them	Able to correlate but not able to identify errors and limitations	Able to identify errors and limitations
10.2.2	Deliver effective oral presentations to technical and non-technical audiences - IA	03	Could not deliver effective presentations.	Could not deliver presentation, but presentation was prepared and attempted.	Able to deliver fair presentation but not able to answer to the audiences	Deliver effective presentations but able to answer partially to the audience queries.	Deliver effective presentation and able to answer all queries of the audience.
9.3.1	Present results as a team, with smooth integration of contributions from all individual efforts – GA + IA	03	No Contribution from an individual to a team	Contributions from an individual to a team is minimal	Contributions from an individual to a team is moderate	A contribution from an individual to a team is good but not well groomed in team.	Contribution from an individual to a team is good and results in an integrated team presentation.

GA – Group Assessment

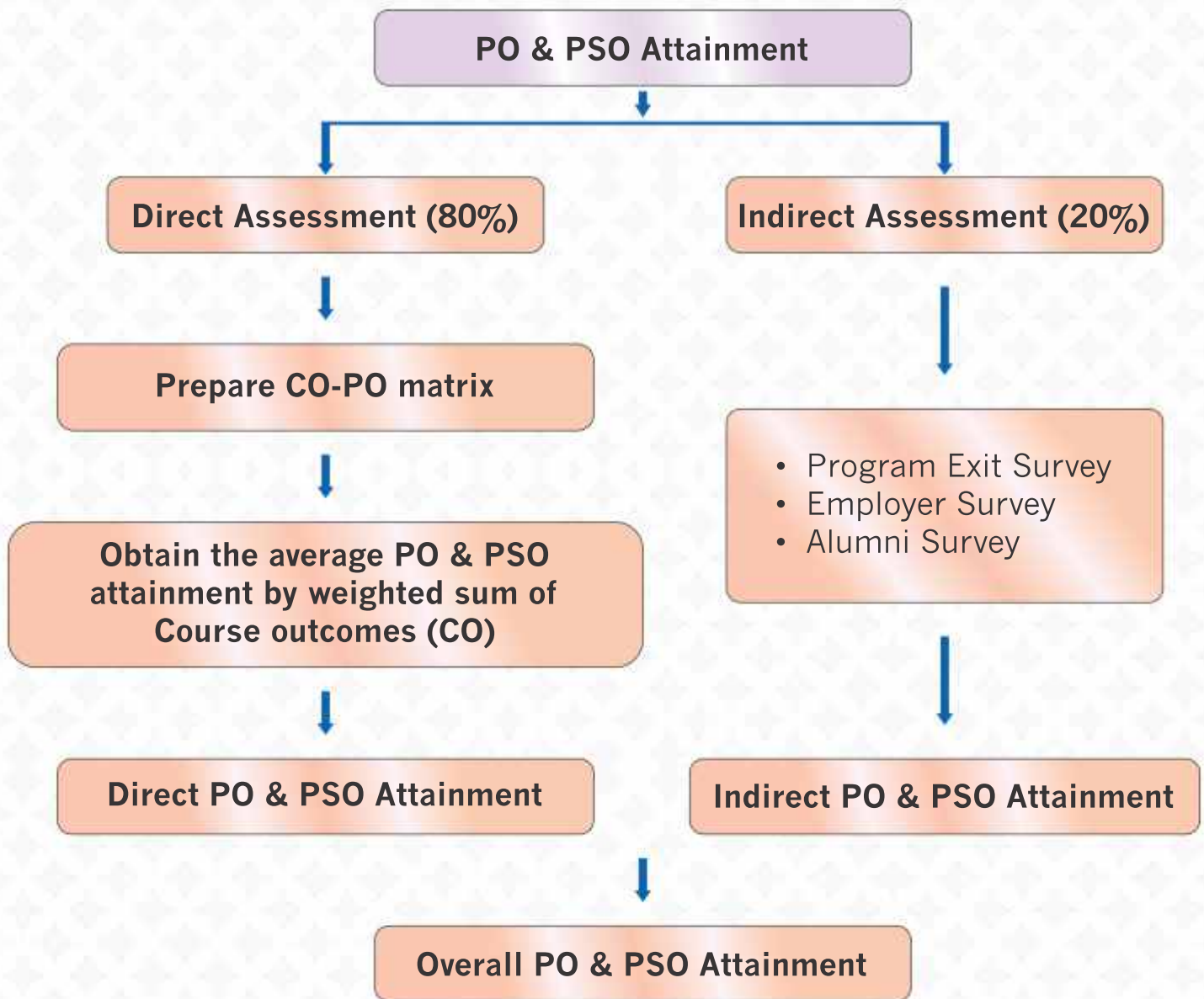
IA – Individual Assessment

Source: AICTE Exam Reform Policy 2018

Attainment of Program Outcomes and Program Specific Outcomes

Attainment of POs and PSOs is computed by using Direct and Indirect Assessment methods. The Direct PO and PSO attainment is calculated using Course Outcome attainment, whereas Indirect Attainment is based on the survey/feedback obtained from stake holders.

PO/PSO Attainment (Overall) = 0.8 x Direct Attainment + 0.2 x Indirect Attainment



Program Outcomes Attainment Sheet

Name of the Course : Operating System - II

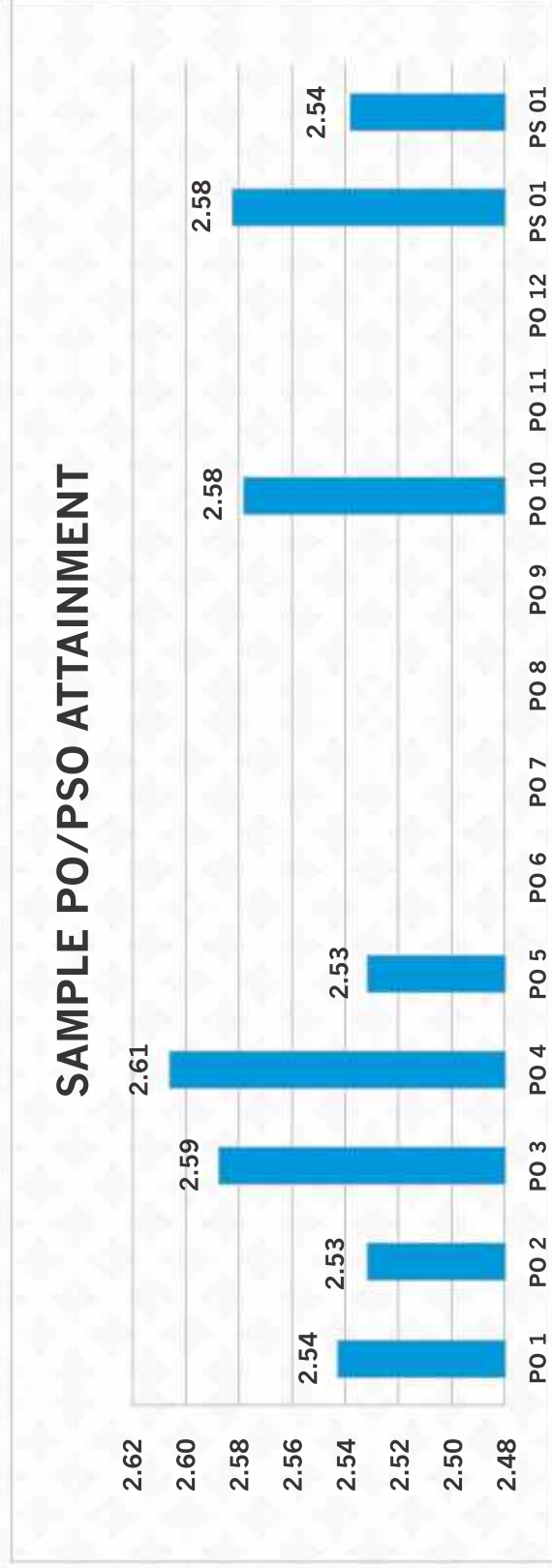
Semester VI

Academic Year 2020-21

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	CO Attainment
CO 1 Explain fundamentals of UNIX operating System and buffer cache algorithms.	2	1	1	1	1								1	1	2.56
CO 2 Illustrate Internal Representation of Files and relevant algorithms	2	2	1	1	1								2		2.56
CO 3 Implement and handle various UNIX system calls.	2	1	2	2									1	1	2.65
CO 4 Describe and demonstrate process structure.	2	1							1				2	1	2.57
CO 5 Apply Process Control and Scheduling algorithms.	2	1	1	1	1									1	2.46
CO 6 Outline key elements of Memory management and I/O Subsystem	2	2												1	2.44
	12	8	3	4	3	0	0	0	0	1	0	0	6	5	
PO Attainment	2.54	2.53	2.59	2.61	2.53				2.58				2.58	2.54	

Sample PO Attainment Calculation

$$\begin{aligned}
 \text{P01 Attainment (Direct)} &= \frac{\{(2.56x2) + (2.56x2) + (2.65x2) + (2.58x2) + (2.46x2) + (2.44x2)\}}{\{2 + 2 + 2 + 2 + 2 + 2\}} \\
 &= 2.54
 \end{aligned}$$





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