HINDUSTAN COLLEGE OF SCIENCE AND TECHNOLOGY

A PROCESS DOCUMENT

FOR OUTCOME BASED EDUCATION

AND

CO-PO-PSO ATTAINMENTS

(2022-23)

1.0 INTRODUCTION TO OUTCOME BASED EDUCATION

The demand for standardized education systems and processes led to the widespread adoption of Outcome-Based Education (OBE) in many higher education institutions. This shift was driven by its endorsement as a recognized framework by both international and local academic accreditation bodies. India also embraced OBE in its higher technical education sector, with the National Assessment and Accreditation Council (NAAC) and the National Board of Accreditation (NBA) taking the lead in promoting global quality standards for technical education.

As of 2013, NBA exclusively accredited programs that adhered to the OBE approach, making it a mandatory requirement for institutions to implement outcome-based education approach.

According to William G. Spady Outcome-Based Education (OBE) advocates the importance of establishing a "clear picture of what is important for students to be able to do, then organizing the curriculum, instruction, and assessment to make sure that this learning ultimately happens."

The three most important premises of OBE are:

1. Decisions about what to teach should be driven by the outcome we would like students to exhibit at the end of their education experience

2. All students can achieve learning outcomes of significance so long as the condition necessary for their success are met

3. Accountability of schools and school systems should be in terms of student outcomes (referred as outputs) rather than in terms of what is provided by way of curriculum, hours of instruction, staff student ratios, school buildings, equipment or textbooks or support services (referred to as inputs)

The systems engineering model for the Outcome Based Education (OBE) as presented in Figure 1.0.1 along with its important steps in implementing the OBE. Some of the important activities involved in implementing the OBE include:

1. Creation of Institute Vision and Mission
2. Creation of Program Education Objectives (PEOs) for each of the programs offered by the institution
3. Development of Program Outcomes (POs) and Program Specific Outcomes (PSOs)
4. Curriculum Development, Course Design and Development of Course Outcomes (CO)
5. Mapping of COs with POs and PSOs
6. Development of Assessment strategy
7. Calculating the Attainments of the Course Outcomes (COs) for each course based on the Assessment strategy
8. Calculating the Overall Attainment of POs and PSOs
9. Evaluating the PEOs

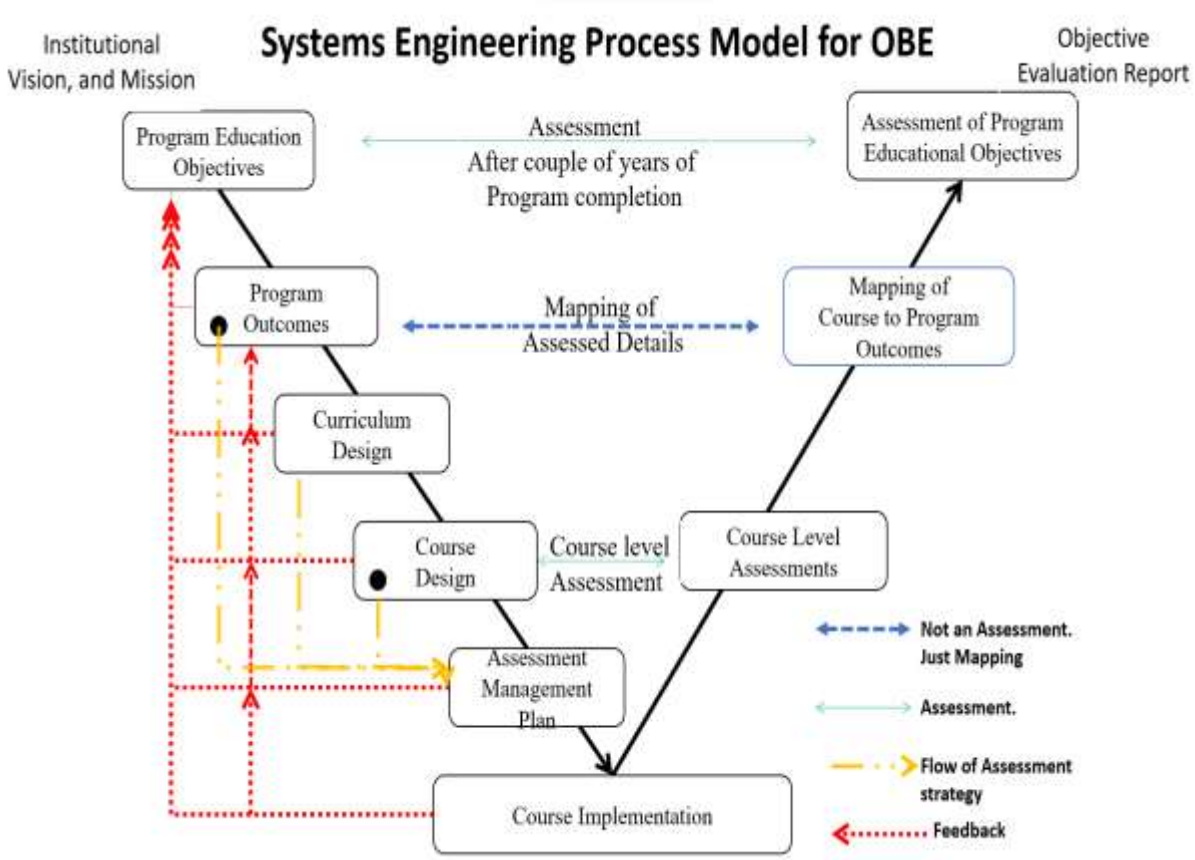


Figure 1.0.1: Systems Engineering Process model for OBE

2.0 IMPLEMENTATION DETAILS OF OUTCOME BASED EDUCATION

Understanding the importance and relevance of outcome-based education, Hindustan College of Science and Technology (HCST), Farah-Mathura, established a culture that fosters continuous improvement and student-centric learning. This shift in educational philosophy not only benefits students but also enhances the overall effectiveness and relevance of the college's academic programs. Through the systematic implementation of OBE, Hindustan College of Science and Technology continues to thrive as a leading institution, contributing significantly to the advancement of technical education in India and beyond.

The systematic implementation details of Outcome Based Education model at Hindustan College of Science and Technology are presented below:

2.1 CREATION OF INSTITUTE VISION AND MISSION

Formulating a clear and compelling Vision and Mission statements for the institute sets the direction and purpose for the entire educational journey. By creating a strong Vision and Mission, the institute fosters a shared sense of purpose among all stakeholders, ensuring a unified focus on student-centred learning, continuous improvement, and the development of tangible learning outcomes. This helps to ensure that the institute's educational practices remain focused, relevant, and impactful, ultimately contributing to the holistic growth and success of its students.

Hindustan College of Science and Technology is the first educational institute established by Sharda Group of Institutions (SGI), Agra. The Vision and Mission statements of HCST are fully aligned with SGI Vision and Mission statements along with its value system.

Vision and Mission Statements of SGI are as follows:

SGI VISION:

- Sharda Educational Trust envisions an ambience of excellence, inspiring value - based education, research and development

SGI MISSION:

- Deliver quality education comparable with the best in its class.
- Train students with world-class competencies and cutting-edge proficiency to face challenges of global markets with confidence.
- Develop student's value sets and attitudes fora value based, fulfilling and a wholesome life.
- Create an effective interface with industry, business and community to make education responsive to changes relevant to needs.
- Absorb and to create through R&D, disseminate and help apply state of the art technologies & practices to social problems.
- Build top of the line faculty through appropriate human resource policies to achieve mission goals.

The Vision and Mission Statement exhibits the SGI's value system integrating five important characters such as

- Commitment and Integrity
- Respect for the Individual
- Team Work
- 0Innovativeness and
- Excellence

The five value feathers of SGI are presented below in Figure 2.1.1.

.

Figure 2.1.1: SGI Attributes of its Value System

Inheriting the SGI's value system, Hindustan College of Science and Technology developed its Vision and Mission statements aligning with SGI's Vision and Mission statements through a participatory process involving all the stakeholders and members of the Institute Advisory Committee.

Hindustan College of Science and Technology's Vision and Mission statements are as follows:

HCST VISION:

- HCST strives to impart a holistic knowledge-centric environment to serve humanity by providing research-oriented technical education to nurture global leaders and entrepreneurs.

HCST MISSION:

- Create an ecosystem to foster a culture of innovation, research, academic excellence, and entrepreneurship.
- Nurture technically competent and socially committed global leaders with high moral and ethical values.
- Impart outcome-based education to facilitate students for their holistic development.

Based on the HCST's Vision and Mission statements, the individual departments in the institute have created their respective departmental Vision and Mission statements through a participatory process involving different stakeholders, department professors, and members of the Program Advisory Committee (PAC) and Department Advisory Panel (DAP).

As an Example, the Computer Science and Engineering departmental Vison and Mission statements are presented below:

HCST-CSE VISION

- To be in the forefront of Computer Science and Engineering through academic excellence and research to successfully contribute to the country's nation-building initiatives, fostering ingenuity, values, and quality.

HCST-CSE MISSION

- To nurture brilliant engineers who are well-versed in both theory and practice in the field of basic sciences and Computer science and engineering
- To adopt a comprehensive strategy built on excellence, analytical ability, initiative, creativity, and innovation that guarantee computer science and engineering proficiency with a focus on interdisciplinary fields.
- To aid in nation building progress by responding to industry and societal demands by strengthening the economy via building socially relevant systems with prudence.
- Instil ethics and morals to develop work dignity and self-sacrifice to serve mankind.
- Provide Computer science and engineering students with an education centred upon well -defined outcomes in order to foster their holistic growth.

The HCST's Computer Science and Engineering departmental Vision and Mission creation process flow diagram is presented below in Figure 2.1.2.:

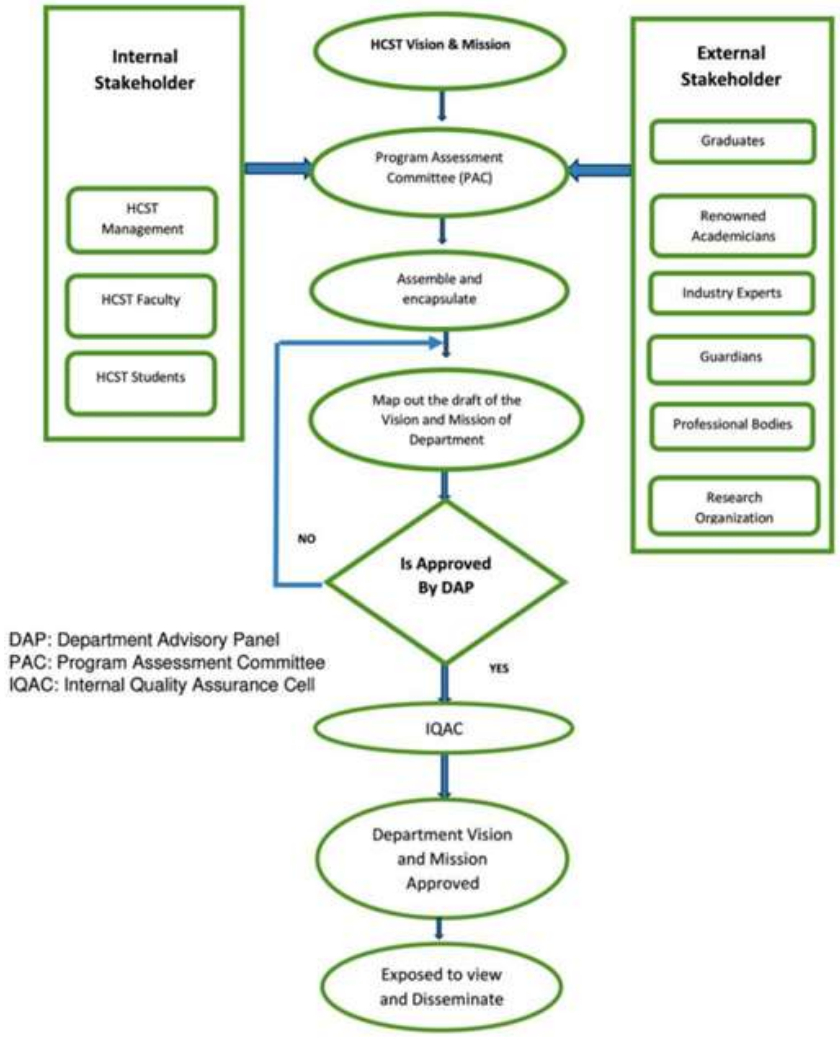


Figure 2.1.2: HCST-CSE Departmental Vision and Mission development process flow

During the process of developing the departmental Vision and Mission statements, utmost importance is placed on ensuring a strong qualitative alignment between the Institute's Vision and Mission statements by all the departments of the institute.

2.2 CREATION OF PROGRAM EDUCATION OBJECTIVES (PEOs)

PEOs mainly depend upon the Goals, Mission and Vision statements of the department along with the inputs from all its stakeholders like parents, students, society, environment, regional, national interests and graduate attributes. In general, PEOs are broad statements that describe w expected to attain after and within few years of graduation. PEOs are designed for e is offered by the departments in the institute.

A generic framework for designing PEOs presented below:

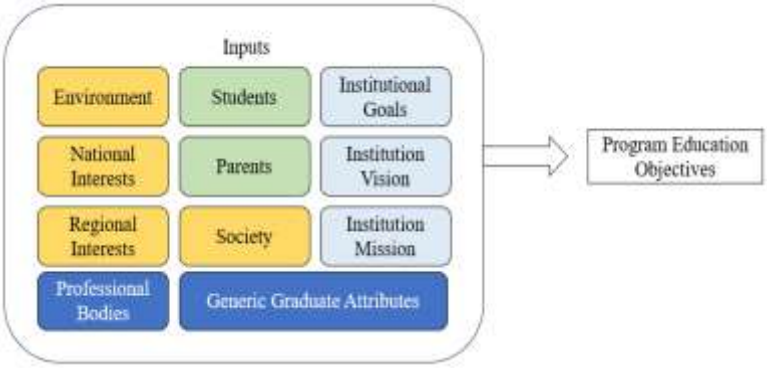


Figure 2.2.1: Generic framework for designing Program Education Objectives

During the process of developing the PEOs, utmost importance is placed on ensuring PEOs to have a strong qualitative correlation with the department's Mission statements.

The HCST's Computer Science and Engineering department's PEO development process flow diagram is presented below in Figure 2.2.2:

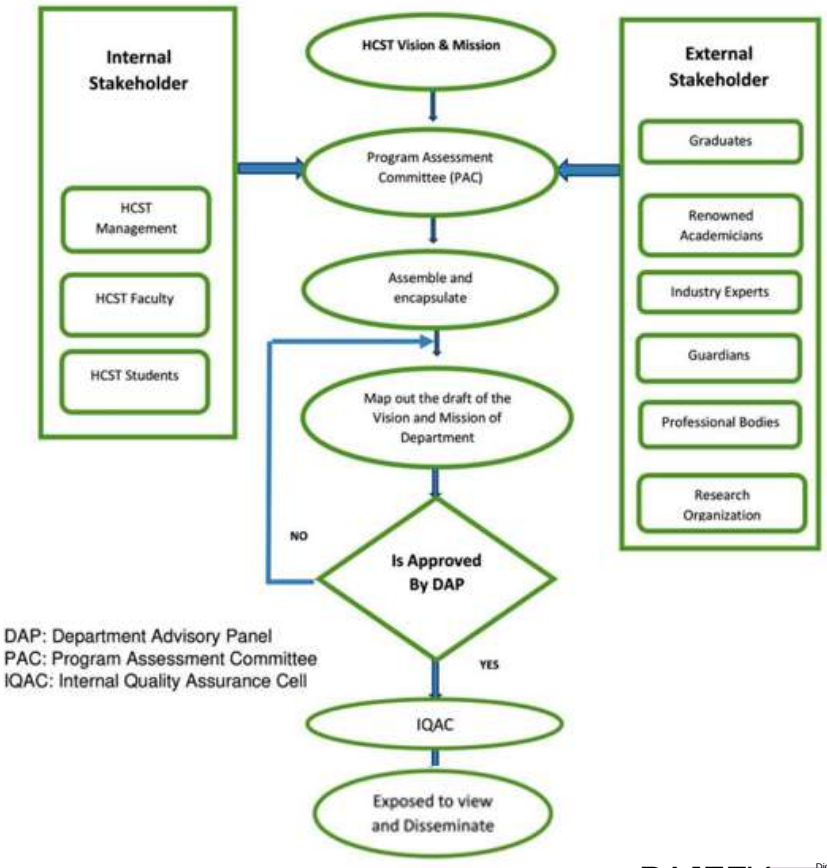


Figure 2.2.2: HCST-CSE Departmental process flow diagram for designing Program Educa

The PEOs for the BTech Computer Science and Engineering program are presented below:

- To provide foundational abilities in the basic sciences, analytical skills, and engineering basics to enable students to successfully develop an engineering and analytical mentality.
- To expose students broadly to the state-of-the-art in the field of computer science and engineering and to prepare them to conduct interdisciplinary research and to build socially relevant systems
- To encourage students to develop skills for lifelong learning, skills for being an innovator, entrepreneur and human values that will help them have to be a socially responsible individual and a successful career.

2.3 CREATION OF PROGRAM OUTCOMES (POs)

"Outcomes" are very different from "Objectives". Objectives are intended results or consequences of instruction, curricula, programs or activities, where as "Outcomes" are achieved results or consequences of what was learned, i.e., evidence that learning took place.

Program Outcomes are defined as the knowledge, skills, or behaviors that a student from a specific program should be able to demonstrate upon program completion.

The Program outcome statements should have the following characteristics:

- POs should be simple, distinctive and specific.
- POs should clearly indicate the level and type of competence that is required of graduates of a program.
- POs should identify program performance indicators
    - Areas/fields that are the focus of the assessment.
    - Knowledge, abilities, values and attitudes that a student in the program is expected to have.
    - Expected depth of the knowledge, abilities, values and attitudes.
- POs should map program performance indicators to Revised Blooms Taxonomy
- POs should be traceable to PEOs

Washington Accord's Program Outcomes are the guidelines for representing generic Program Outcomes for majority of internationally recognized Engineering and Management programs.

Hindustan College of Science and Technology (HCST) is affiliated with Dr. A.P.J Abdul Kalam Technical University (AKTU), Lucknow, and follows the curriculum prescribed by AKTU. AKTU aligned all their programs with the standard Washington Accord's 12 Program Outcomes. Following AKTU guidelines, HCST aligned all the professional engineering and management courses with the standard 12 generic Program outcomes prescribed by the Washington Accord.

The twelve Washington Accord's Program Outcomes are as follows:

- PO-1: Engineering Knowledge - Ability to apply knowledge of mathematics, science, mechanical engineering fundamentals and specialization to the solutions of complex engineering problems;

- PO-2: Problem Analysis - Ability to identify, formulate, conduct research literature and analyze complex engineering problems using principles of mathematics, natural sciences and mechanical engineering sciences;

- PO-3: Design/Development of Solutions - Ability to design mechanical solutions for complex engineering problems and systems, components or processes that meet specified needs;

- PO-4: Investigation - Ability to conduct investigation of complex problems using research-based knowledge and research methods to provide valid conclusions;

- PO-5: Modern Tools: Ability to develop and apply appropriate techniques, resources, and innovative engineering tools to complex mechanical engineering activities;

- PO-6: The Engineer and Society - Ability to apply contextual knowledge to assess societal, health, safety, legal and cultural issues with the awareness of the consequent responsibilities to professional mechanical engineering practice for the betterment of society;

- PO-7: Environment and Sustainability - Ability to understand the impact of professional mechanical engineering solutions in societal, economic and environmental contexts and demonstrate knowledge of and need for sustainable development;

- PO-8: Ethics - Ability to apply ethical principles and demonstrate commitment to professional ethics, responsibilities and norms of mechanical engineering practice;

- PO-9: Communication - Ability to communicate effectively on complex engineering activities with the engineering community and with society at large;

- PO-10: Individual and Team Work - Ability to demonstrate knowledge and understanding of mechanical engineering and management principles and apply these effectively as an individual, a member or a leader in diverse teams and in multidisciplinary settings;

- PO-11: Project Management and Finance - Ability to demonstrate knowledge and understanding of project management, finance principles, business development within the scope of mechanical engineering practices.

- PO-12: Life Long Learning - Ability to recognize the need for, and have th… cation and ability to engage in independent and life-long learning in the co… ontext of technological change in mechanical engineering practice

From the below Figure 2.3.1 we can observe that, all the POs are categorized into four dimensions such as Academic, Professional skills, Values and Ethics, and Social Sensibilities.

Figure 2.3.1: Dimensions of Program outcomes

Every PO should describe the competency that a student can demonstrate after going through the learning experience and completing the program. In general, competency is a general statement that describes the desired knowledge, skills, and behaviours of a student graduating from a program (or completing a course). Competencies are obtained or developed during the process of learning by the student/learner. Competencies represent a dynamic combination of knowledge, understanding, skills and abilities implied by a program outcome statement. Fostering competences is the object of educational program initiatives. Actual competencies will be formed in various course units and assessed at different stages.

In general, a POs should clearly indicate the level and type of competence that is to be achieved by the graduates of the program and a every competency should identify program performance indicators which describes the areas/fields that are the focus of the assessment and expected depth of Knowledge, abilities, values and attitudes that a student in the program is expected to have. The correlation between the Program Outcome, Competency and performance indicators is represented in below Figure 2.3.2.

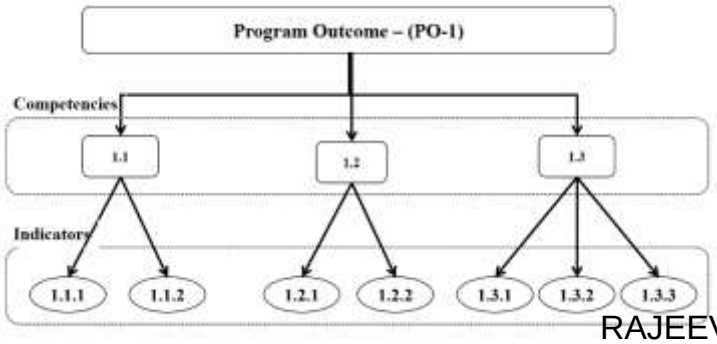


Figure 2.3.2: Relationship between POs, Competency and performance indicat

The Competencies and their associated performance indicators for each of the twelve program outcomes are well represented in Washington Accord's Program Outcome models. For depiction and better understanding, PO-2: Problem Analysis's Competencies and their associated performance indicators are presented in the table 2.3.1

We can observe from the table 2.3.1 that, the performance indicators clearly describe a key verb that describe the level of performance that needs to be exhibited by the graduating student to demonstrate the competency and to achieve the desired outcome.

PO 2: Problem analysis: Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences		
	Competency	Performance Indicators
2.1	Demonstrate an ability to identify and formulate complex engineering problem	Articulate problem statements and identify objectives
		Identify engineering systems, variables, and parameters to solve the problems
		Identify the mathematical, engineering and other relevant knowledge that applies to a given problem
2.2	Demonstrate an ability to formulate a solution plan and methodology for an engineering problem	Reframe complex problems into interconnected sub problems Identify, assemble and evaluate information and resources.
		Identify existing processes/solution methods for solving the problem, including forming justified approximations and assumptions
		Compare and contrast alternative solution processes to select the best process.
2.3	Demonstrate an ability to formulate and interpret a model	Combine scientific principles and engineering concepts to formulate model/s (mathematical or otherwise) of a system or process that is appropriate in terms of applicability and required accuracy.
		Identify assumptions (mathematical and physical) necessary to allow modeling of a system at the level of accuracy required.
2.4	Demonstrate an ability to execute a solution process and analyze results	Apply engineering mathematics and computations to solve mathematical models
		Produce and validate results through skilful use of contemporary engineering tools and Differentiate models and generate new models
		Identify sources of error in the solution process, and limitations of the solution
		Extract desired understanding and conclusions consistent with objectives and limitations of the analysis

Figure 2.3.1: PO-2: Competencies and their associated performance indicators

Performance indicators can utilize the revised Bloom's Taxonomy to indicate at what revised Bloom's taxonomy level the student is expected to perform. Revised Bloom's taxonomy describes levels of thinking skills. It represents 6 levels of thinking abilities as presented in the figure 2.3.3.

The bottom three levels are represented as Lower order thinking skills and upper three levels represent higher order thinking skills. The sample list of action words that can be used when creating the expected student learning outcomes related to critical thinking is presented in the below table 2.3.2

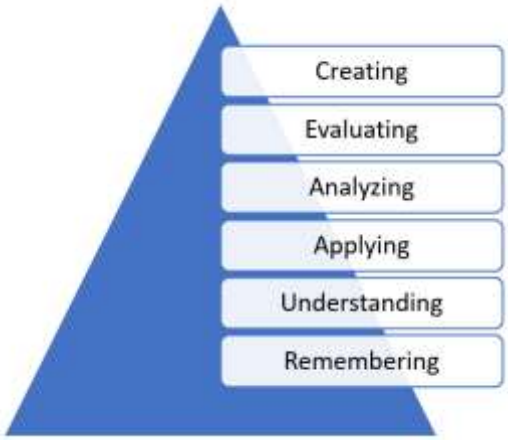


Figure 2.3.3: Revised Bloom's Taxonomy levels

Lower Order of Thinking (LOT)			Higher Order of Thinking (HOT)		
Remember	**Understand**	**Apply**	**Analyze**	**Evaluate**	**Create**
Define	Explain	Solve	Analyse	Reframe	Design
Describe	Describe	Apply	Compare	Criticize	Create
List	Interpret	Illustrate	Classify	Judge	Plan
State	Summarise	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

Table 2.3.2: Revised Bloom's Taxonomy keywords based on the levels

We can observe from the table 2.3.1 that, the keywords used in the performance indicator section help us to understand which revised Bloom's taxonomy level the student should demonstrate his/her competency. Integrating the revised Bloom's taxonomy level, we can demonstrate the seamless integration between the program outcome, competency, performance indicators and revised Bloom's taxonomy level as shown in the Table 2.3.3.

Program Outcome (PO1)				**Assessment Based on Blooms Taxonomy**					
C.S.No	Competency	I.S.No	Indicators	Remembering	Understanding	Applying	Analyzing	Evaluating	Creating
1.1	Competency 1	1.1.1	Indicator 1						
		1.1.2	Indicator 2						
1.2	Competency 2	1.2.1	Indicator 1						
		1.2.2	Indicator 2						
1.3	Competency 3	1.3.1	Indicator 1						
		1.3.2	Indicator 2						

Table 2.3.3: Template for PO-Competency, Performance indicator and Revised Blo integration

2.3.1 CREATION OF PROGRAM SPECIFIC OUTCOMES (PSOs)

Washington Accord's 12 generic Program Outcomes are the guidelines for representing Program Outcomes for majority of internationally recognized Engineering and Management programs. It is mandatory to have these 12 Program Outcomes to be achieved by any program to be recognized by the international bodies. To bring the flexibility, OBE model provides an opportunity to add more program outcomes specific to that program. These additional program outcomes are referred as Program Specific Outcomes (PSO). Generally, 2 to 4 Program Specific Outcomes (PSOs) could be created that demonstrate the program's focus and uniqueness.

Example of PSOs created by the HCST – CSE Department are presented below:

- Capability to design and develop effective technological solutions for complex business challenges, making use of the appropriate data structures, algorithms and database systems.
- The capacity to apply fundamental computing skills as well as contemporary computer programming languages and environments to build innovative research projects for the benefit of a social cause.
- The capacity to understand and implement software engineering process models, software design principles, and software project management methodologies in order to ensure the successful implementation of software projects.

2.4 CURRICULUM DEVELOPMENT, COURSE DESIGN and COURSE OUTCOMES (CO)

Program outcomes characterize Student's cumulative learning across courses at the end of the program, whereas Course outcomes identify "the ingredients" that make up the program. CO provides the Incremental knowledge and skills that students develop bit by bit throughout the program aligned with. While developing the course outcomes, it is at most important to keep the outcome statements to simple, achievable, measurable, realistic and timebound.

Once the Program outcomes are designed, aligning to the program outcomes, program competencies and program performance indicators, the course curriculum is designed followed by course objectives, Course outcomes, course competencies and course performance indicators. The overall integration is depicted table 2.4.1.

As Hindustan College of Science and Technology (HCST) is affiliated with Dr. A.P.J Abdul Kalam Technical University (AKTU), Lucknow, and follows the curriculum prescribed by AKTU. AKTU predefines the courses for each program and shares the planned Course Outcomes and their performance indicators using revised Bloom's taxonomy levels for most of the courses to bring the uniformity across all the affiliated institutions. Wherever the courses are assigned with well-defined Course Outcomes by the AKTU, HCST team will use the defined Course Outcomes. In case, for any specific program where Course Outcomes are not designed, the HCST team will design the Course Outcomes using the process defined by the departmental advisory committee.

PO-1: Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization for the solution of complex engineering problems.				Assessment Based on Blooms Taxonomy						CO-1: Engineering Mathematics - 1: Application of fundamental principles of Calculus to solve real world problems				Assessment Based on Blooms Taxonomy					
C.S. No	Competency	I.S. No	Indicators	Remembering	Understanding	Applying	Analyzing	Evaluating	Creating	C.S. No	Course Competency	I.S. No	Course Performance Indicators	Remembering	Understanding	Applying	Analyzing	Evaluating	Creating
1.1	Demonstrate competence in mathematical modeling	1.1.1	Apply mathematical techniques such as calculus, linear algebra, and statistics to solve problems							1.1	Demonstrate the ability to solve real world problems using Calculus	1.1.1	Apply Calculus to compute motion of a particle in Physics - Velocity, Acceleration and Distance travelled.						
												1.1.2	Apply optimization techniques to solve real world problems in economics and Engineering optimization problems.						
										1.2	Demonstrate the ability to solve real world problems using Differential Equations		Apply Laplace transformation to solve initial value problems						
		1.1.2	Apply advanced mathematical techniques to model and solve mechanical engineering problems																

Table 2.4.1: PO and CO Correlation and mapping

RAJEEV KUMAR UPADHYAY

Digitally signed by RAJEEV KUMAR UPADHYAY
DN: C=IN, O=Personal, PostalCode=282001, S=Uttar Pradesh, SERIALNUMBER=AA3E8C12CFAA9098785ACF2B07E25E09D7F5B87A4DCA301247D08CBAEE03B9A3, CN=RAJEEV KUMAR UPADHYAY
Reason: I am the author of this document
Location: your signing location here
Date: 2023.09.06 16:51:33+05'30'
Foxit PhantomPDF Version: 10.1.1

As an example, a well-defined course outcome along with its performance indicator levels for a BTech Computer Science and Engineering course from AKTU is presented below in table 2.4.2.

OPERATING SYSTEMS (KCS – 401)

Course Outcomes (COs):

CO No.	Statement of Course Outcome	Bloom's Knowledge Level
After completion of the course, the student will be able to		
CO1	Understand and classify operating systems based on their functions and list the components of an operating system.	K2
CO2	Understand concurrent processes and demonstrate how to solve classical problems in concurrency using synchronization mechanisms.	K3
CO3	Analyze and Evaluate CPU scheduling algorithms, analyze their performance criteria, and describe deadlock prevention, detection, and recovery mechanisms.	K2, K4
CO4	Understand and assess memory management techniques and discuss virtual memory concepts, and solve problems related to paging, segmentation, and page replacement algorithms.	K2, K3
CO5	Understand I/O management techniques, compare different disk scheduling algorithms, and discuss file system organization, implementation, and security.	K2, K4

Table 2.4.2: Course Outcomes and associated Blooms Taxonomy levels

2.5 MAPPING OF COs WITH POs AND PSOs

As we have seen from the OBE systems engineering process flow diagram presented in figure 1.0.1, the assessments are performed at the course level and the Course outcomes are measured. To compute the Program Outcomes, the Course Outcomes have to be mapped to Program Outcomes. Mapping of the Program Outcomes with the Course Outcomes is one of important steps in implementing the OBE.

A course outcome (CO) can be mapped one or many program outcomes and the association and the degree of correlation between the Course Outcome and the Program Outcome needs to be specified. The correlation can be "LOW", "MEDIUM" or "HIGH". For ease of computation, the above correlations are represented in numeric as 1, 2 and 3 respectively. If there is no correlation between CO and PO a '-' may be used to represent the same.

Very similar to CO-PO mapping, the correlation between the COs and the Program Specific Outcome (PSOs) are also mapped.

A sample CO-PO and PSO correlation mapping is presented below in table 2.5.1

HINDUSTAN COLLEGE OF SCIENCE & TECHNOLOGY INFORMATION TECHNOLOGY 2021-22															
SEMESTER	4TH							COURSE TEACHER		MR. AJAY PARASHAR					
COURSE CODE	KCS401							COURSE TITLE		OPERATING SYSTEM					
CO - PO Mapping															
CO5	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	2	-	-	-	-	-	-	2	-	3	3	3	-
CO2	3	3	2	1	-	-	-	-	-	1	-	3	3	3	-
CO3	3	3	3	3	-	-	-	-	-	2	-	3	3	3	-
CO4	3	3	2	3	-	-	-	1	-	2	-	3	3	3	-
CO5	3	2	3	2	-	-	-	2	-	1	-	3	3	3	-
Average	3	2.6	2.4	2.25	0	0	0	1.5	0	1.6	0	3	3	3	0

Table 2.5.1: CO-PO-PSO Mapping

The CO-PO-PSO mapping is to be documented by the subject teacher with proper justification and the mapping document should be reviewed by the course coordinator and approved by the departmental advisory panel. An example of CO-PO and CO-PSO Mapping justifications are presented below in table 2.5.2 and 2.5.3 respectively:

CO-PO Mapping Justification:

Course Outcome	Mapping Justification
CO1	PO1: Strongly mapped as the students will be able to gain foundational concepts of OS and their types.
	PO2: Moderately mapped as the students will be able to identify the types of OS and will be able to suggest problems associated with particular OS and how to solve it.
	PO3: Moderately mapped as the students will be to develop engineering based solutions related to OS.
	PO10: Moderately mapped as the students will be able to communication about the types of OS and Kernels along with the problems associated with them.
	PO12: Strongly mapped looking at the understanding of OS in current scenario, it will a life long learning for students.
CO2	PO1: Strongly mapped as the students will be able to gain the basic idea of concurrent processes.
	PO2: Strongly mapped as the students will be able to identify the problems related to concurrent processes in OS and their solutions.
	PO3: Moderately mapped as the students will be able to solve real life problems such as producer consumer problem, dining philosophers types of issues.
	PO4: Weakly mapped as the students will be able to try and conduct investigations related to problems related to OS.
	PO10: Weakly mapped as the students will be able to communicate the issues related to OS process synchronization etc.
	PO12: Strongly mapped as it will a life long learning for students.
CO3	PO1: Strongly mapped as the students will be able to gain the idea of CPU scheduling algorithms and deadlock.
	PO2: Strongly mapped as the students will be able to identify the problems related to CPU scheduling and deadlocks along with their resolutions.
	PO3: Strongly mapped as the students will be able to solve real life problems such as deadlocks in OS.
	PO4: Strongly mapped as the students will be able to conduct investigations related to problems related to CPU scheduling and Deadlocks such as the factors and conditions related to them.
	PO10: Moderately mapped as the students will be able to communicate the problems and conditions related to CPU scheduling algorithms such as FCFS, SJF, Priority, and Round Robin Scheduling and Bankers Algorithm.
	PO12: Strongly mapped as it will a life long learning for students due to their use in real life scenarios.
CO4	PO1: Strongly mapped as the students will be able to gain the idea of memory management schemes.
	PO2: Strongly mapped as the students will be able to identify the problems related to memory management such as fragmentation, thrashing etc.
	PO3: Moderately mapped as the students will be able to solve real life problems related to paging, segmentation and virtual memory etc.
	PO4: Strongly mapped as the students will be able to conduct investigations related to MFT, MVT, paging, segmentation, and virtual memory.
	PO8: Weakly mapped as students will get the idea about the use of memory in an ethical way because it is dealing with memory allocation techniques which may have some consequences.
	PO10: Moderately mapped as the students will be able to communicate the issue related with each of the memory management schemes in efficient way.
	PO12: Strongly mapped as it will a life long learning for students due to the uses of memory concept in almost all areas related to programming.
CO5	PO1: Strongly mapped as the students will be able to gain the idea of disk scheduling in depth.
	PO2: Moderately mapped as the students will be able to identify the problems related to disk scheduling schemes such as FCFS, SSTF etc.
	PO3: Strongly mapped as the students will be able to solve real life problems related to disk scheduling in minimum time as possible.
	PO4: Moderately mapped as the students will be able to conduct investigations related disk management strategies, file handling techniques etc.
	PO8: Moderately mapped as students will get the idea about the use of files, and directory management schemes. Also it deals with security mechanisms related to disks.
	PO10: Weakly mapped as the students will be able to communicate the issue related OS file systems.
	PO12: Strongly mapped as it will a life long learning for students due to the uses of disks, files and security mechanisms.

Table 2.5.2: CO-PO-Justification

RAJEEV KUMAR UPADHYAY

Digitally signed by RAJEEV KUMAR UPADHYAY
DN: C=IN, O=Personal, PostalCode=282001, S=Uttar Pradesh, SERIALNUMBER=AA3E8C12CFAA9098785ACF2B07E25E09D7F5B87A4DCA301247D08CBAEE03B9A3, CN=RAJEEV KUMAR UPADHYAY
Reason: I am the author of this document
Location: your signing location here
Date: 2023.09.06 16:51:34+05'30'
Foxit PhantomPDF Version: 10.1.1

CO-PSO Mapping Justification

Course Outcome	CO-PSO Mapping Justification
CO1	PSO1: Strongly mapped as the students will be able to get latest knowledge related to types of OS and will be able to understand real world issues.
	PSO2: Strongly mapped as the students will be able to use their communication skills while learning and will be able to understand how OS is used for problem solving.
CO2	PSO1: Strongly mapped as the students will be able to learn new skills to understand topics such as critical sections, semaphores etc.
	PSO2: Strongly mapped as the students will be able to use their critical thinking and problem solving skills to solve issue related to process synchronization.
CO3	PSO1: Strongly mapped as the students will be able to get the idea of latest algorithms used in CPU scheduling and how OS deals with deadlocks.
	PSO2: Strongly mapped as the students will be able to use their problem solving skills along with critical thinking to find the solutions of problems related to CPU scheduling and deadlocks.
CO4	PSO1: Strongly mapped as the students will be able to learn latest techniques used in memory managament in OS such virtual memory, buddy systems etc.
	PSO2: Strongly mapped as the students will be able to use their critical thinking and problem solving to solve issue related to MFT, MVT, paging, segmentation etc.
CO5	PSO1: Strongly mapped as the students will be able to learn latest techniques used in file management, file allocation techniques and storage techniques such as RAID.
	PSO2: Strongly mapped as the students will be able to use their critical thinking and problem solving to solve issue related to file allocations, disk scheduling schemes, and security mechanisms.

Table 2.5.3: CO-PSO-Justification

2.6 DEVELOPMENT OF ASSESSMENT STRATEGY AND EVALUTION

HCST follows AKTU's assessment strategy for implementing the student's continuous internal assessment and external university assessment. For each of the assessments, the institute's academic process framework is followed. A self-explanatory assessment strategy for Theory courses are presented below in figure 2.6.1 and in table 2.6.1, the correlation of every assessment with Course Outcomes is presented.

The Assessment plan for Theory course:

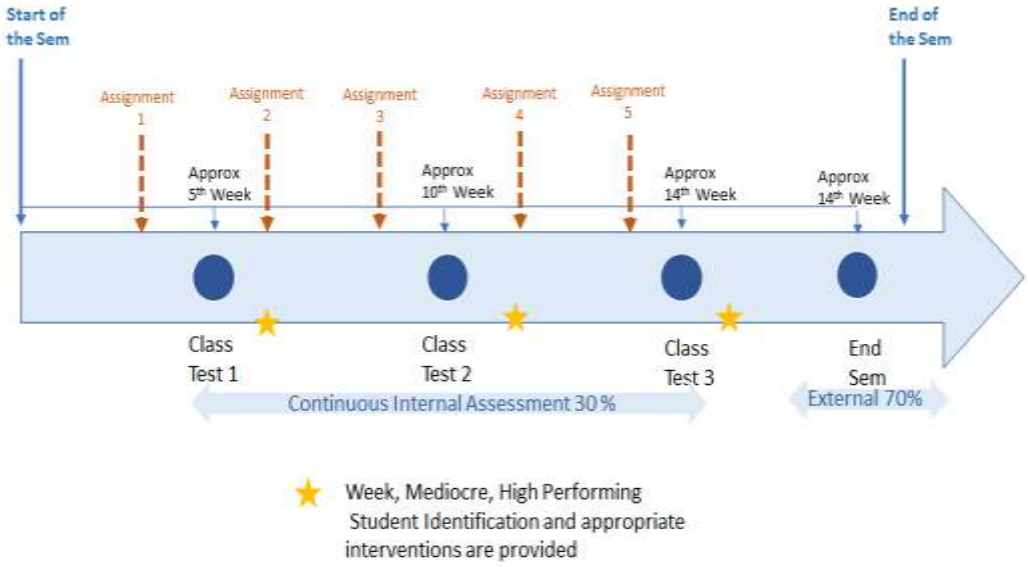


Figure 2.6.1: Assessment Strategy (Theory)

The below described table presents a generic high-level guideline for the assessment internal assessment type with the COs as per the AKTU university guidelines.

teacher can make necessary modifications with the approval of the concerned head of the department.

Assessment of Theory Courses

Internal Assessment	CO1	CO2	CO3	CO4	CO5
Class Test1	X	X			
Class Test2		X	X		
Class Test3 (PUT)	X	X	X	X	X
Class Test (Best 2 of 3)					
Class Assignment	X	X	X	X	X
Attendance	X	X	X	X	X

Table 2.6.1: Assessment type and its correlation with Course Outcomes (Theory)

For the successful implementation of the assessment strategy, HCST has implemented two important initiatives.

1. The internal class test question papers are prepared with COs and revised Bloom's taxonomy level
   - The template of the model question paper is attached as the Appendix-2
2. The recorded marks in the answer sheet are well documented based on COs
   - The template of the first page of the answer sheet to record the marks is attached as the Appendix-3

Similar to the Theory course, a self-explanatory Laboratory Assessment plan is presented below in figure 2.6.2

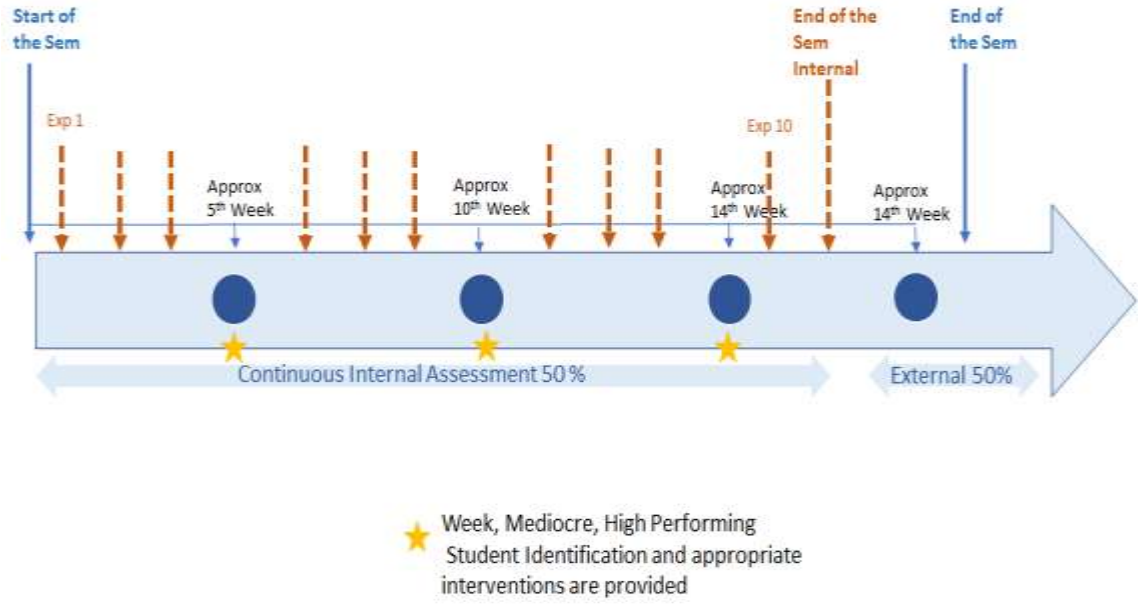


Figure 2.6.2: Assessment Strategy (Lab)

A generic high-level guideline for mapping of laboratory course's internal assessment with the COs as per the AKTU university guidelines is presented below in table 2.6.2. It is observed that, in some of the laboratory courses, the prescribed number of

limited to eight, whereas in some other courses it is prescribed more than 10 experiments. The subject teacher can make necessary modifications with the approval of the concerned head of the department.

Assessment of Practical Course

Internal Assessment	CO1	CO2	CO3	CO4	CO5
Experiment 1-2	X				
Experiment 3-4		X			
Experiment 5-6			X		
Experiment 7-8				X	
Experiment 9-10					X
Viva and Report	X	X	X	X	X
Attendance	X	X	X	X	X

Table 2.6.2: Assessment type and its correlation with Course Outcomes (Lab)

On the same lines, for the courses related to projects and internships internal and external assessment strategies are followed as per the AKTU's guidelines.

2.7 ATTAINMENT OF COURSE OUTCOMES

The calculation of Course Outcome is a structured process. HCST follows a 12 steps process for calculating the Course Outcomes. The steps are as follows:

- Step1: Define Internal and external course attainment level criteria
- Step2: Define Direct assessment ratio (Internal Vs External)
- Step3: Define Overall Direct and Indirect Attainment ratio
- Step 4: Define the marks for each of the assessment criteria and Course Outcome
- Step 5: Use of standardised tool
- Step 6: Enter the Course level basic information
- Step 7: Enter the Marks at CO level
- Step 8: Compute the Direct Internal assessment marks attainment
- Step 9: Compute the Direct External assessment marks attainment
- Step 10: Compute overall Direct attainment
- Step 11: Overall Attainment of the Course Outcomes
- Step 12: Compute POs attainment of the course

Each of the above steps are explained below in detail.

Step1: Define Internal and external course attainment level criteria:

Departmental internal review committee reviews the draft attainment level criteria for each of the courses created by the subject teacher/course coordinator and moderates as per the requirement and approves the respective subject attainment level criteria. The below table 2.7.1 describes the subject level CO attainment level criteria for a subject.

INTERNAL ATTAINMENT GUIDELINES		
CRITERIA	MARKS	ATTAINMENT LEVEL
LESS THAN	40	0
>40 & LESS THAN	60	1
>60 & LESS THAN	80	2
GREATER THAN	80	3

EXTERNAL ATTAINMENT GUIDELINES		
CRITERIA	MARKS	ATTAINMENT LEVEL
LESS THAN	40	0
>40 & LESS THAN	50	1
>50 & LESS THAN	65	2
GREATER THAN	65	3

Table 2.7.1: Course level internal and external attainment level criteria

Step2: Define Direct assessment ratios (Internal Vs External)

Based on the institute academic policy, define Direct (Direct Internal Assessment and External Assessment) attainment level. As HCST is affiliated to AKTU. AKTU has a well-defined policy for internal and external assessment policy for each course type. HCST will observe the AKTU's policy in defining the direct attainment ratio as presented in table 2.7.2.

DIRECT ATTAINMENT RATIO					
CRITERIA	THEORY	LAB	NTERNSHI	7-SEM PROJECT	8-SEM PROJECT
INTERNAL	30%	50%	100%	100%	25%
EXTERNAL	70%	50%	0%	0%	75%

Table 2.7.2: Direct attainment Ratios – Internal Vs External

Step3: Define Overall Direct and Indirect Attainment ratio

As per the institute guidelines, institute can decide on the direct and indirect attainment percentages. In general NBA guidelines suggest direct vs indirect can be 80:20 as shown in table 2.7.3. But this can be moderated to 90:10 or 70:30 depending upon the institute guidelines.

DIRECT AND INDIRECT ATTAINMENT	
CRITERIA	PERCENTAGE
DIRECT	80%
INDIRECT	20%

Table 2.7.3: Direct Vs Indirect attainment ratio

Step 4: Define the marks for each of the assessment criteria and Course Outcome

As per the AKTU guidelines, HCST allocates the internal marks in the following criteria

1. 30 Marks for Internal Subjective Test (CT1, CT2 and CT3)

    a. Equally dividing the 30 Marks into number of COs identified for the course.
    b. As the number of COs designed by AKTU for each subject is 5, each CO carries 6 Marks
    c. A deviation of about 10% marks variation between the COs can be considered after the approval from the HOD.
2. 10 Marks for Additional Assignment
    a. Equally dividing the 10 Marks into number of COs identified for the course.
    b. As the number of COs designed by AKTU for each subject is 5, each CO carries 2 Marks
3. 10 Marks for Classroom Attendance
    a. Equally dividing the 10 Marks into number of COs identified for the course.
    b. As the number of COs designed by AKTU for each subject is 5, each CO carries 2 Marks

Step 5: Use of standardised tool

For computing the Course outcomes for each of the subject, HCST has designed a standard spread sheet with relevant details to automatically computing the COs given the input continuous assessment marks. The details of the template can be observed in Step 7 through Step 12.

Step 6: Enter the Course level basic information

In the first sheet the following details are entered:

- CO-PO-PSO Mapping and the system computes weighted average of each PO's impact for all the COs
- CO-PO-PSO Mapping Justification
- Define Benchmarks discussed in Step 1 through Step 4 – (This information will be used in other sheets)
    - Define Internal assessment attainment benchmark level
    - Define External assessment attainment benchmark level
    - Define Direct attainment (internal vs external) percentage
    - Overall Direct and Indirect attainment ratio

Step 7: Enter the Marks obtained at CO level:

The following details are entered in the second sheet

- Enter the student roll numbers enrolled into the subject
- Enter the Class test marks by CO
- Enter the Class Additional Assessment marks (Class Assignment + Attendance) by CO
- Enter the Informal Feedback Attainment – (Appendix -1)
- Enter the External Marks

The informal attainment form provides the teaching staff on the actual understanding of the subject by the student in each of the Course outcomes from CO1 to CO5. The informal attainment feedback is advised to collect from each student after every CO course completion. Informal attainment feedback form is included as an Appendix-1 at the end of the document. Though it is advised to take the informal attainment feedback after completion of every CO syllabus, for the demonstration, the informal attainment feedback form contains all the CO based question in one form.

The actual data sheet is attached below for better understanding. The overall internal marks (CT+TA+AT) are automatically computed as shown in the table 2.7.4 .

Roll No	CT MARKS OUR OF 30					TA + AT MARKS					Overall Interal Marks (CT+TA+AT)					Total CT	Total TA	Total Internal	STUDENT FEEDBACK ON THE BASIS OF PERCENTAGE DIVIDE EQUALLY IN ALL CO'S					University Exam Marks
	Interal Marks					Interal Additional Assessment					Interal Marks								Informal Attainment					External Marks
	7	6	6	6	5	4	4	4	4	4	11	10	10	10	9	CT	TA	50	3	3	3	3	3	100
	CO1	CO2	CO3	CO4	CO5	CO1	CO2	CO3	CO4	CO5	CO1	CO2	CO3	CO4	CO5	30	20		CO1	CO2	CO3	CO4	CO5	ALL COs
2000640130001	4.2	3.6	3.6	3.6	3	2.4	2.4	2.4	2.4	2.4	6.6	6	6	6	5.4	18	12	30	3	2	3	3	3	48
2000640130003	6.3	5.4	5.4	5.4	4.5	4	4	4	4	4	10	9.4	9.4	9.4	8.5	27	20	47	3	2	3	2	2	44
2000640130004	4.7	4	4	4	3.3	3	3	3	3	3	7.7	7	7	7	6.3	20	15	35	3	3	3	2	3	58
2000640130005	4.2	3.6	3.6	3.6	3	2.4	2.4	2.4	2.4	2.4	6.6	6	6	6	5.4	18	12	30	2	2	2	3	2	38
2000640130006	7.0	6	6	6	5	4	4	4	4	4	11	10	10	10	9	30	20	50	3	3	3	3	3	78
2000640130007	4.2	3.6	3.6	3.6	3	2.4	2.4	2.4	2.4	2.4	6.6	6	6	6	5.4	18	12	30	2	3	2	3	3	43
2000640130008	6.3	5.4	5.4	5.4	4.5	4	4	4	4	4	10	9.4	9.4	9.4	8.5	27	20	47	2	2	3	3	3	34
2000640130009	4.7	4	4	4	3.3	2.4	2.4	2.4	2.4	2.4	7.1	6.4	6.4	6.4	5.7	20	12	32	2	2	2	2	2	19
2000640130010	5.1	4.4	4.4	4.4	3.7	2.6	2.6	2.6	2.6	2.6	7.7	7	7	7	6.3	22	13	35	3	3	3	3	2	64
2000640130011	4.7	4	4	4	3.3	3	3	3	3	3	7.7	7	7	7	6.3	20	15	35	2	3	2	3	2	41

Table 2.7.4: Template for entering the Internal Marks, External Marks and the Informal Attainment

Step 8: Compute the Direct Internal assessment marks attainment

In this step, the internal marks computed in Step 7 are converted into its respective percentages and based on the internal attainment guidelines, the internal (Direct) attainment is computed as shown the below table 2.7.5.

INTERNAL ATTAINMENT GUIDELINES		
LESS THAN	40	0
>40 & LESS THAN	60	1
>60 & LESS THAN	80	2
GREATER THAN	80	3

Interal Marks						Internal Marks Percentage					Internal Attainment (Direct)				
11	10	10	10	9	50	11	10	10	10	9					
CO1	CO2	CO3	CO4	CO5	total	CO1	CO2	CO3	CO4	CO5	CO1	CO2	CO3	CO4	CO5
6.6	6	6	6	5.4	30	60	60	60	60	60	2	2	2	2	2
10	9.4	9.4	9.4	8.5	47	94	94	94	94	94	3	3	3	3	3
7.7	7	7	7	6.3	35	70	70	70	70	70	2	2	2	2	2
6.6	6	6	6	5.4	30	60	60	60	60	60	2	2	2	2	2
11	10	10	10	9	50	100	100	100	100	100	3	3	3	3	3
6.6	6	6	6	5.4	30	60	60	60	60	60	2	2	2	2	2
10	9.4	9.4	9.4	8.5	47	94	94	94	94	94	3	3	3	3	3
7.1	6.4	6.4	6.4	5.7	32	64	64	64	64	64	2	2	2	2	2
7.7	7	7	7	6.3	35	70	70	70	70	70	2	2	2	2	2
7.7	7	7	7	6.3	35	70	70	70	70	70	2	2	2	2	2

Table 2.7.5: Template for computing internal direct Attainment

Step 9: Compute the Direct External assessment marks attainment

In this step, the external marks recorded in the previous sheet is reflected. The external marks from AKTU are not presented based on the COs. They are just presented based on 100 marks. In this step, we calculate the overall percentage of marks scored by the student and we use the same percentage in each of the COs identified. Once the percentage is distributed across all the COs, the Direct external attainment for all the COs is computed using the

External attainment guidelines presented. The details of the direct external attainment calculations are shown in the table below 2.7.6.

EXTERNAL ATTAINMENT GUIDELINES		
LESS THAN	35	0
>40 & LESS THAN	40	1
>50 & LESS THAN	55	2
GREATER THAN	65	3

External Percentage					External Marks	External Attainment (Direct)				
20	20	20	20	20	100	3	3	3	3	3
CO1	CO2	CO3	CO4	CO5	ALL COs	CO1	CO2	CO3	CO4	CO5
48	48	48	48	48	48	2	2	2	2	2
44	44	44	44	44	44	2	2	2	2	2
58	58	58	58	58	58	3	3	3	3	3
38	38	38	38	38	38	1	1	1	1	1
78	78	78	78	78	78	3	3	3	3	3
43	43	43	43	43	43	2	2	2	2	2
34	34	34	34	34	34	0	0	0	0	0
19	19	19	19	19	19	0	0	0	0	0
64	64	64	64	64	64	3	3	3	3	3
41	41	41	41	41	41	2	2	2	2	2

Table 2.7.6: Template for computing External direct Attainment

Step 10: Compute overall Direct attainment

The overall Direct attainment is computed by consolidating the direct internal attainment and the direct external attainment based on the direct attainment ratio presented before. For all the AKTU theory courses, 30% direct internal attainment is considered and 70% direct external attainment is considered for computing the overall direct attainment.

Overall Direct attainment = 30% Internal direct attainment + 70% external direct attainment

The overall direct attainment computation is presented in the table 2.7.7 below:

INTERNAL ATTAINMENT GUIDELINES		
LESS THAN	40	0
>40 & LESS THAN	60	1
>60 & LESS THAN	80	2
GREATER THAN	80	3

EXTERNAL ATTAINMENT GUIDELINES		
LESS THAN	35	0
>40 & LESS THAN	40	1
>50 & LESS THAN	55	2
GREATER THAN	65	3

DIRECT ATTAINMENT RATIO	
INTERNAL	0.300
EXTERNAL	0.700

Internal Attainment (Direct)					External Percentage					External Marks	External Attainment (Direct)					DIRECT (Internal + External) Attainment				
					20	20	20	20	20	100	3	3	3	3	3	3	3	3	3	3
CO1	CO2	CO3	CO4	CO5	CO1	CO2	CO3	CO4	CO5	ALL COs	CO1	CO2	CO3	CO4	CO5	CO1	CO2	CO3	CO4	CO5
2	2	2	2	2	48	48	48	48	48	48	2	2	2	2	2	2	2	2	2	2
3	3	3	3	3	44	44	44	44	44	44	2	2	2	2	2	2.3	2.3	2.3	2.3	2.3
2	2	2	2	2	58	58	58	58	58	58	3	3	3	3	3	2.7	2.7	2.7	2.7	2.7
2	2	2	2	2	38	38	38	38	38	38	1	1	1	1	1	1.3	1.3	1.3	1.3	1.3
3	3	3	3	3	78	78	78	78	78	78	3	3	3	3	3	3	3	3	3	3
2	2	2	2	2	43	43	43	43	43	43	2	2	2	2	2	2	2	2	2	2
3	3	3	3	3	34	34	34	34	34	34	0	0	0	0	0	0.9	0.9	0.9	0.9	0.9
2	2	2	2	2	19	19	19	19	19	19	0	0	0	0	0	0.6	0.6	0.6	0.6	0.6
2	2	2	2	2	64	64	64	64	64	64	3	3	3	3	3	2.7	2.7	2.7	2.7	2.7
2	2	2	2	2	41	41	41	41	41	41	2	2	2	2	2	2	2	2	2	2

Table 2.7.7: Template for Overall direct attainment computation

Step 11: Overall Attainment of the Course Outcomes

The overall attainment of the Course Outcomes is computed by consolidating the informal (indirect) attainment obtained from the student informal feedback forms recorded earlier in step 7 and the overall direct attainment computed in the previous step 10. The consolidation is based on the overall attainment ratio defined earlier. In this case, 80% overall direct attainment and 20% informal attainment is considered.

Overall Attainment = 80% overall direct attainment + 20% of informal (Indirect) attainment

The overall attainment computation is presented in the table 2.7.8 below:

DIRECT ATTAINMENT RATIO	
INTERNAL	0.300
EXTERNAL	0.700

OVERALL ATTAINMENT RATIO	
DIRECT	0.80
INDIRECT	0.20

DIRECT (Internal + External) Attainment					Informal Attainment					overall Attainment				
3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO1	CO2	CO3	CO4	CO5	CO1	CO2	CO3	CO4	CO5	CO1	CO2	CO3	CO4	CO5
2	2	2	2	2	3	2	3	3	3	2.2	2	2.2	2.2	2.2
2.3	2.3	2.3	2.3	2.3	3	2	3	2	2	2.4	2.2	2.4	2.2	2.2
2.7	2.7	2.7	2.7	2.7	3	3	3	2	3	2.8	2.8	2.8	2.6	2.7
1.3	1.3	1.3	1.3	1.3	2	2	2	3	2	1.4	1.4	1.4	1.6	1.4
3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
2	2	2	2	2	2	3	2	3	3	2	2.2	2	2.2	2.2
0.9	0.9	0.9	0.9	0.9	2	2	3	3	3	1.1	1.1	1.3	1.2	1.3
0.6	0.6	0.6	0.6	0.6	2	2	2	2	2	0.9	0.9	0.9	0.9	0.9
2.7	2.7	2.7	2.7	2.7	3	3	3	3	2	2.8	2.8	2.8	2.7	2.6
2	2	2	2	2	2	3	2	3	2	2	2.2	2	2.2	2
Average Attainment of each CO										2.1	2.1	2.1	2.1	2.1

Table 2.7.8: Template for Overall (direct and indirect) attainment computation

The overall Course outcome computation consolidating from steps 8 through step 11 is presented in table 2.7.9 below:

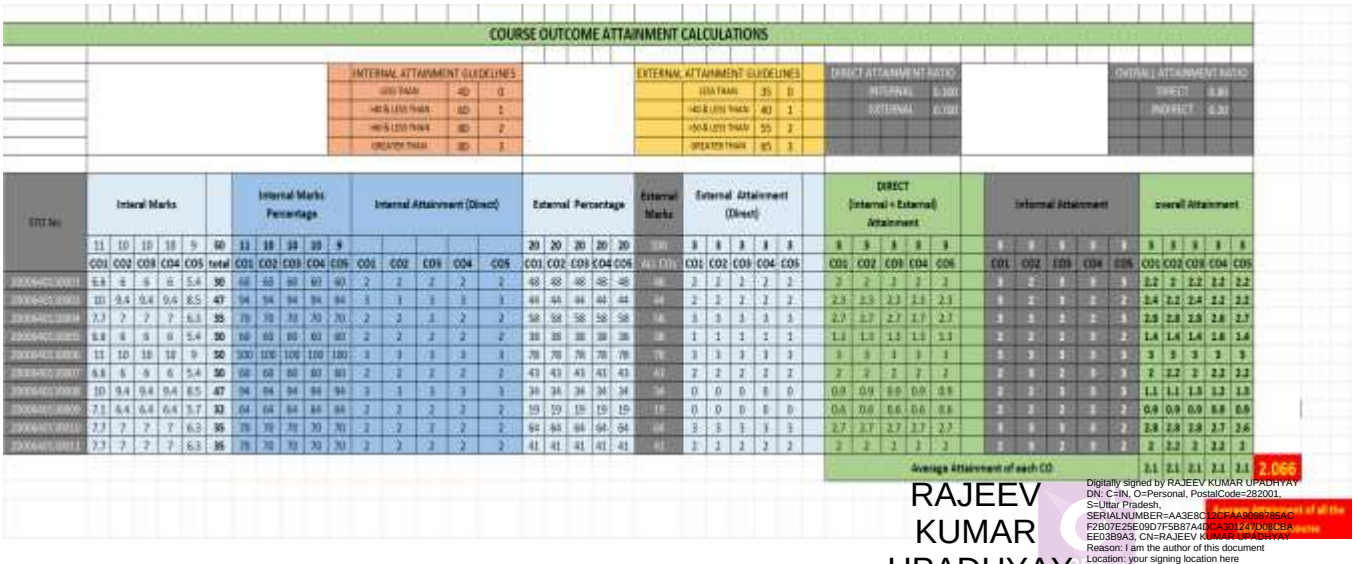


Table 2.7.9: Template for Overall Course Outcomes attainment

From the above table 2.7.9 we can see that, the average attainment of all the COs is 2.066.

Step 12: Compute POs attainment of the course

After computing the average course outcome attainment, each impacted PO's and PSO's attainments are computed using the below formulae:

PO attainment =

*[(Weighted average value of the PO * Average attainment value of CO) / Maximum attainment value (3 in this case)]*

PSO attainment =

*[(Weighted average value of the PSO * Average attainment value of CO) / Maximum attainment value (3 in this case)]*

The Calculated PO Attainments are represented in the table 2.7.10 along with the visualization graph in figure 2.7.1 and the overall computed PSO attainments are presented in table 2.7.11 and the respective visualization is presented in figure 2.7.2.

Evaluation of PO Attainment			
AVERAGE CO ATTAINMENT			2.066
	PROGRAM OUTCOME	PO WEIGHTED AVERAGE	OVERALL PO ATTAINMENT
	PO1	3	2.066
	PO2	2.6	1.790533333
	PO3	2.4	1.6528
	PO4	2.25	1.5495
	PO5	0	0
	PO6	0	0
	PO7	0	0
	PO8	1.5	1.033
	PO8	0	0
	PO10	1.6	1.101866667
	PO11	0	0
	PO12	3	2.066

Table 2.7.10: Evaluation of PO Attainment

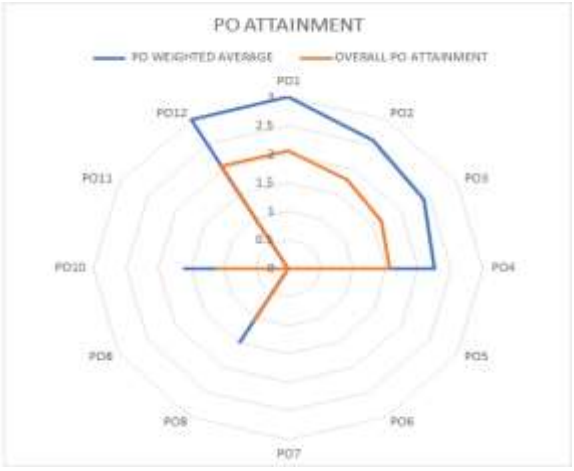


Figure 2.7.1: PO Attainment Visualization

Evaluation of PSO Attainment			
AVERAGE CO ATTAINMENT			2.066
	PROGRAM SPECIFIC OUTCOMES	PSO WEIGHTED AVERAGE	OVERALL PSO ATTAINMENT
	PSO1	3	2.066
	PSO2	3	2.066
	PSO3	0	0

Table 2.7.11: Evaluation of PSO Attainment

Figure 2.7.2: PSO Attainment

The overall PO-PSO attainment for the course, is also presented in the below table 2.7.12 for better visualization, understanding and comparison.

COMPUTER SCIENCE & ENGINEERING 2021-22						
SEMESTER	2nd				COURSE TEACHER	Dr.KAPIL SRIVASTAVA
COURSE CODE	C212				COURSE TITLE	DESIGN ANALYSIS OF ALGOEITHMS

CO - PO Mapping															
COS	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
C212.1	3	2	2	-	-	-	-	-	-	2	-	3	3	3	-
C212.2	3	3	2	1	-	-	-	-	-	1	-	3	3	3	-
C212.3	3	3	3	3	-	-	-	-	-	2	-	3	3	3	-
C212.4	3	3	2	3	-	-	-	1	-	2	-	3	3	3	-
C212.5	3	2	3	2	-	-	-	2	-	1	-	3	3	3	-
Weighted Average	3	2.6	2.4	2.3	0	0	0	1.5	0	1.6	0	3	3	3	0
PO Attainment	2.01	1.7	1.6	1.5	0	0	0	1	0	1.07	0	2.01	2.01	2.01	0

Table 2.7.12: Overall Attainment Vs Planned

Once we identify the difference between the weighted average of the PO/PSO values and the computed PO/PSO attainment values, it is important of understand and deliberate on why this variance is observed and what corrective actions needs to be explored to minimize the difference between the weighted average of the PO/PSO values and the computed PO/PSO attainment values.

The corrective measures can be recorded in the below format presented in table 2.7.13. The action plan can be referred and communicated back to the management for necessary steps to be considered when this subject is taught next time.

Evaluation of PO Attainment				
AVERAGE CO ATTAINMENT			2.008	
	PROGRAM OUTCOME	PO WEIGHTED AVERAGE	OVERALL PO ATTAINMENT	ACTION PLAN/ CORRECTIVE MEASURES
	PO1	3	2.008	
	PO2	2.6	1.740266667	
	PO3	2.4	1.6064	
	PO4	2.25	1.506	
	PO5	0	0	
	PO6	0	0	
	PO7	0	0	
	PO8	1.5	1.004	
	PO8	0	0	
	PO10	1.6	1.070933333	
	PO11	0	0	
	PO12	3	2.008	

Evaluation of PSO Attainment				
AVERAGE CO ATTAINMENT			2.008	
	PROGRAM SPECIFIC OUTCOMES	PSO WEIGHTED AVERAGE	OVERALL PSO ATTAINMENT	ACTION PLAN/ CORRECTIVE MEASURES
	PSO1	3	2.008	
	PSO2	3	2.008	
	PSO3	0	0	

Table 2.7.13: Template for defining the action plan for deviation of panned vs attained PO-PSO attainments

2.8 ATTAINMENT OF OVERALL PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

Once the Course Outcomes of all the courses are calculated, the overall Program Outcomes and Program Specific Outcomes can be computed using the following steps.

Step 1: Consolidate all the POs weighted average of all the courses

As an example, the list of courses and their associated PO and PSO weighted averages computed for each course for the BTech in Information Technology Program for the batch 2019-2023 has been presented below in table 2.8.1. The total of 58 number of courses are offered to the students in four-year BTech program and the overall weighted average of all these 58 course's POs and PSOs are further calculated.

HINDUSTAN COLLEGE OF SCIENCE & TECHNOLOGY

DEPARTMENT OF INFORMATION TECHNOLOGY

WEIGHTED AVERAGE OF CO-PO Mapping (2019-23 Batch)

S NO.	SESSION	SEM	SUB CODE	SUB NAME	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1			KAS103	Maths I	3.00	2.80	2.40									2.00			
2			KAS101	Physics	3.00	3.00				3.00						2.40			
3		I	KEE101	Basic Electrical Engineering	3.00	2.72	2.00												
4			KEE101P	EE Lab	2.00	2.20	1.80												
5			KAS101P	Physics Lab	2.20	2.00	1.25	1.25					3.00			2.00			
6			KWS201	Workshop Lab	3.00		3.00						3.00						
7	2019-20		KAS203	Maths II	3.00	3.00	2.80									2.80			
8			KAS102	Chemistry	2.20		3.00				1.80					1.40			
9			KCS201	CCP	3.00	3.00	3.00									3.00			
10		II	KAS204	Professional English									2.60	2.60		2.60			
11			KCE201	Graphics Lab	2.00			2.00	3.00										
12			KAS102P	Chemistry Lab	1.00	2.00			1.25	1.00			1.20			1.40			
13			KCE201P	CCP Lab	3.00	3.00	3.00									3.00			
14			KAS301	Technical Communication					2.00				1.00	3.00		2.00	1.20	1.00	
15			KAS302	MATHS-IV	2.60	2.80	1.60	2.67								2.00		2.00	
16			KCS301	Data Structure	3.00	3.00	3.00	2.60	2.40			1.60		1.80	2.60	3.00	2.60	3.00	
17			KCS302	COA	3.00	2.00	1.00										1.00	1.00	
18		III	KCS303	Discrete Structure & Theory of Logic	2.60	2.00	3.00	1.50	1.67							1.20	1.80	1.60	
19			KCS351	Data Structure LAB	2.40	2.20	2.40	2.40	2.40					2.80	2.40	2.60	3.00	3.00	
20			KCS352	Computer Organisation LAB	1.20	1.80	1.33										1.80	1.00	
21			KCS 353	Discrete Structure & Theory of Logic LAB	2.80	2.00	2.20	1.80	1.80							2.00	1.40	1.00	
22	2020-21		KCS354	Industrial Training LAB	2.25	2.00	1.75	2.25	1.33				1.25		1.25	1.25	1.50	1.50	1.50
23			KCS401	Operating System	3.00	2.60	2.40	2.25				1.50		1.60		3.00	3.00	3.00	
24			KCS402	Theory & Formal Language	1.20	2.20	2.20	1.60								1.20	1.60	1.80	1.00
25			KIT401	Web Design	1.80	1.80	2.60	1.20	2.00			2.00	2.00	2.00	2.00	2.20	2.60	2.00	
26		IV	KOE048	Electronics Engg.	3.00	2.00	1.00										1.00	1.00	
27			KVE401	Universal Human Values								3.00				3.00			
28			KCS451	Operating System LAB	3.00	3.00	2.60	3.00	1.50				1.00			2.00	3.00	3.00	
29			KIT451	Web Design LAB	2.00	1.60	1.40	2.00	1.60				1.25	1.50	2.50	2.60	1.40	1.20	
30			KCS453	Python Programming LAB	2.80	2.80	2.80	2.00	2.60			2.00	1.00	1.00	2.00	2.60	2.00	2.40	
31			KCS058	Human Computer Interface	2.25	2.67	3.00		2.00								1.40	1.60	
32			KCS501	Database Management System	2.60	2.40	3.00	2.50	2.40			2.00	1.40	2.20	1.40	2.20	2.80	2.60	2.60
33			KCS503	Design Analysis & Algorithms	3.00	2.40	3.00		2.60			2.00	1.00	2.00	2.00	3.00	3.00	2.60	2.40
34			KIT052	Compiler Design	2.00	2.20	2.60	2.00	1.20						1.00	2.20	1.20	1.20	
35		V	KIT501	Web Technology	2.40	2.80	2.00	1.00	1.80			2.00		2.00	2.00	2.20	3.00	2.60	
36			KCS551	Database Management System LAB	2.00	2.80	2.80	2.00	3.00			2.00	2.00	1.00	1.00	2.00	2.20	2.00	
37			KCS553	Design Analysis & Algorithms LAB	2.00	3.00	3.00	2.00	3.00			2.00	1.00	1.00	1.00	2.00	3.00	3.00	
38			KIT553	Web TechnologyLAB	3.00	2.00	2.00	1.00	2.00				3.00	2.00	2.40	3.00	3.00	2.60	
39	2021-22		KCS554	Industrial Training LAB	1.50	2.00	1.50	1.50	1.25	1.00		1.00	1.50	1.33	1.50	1.25	2.25	2.00	2.25
40			KCS064	Data Compression	2.40	2.20	2.60		1.00							2.00	1.60	1.60	
41			KCS601	Software Engg.	2.20	2.20	2.20	1.60	1.75	1.00			1.00		1.80	2.80	2.00	2.00	
42			KCS603	Computer Networks	2.20	2.00	2.40		3.00			2.00	1.20	2.00	2.00	2.60	2.60	2.60	2.40
43		VI	KIT601	Data Analytics	2.80	2.60	3.00	3.00	3.00	1.00	1.00	1.00	2.00	2.00	2.00	2.20	3.00	2.40	
44			KNC602	ICT								3.00	2.00			2.80			
45			KCS651	Software Engg. LAB	2.60	2.60	2.50	2.75	2.00		1.00	1.00	1.00	1.00	1.50	2.60	1.60	1.40	
46			KIT651	Data Analytics LAB	3.00	3.00	3.00	3.00	3.00							2.00	3.00	3.00	
47			KCS653	Computer Networks LAB	2.20	2.80	2.80		3.00			2.00	1.00	2.00	1.80	3.00	2.00	2.00	2.20
48			KCS074	Cryptography & Network Security	2.33	2.67			2.33								2.25	2.00	
49			KHU701	Rural Development						1.60	2.00	1.60	2.00		1.00	1.60			2.00
50			KIT071	Software Project Management	2.25	2.67	3.00		2.00								1.40	1.60	
51		VII	KOE076	Vision for Human Society					1.00	1.67	2.00	1.75		1.33		2.00	1.20	1.00	
52			KIT751A	Cryptography & Network Security LAB	2.60	2.80	3.00				2.50						1.20	1.20	
53	2022-23		KIT752	Industrial Training LAB	1.40	1.80	2.20	1.80	2.00	1.60		1.60	1.80	1.50	1.60	1.60	2.20	1.80	2.00
54			KIT753	PROJECT-I	1.60	2.20	2.25	1.80	1.40	1.00	1.00	1.00	1.80	1.00	2.25	2.00	2.20	2.00	2.40
55			KHU802	Cloud Computing	2.67	2.00	3.00		2.50								1.67	2.33	
56		VIII	KOE094	Digital & Social Media Marketing	2.40	2.00	2.25	1.75	2.25	1.33	2.00	2.00	1.75	3.00	2.00	2.50	1.40	1.60	
57			KHU802	Project Management & Entrepreneurship	2.00	3.00				2.00	2.67	2.25	2.50						
58			KIT851	PROJECT-II	1.60	2.20	2.25	1.80	1.40	1.00	1.00	1.00	1.80	1.00	2.25	2.00	2.2		
WEIGHTED AVERAGE					2.39	2.42	2.40	2.00	2.07	1.43	1.70	1.80	1.68	1.7					

Table 2.8.1: PO and PSO (planned) weighted averages computed for - BTech in IT

Step 2: Obtain the attainment values for PO and PSO of all the courses – (referred as Direct PO/PSO Attainment)

For all the 58 courses, consolidate the PO and PSO attainments achieved by each course and calculate the overall weighted average of all the POs and PSOs.

HINDUSTAN COLLEGE OF SCIENCE & TECHNOLOGY
DEPARTMENT OF INFORMATION TECHNOLOGY
AVERAGE OF FINAL ATTAINMENT (2019-23 Batch)

S NO.	SESSION	SEM	SUB CODE	SUB NAME	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1			KAS103	Maths I	1.95	1.82	1.56									1.30			
2			KAS101	Physics	2.62	2.62				2.62						2.62			
3		I	KEE101	Basic Electrical Engineering	2.04	1.87	1.36												
4			KEE101P	EE Lab	1.69	1.86	1.54												
5			KAS101P	Physics Lab	2.12	1.93	1.21	1.21					2.89			1.93			
6			KWS201	Workshop Lab	0.15		0.15						0.15						
7	2019-20		KAS203	Maths II	2.28	2.28	2.12									2.12			
8			KAS102	Chemistry	1.71		2.33				1.40					1.09			
9			KCS201	CCP	0.13	0.13	0.13									0.13			
10		II	KAS204	Professional English									1.13	1.13		1.13			
11			KCE201	Graphics Lab	1.71			1.71	2.57										
12			KAS102P	Chemistry Lab	0.93	1.85			0.93	0.93			0.93			0.93			
13			KCE201P	CCP Lab	2.61	2.61	2.61									2.61			
14			KAS301	Technical Communication					1.37				0.68	2.06		1.37	0.82	0.68	
15			KAS302	MATHS-IV	1.15	1.24	0.71	1.18								0.89		0.89	
16			KCS301	Data Structure	2.36	2.36	2.36	2.04	1.89			1.26		1.42	2.04	2.36	2.04	2.36	
17			KCS302	COA	1.70	1.13	0.56										0.56	0.56	
18		III	KCS303	Discrete Structure & Theory of Logic	1.85	1.42	2.13	1.06	1.18							0.85	1.28	1.14	
19			KCS351	Data Structure LAB	2.28	2.09	2.28	2.28	2.28					2.66	2.28	2.47	2.85	2.85	
20			KCS352	Computer Organisation LAB	1.17	1.75	1.30										1.75	0.97	
21			KCS 353	Discrete Structure & Theory of Logic LAB	2.66	1.90	2.09	1.71	1.71							1.90	1.33	0.95	
22	2020-21		KCS354	Industrial Training/Internship LAB	1.96	1.74	1.52	1.96	1.16				1.09		1.09	1.09	1.30	1.30	1.30
23			KCS401	Operating System	2.90	2.50	2.40	2.20				1.50		1.60		2.90	2.90	2.90	
24			KCS402	Theory & Formal Language	1.04	1.92	1.92	1.39								1.04	1.39	1.57	0.87
25			KIT401	Web Design	1.69	1.69	2.45	1.13	1.88			1.88	1.88	1.88	1.88	2.07	2.45	1.88	
26		IV	KOE048	Electronics Engg.	2.01	1.34	0.67										0.67	0.67	
27			KVE401	Universal Human Values								2.93				2.93			
28			KCS451	Operating System LAB	2.80	2.80	2.43	2.80	1.40				0.93			1.87	2.80	2.80	
29			KIT451	Web Design LAB	1.91	1.53	1.34	1.91	1.53				1.19	1.43	2.39	2.49	1.34	1.15	
30			KCS453	Python Programming LAB	2.55	2.55	2.55	1.82	2.37			1.82	0.91	0.91	1.82	2.37	1.82	2.19	
31			KCS058	Human Computer Interface	1.45	1.72	1.93		1.29								0.93	1.03	
32			KCS501	Database Management System	1.75	1.62	2.02	1.69	1.62			1.35	0.94	1.48	0.90	1.48	1.89	1.75	1.75
33			KCS503	Design Analysis & Algorithms	1.95	1.56	1.95		1.69			1.30	0.65	1.30	1.30	1.95	1.95	1.69	1.56
34			KIT052	Compiler Design	1.26	1.38	1.64	1.26	0.75						0.63	1.38	0.75	0.75	
35		V	KIT501	Web Technology	1.09	1.28	0.91	0.45	0.82			0.91		0.91	0.91	1.00	1.37	1.18	
36			KCS551	Database Management System LAB	1.78	2.49	2.49	1.78	2.66			1.78	1.78	0.89	0.89	1.78	1.95	1.78	
37			KCS553	Design Analysis & Algorithms LAB	1.69	2.54	2.54	1.69	2.54			1.69	0.85	0.85	0.85	1.69	2.54	2.54	
38			KIT553	Web TechnologyLAB	2.62	1.75	1.75	0.87	1.75				2.62	1.75	2.09	2.62	2.62	2.27	
39	2021-22		KCS554	Industrial Training LAB	1.25	1.67	1.25	1.25	1.04	0.83		0.83	1.25	1.11	1.25	1.04	1.88	1.67	1.88
40			KCS064	Data Compression	1.96	1.79	2.12		0.81							1.63	1.30	1.30	
41			KCS601	Software Engg.	1.52	1.52	1.52	1.11	1.21	0.69			0.69		1.24	1.94	1.39	1.38	
42			KCS603	Computer Networks	1.24	1.13	1.35		1.69			1.13	0.67	1.13	1.13	1.47	1.47	1.47	1.35
43		VI	KIT601	Data Analytics	1.92	1.78	2.05	2.05	2.05	0.68	0.68	0.68	1.37	1.37	1.37	1.51	2.05	1.64	
44			KNC602	ICT								2.16	1.44			2.02			
45			KCS651	Software Engg. LAB	2.54	2.54	2.44	2.68	1.95		0.97	0.97	0.97	0.97	1.46	2.54	1.54	1.36	
46			KIT651	Data Analytics LAB	2.81	2.81	2.81	2.81	2.81							1.87	2.81	2.81	
47			KCS653	Computer Networks LAB	2.05	2.61	2.61		2.79			1.86	0.93	1.86	1.67	2.79	1.86	1.86	2.05
48			KCS074	Cryptography & Network Security	1.61	1.84			1.61								1.56	1.38	
49			KHU701	Rural Development						1.11	1.39	1.11	1.39		0.69	1.11			1.39
50			KIT071	Software Project Management	1.71	2.02	2.28		1.52								1.06	1.21	
51		VII	KOE076	Vision for Human Society					0.61	1.03	1.23	1.08		0.82		1.23	0.74	0.61	
52			KIT751A	Cryptography & Network Security LAB	2.29	2.46	2.64				2.20						1.05	1.05	
53	2022-23		KIT752	Industrial Training/Internship LAB	1.10	1.42	1.73	1.42	1.57	1.26		1.26	1.42	1.18	1.26	1.26	1.73	1.42	1.57
54			KIT753	PROJECT-I	1.14	1.57	1.61	1.29	1.00	0.71	0.71	0.71	1.29	0.71	1.61	1.43	1.57	1.43	1.72
55			KHU802	Cloud Computing	1.86	1.39	2.09		1.74								1.16	1.62	
56		VIII	KOE094	Digital & Social Media Marketing	1.09	0.90	1.02	0.79	1.02	0.60	0.90	0.90	0.79	1.36	0.90	1.13	0.63	0.72	
57			KHU802	Project Management & Entrepreneurship	1.18	1.74				1.18	1.58	1.33	1.48				1.07	0.95	
58			KIT851	PROJECT-II	1.36	1.87	1.92	1.53	1.19	0.85	0.85	0.85	1.53						
WEIGHTED AVERAGE					1.77	1.84	1.80	1.62	1.61	1.04	1.19	1.36	1.21	1.22	1.09	1.73			

Table 2.8.2: PO – PSO Attainments for BTech – IT (2019-2023)

As an example, the list of courses and their associated PO and PSO attainments and their overall weighted averages are calculated for the BTech in Information Technology Program for 2019-2023 batch has been presented in table 2.8.2

Step 3: Obtain informal attainment from the final year students on the PO and PSO criteria and compute the average attainment at each PO and PSO level

Formula:
Average PO/PSO informal attainment =
(L1*no of students + L2 * no of students + L3 * no of students)/ total No of students

As an example, the informal attainment perceived by the BTech Information Technology program's final year students are recorded and the average as calculated as shown in the below table 2.8.3:

HINDUSTAN COLLEGE OF SCIENCE & TECHNOLOGY
DEPARTMENT OF INFORMATION TECHNOLOGY
INFORMAL PO & PSO ATTAINMENT (BATCH: 2019-2023)

S.NO.	STUDENT NAME	ROLL NO.	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	AMAN KUMAR SONI	190064013001	3	3	2	2	3	3	1	3	3	3	2	2	3	2	2
2	HIMANSHU MOOLCHANDANI	190064013002	3	3	3	3	2	1	2	2	3	3	3	3	2	3	1
3	KUNAL	190064013004	3	3	3	2	3	2	1	2	2	2	3	3	3	3	1
4	SEJAL JAIN	190064013005	2	3	3	3	3	2	2	3	3	3	2	2	3	2	2
5	URVASHI VERMA	190064013006	3	3	2	2	2	1	1	3	3	2	2	3	3	3	2
6	VIPLAV KANT RAI	190064013007	3	3	3	2	3	1	2	2	2	3	3	3	2	3	1
7	VIVEK SHARMA	190064013008	2	2	3	3	3	1	2	3	3	3	2	3	3	3	2
OVEALL INFORMAL PO-PSO ATTAINMENT			2.71429	2.857143	2.714286	2.428571	2.714286	1.571429	1.571429	2.571429	2.714286	2.714286	2.428571	2.714286	2.714286	2.714286	1.571429

Table 2.8.3: Informal Attainment of BTech Final Year Students on PO-PSO

Step 4: Compute Overall Attainment using the Overall Attainment ratio

The overall attainment integrating direct and informal attainment is calculated using the below formula and is presented in the table 2.8.4.

Formula:
Overall PO/PSO attainment =
(80% Direct PO/PSO Attainment + 20% Informal (Indirect) PO/PSO Attainment)

OVERALL ATTAINMENT CALCULATIONS

Direct/Indirect Attainment	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
Direct Attainment	1.772705	1.843337	1.795447	1.623052	1.610992	1.040514	1.190785	1.360435	1.208574	1.317994	1.39875	1.711647	1.610683	1.510238	1.59
Informal Attainment	2.714286	2.857143	2.714286	2.428571	2.714286	1.571429	1.571429	2.571429	2.714286	2.714286	2.428571	2.714286	2.714286	2.714286	1.571429
80% of the Direct Attainment	1.418164	1.47467	1.436358	1.298442	1.288794	0.832411	0.952628	1.088348	0.966859	1.054396	1.119	1.369318	1.288546	1.20819	1.272
20% of the Informal Attainment	0.542857	0.571429	0.542857	0.485714	0.542857	0.314286	0.314286	0.514286	0.542857	0.542857	0.485714	0.542857	0.542857	0.542857	0.314286
Overall Attainment	**1.961021**	**2.046099**	**1.979215**	**1.784156**	**1.831651**	**1.146697**	**1.266914**	**1.602634**	**1.509717**	**1.597253**	**1.604714**	**1.912175**	**1.831**		

Table 2.8.4: Overall attainment of BTech IT 2019-2023

After computing the overall attainments, compare the achieved POs and PSOs attainment values with the planned attainment values and document the plan of action to improve the attainment levels for the program as presented in table 2.8.5 and its comprehensive visualization is presented in figure 2.8.1

Planned Attainment	2.39	2.42	2.40	2.00	2.07	1.43	1.70	1.80	1.68	1.78	1.80	2.24	2.05	1.95	2.10
Achieved Atytianment	1.96	2.05	1.98	1.78	1.83	1.15	1.27	1.60	1.51	1.60	1.60	1.91	1.83	1.75	1.59

Table 2.8.5: Overall Attainment comparison with planned values

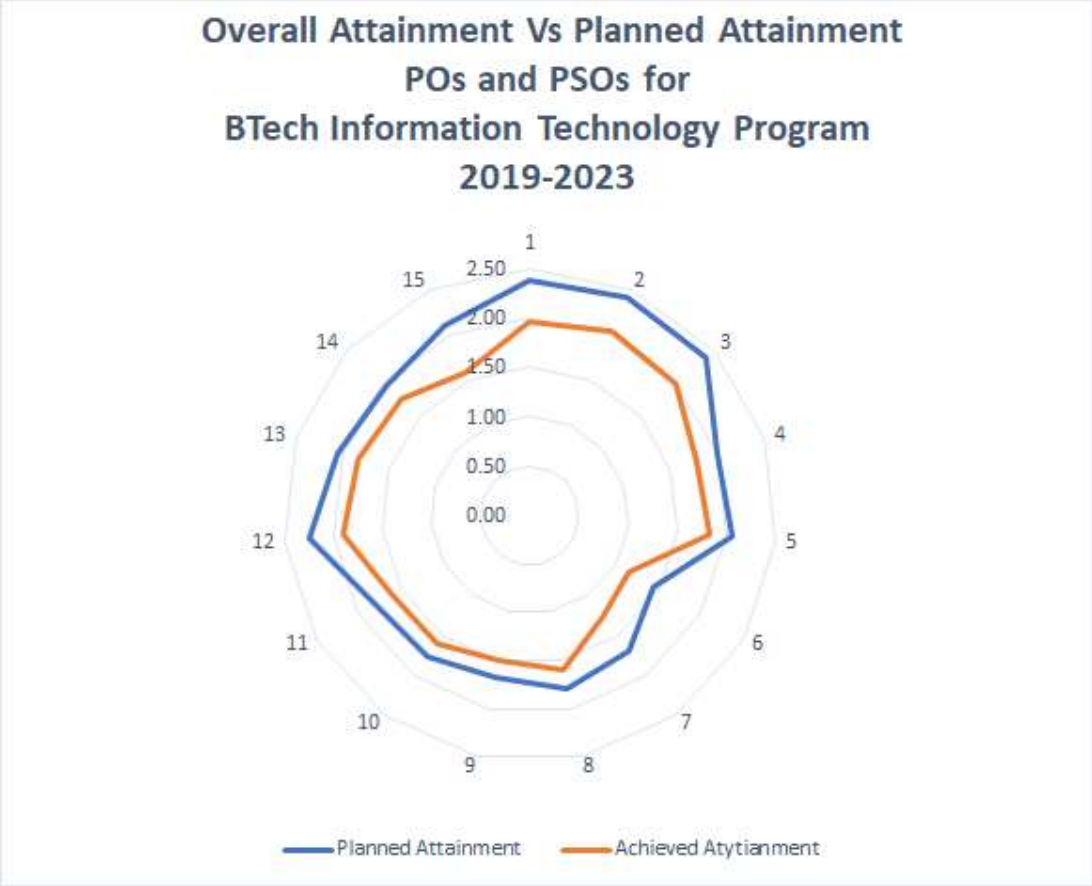


Figure 2.8.1: Visual analysis of the attainment values

2.9 EVALUATING THE PEOs

Evaluation of PEOs can be performed after by obtaining the feedback from the Alumni on Program Education objectives after 2 to 3 years of graduating from the program to understand the attainment of Program Educational Objectives and accordingly corrective measures and action plan is designed at the program level for further finetuning the processes

Appendix-1: Informal Attainment Feedback form

Hindustan College of Science & Technology (064)

Department of Information Technology

STUDENTS INFORMAL ATTAINMENT FEEDBACK FORM

Subject Name with code: Operating System (KCS401)

Course Name: B. Tech IV Sem (IT)

Student Name : …….

Section : …….

University Roll no. : …….

Note: Kindly rate yourself in the scale of (1,2,3) as indicated below:

: 1 for least able to answer

: 2 moderately able to answer

: 3 strongly able to answer

MARK ☑TICK APPROPRIATELY.

Course Outcome (CO)		Bloom's Knowledge Level (KL)
CO 1	Understand and classify operating systems based on their functions and list the components of an operating system.	K2
CO 2	Understand concurrent processes and demonstrate how to solve classical problems in concurrency using synchronization mechanisms.	K3
CO 3	Analyze and Evaluate CPU scheduling algorithms, analyze their performance criteria, and describe deadlock prevention, detection, and recovery mechanisms.	K2, K4
CO 4	Understand and assess memory management techniques and discuss virtual memory concepts, and solve problems related to paging, segmentation, and page replacement algorithms.	K2, K3
CO 5	Understand I/O management techniques, compare different disk scheduling algorithms, and discuss file system organization, implementation, and security.	K2, K4

Course Outcome (CO1)

Ques. A) Can you explain the different types of operating systems based on their functions and provide examples for each type?

FEEDBACK: □1 □2 □3

RAJEEV KUMAR UPADHYAY

Digitally signed by RAJEEV KUMAR UPADHYAY
DN: C=IN, O=Personal, PostalCode=282001, S=Uttar Pradesh, SERIALNUMBER=AA3E8C12CFAA9098785ACF2B07E25E09D7F5B87A4DCA301247D08CBAEE03B9A3, CN=RAJEEV KUMAR UPADHYAY
Reason: I am the author of this document
Location: your signing location here
Date: 2023.09.06 16:51:44+05'30'
Foxit PhantomPDF Version: 10.1.1

Ques. B) Do you know how the components of an operating system, such as the kernel, file system, and device drivers, work together to provide an environment for executing programs?
FEEDBACK: □1 □2 □3

Ques. B) Can you understand and classify operating systems based on their functions and list the components of an operating system.?
FEEDBACK: □1 □2 □3

Course Outcome (CO2)

Ques. A) Can you explain the concept of concurrency in operating systems, and why is it important?
FEEDBACK: □1 □2 □3

Ques. B) Do you know how synchronization mechanisms, such as semaphores or mutexes, can be used to solve classical concurrency problems like the “producer-consumer problem” or the “dining philosophers” problem"?
FEEDBACK: □1 □2 □3

Course Outcome (CO3)

Ques. A) Can you compare different CPU scheduling algorithms, such as First-Come, First-Served (FCFS) and Round Robin and able to discuss their advantages and disadvantages in terms of performance criteria like turnaround time and response time.
FEEDBACK: □1 □2 □3

Ques. B) Can you explain the concept of deadlock in operating systems and how can deadlock prevention, detection, and recovery mechanisms help in handling deadlock situations?
FEEDBACK: □1 □2 □3

Course Outcome (CO4)

Ques. A) Do you know and able to describe the concept of virtual memory and its advantages in operating systems.
FEEDBACK: □1 □2 □3

Ques. B) Given a scenario with a specific page replacement algorithm, such as Least Recently Used (LRU), Can you solve a problem related to page replacement by determining the page faults and the resulting page table changes?
FEEDBACK: □1 □2 □3

Course Outcome (CO5)

Ques. A) Can you explain the different I/O management techniques used in operating systems, such as polling, interrupts, and DMA with their advantages and disadvantages.
FEEDBACK: □1 □2 □3

Ques. B) Can you compare different disk scheduling algorithms, such as FCFS, SSTF, and SCAN and also analyze their performance criteria and provide examples to illustrate their behaviour.
FEEDBACK: □1 □2 □3

RAJEEV KUMAR UPADHYAY

Digitally signed by RAJEEV KUMAR UPADHYAY
DN: C=IN, O=Personal, PostalCode=282001, S=Uttar Pradesh, SERIALNUMBER=AA3E8C12CFAA9098785ACF2B07E25E09D7F5B87A4DCA301247D08CBAEE03B9A3, CN=RAJEEV KUMAR UPADHYAY
Reason: I am the author of this document
Location: your signing location here
Date: 2023.09.06 16:51:45+05'30'
Foxit PhantomPDF Version: 10.1.1

Appendix-2: Question paper format representing CO number for each of the questions

Hindustan College of Science & Technology (064)

Department of Information Technology

Class Test-1 (CT-1)

Subject Name with code: OPERATING SYSTEMS(KCS-401) **Max Marks: 30**
Sem. /Section: 4th Sem (IT-A) **Time: 01:30 Hrs.**

Course Name: B.Tech. (IT)

Course Outcomes (COs):

At the end of the course the student should be able to:

1. CO-1: Understand and classify operating systems based on their functions and list the components of an operating system.
2. CO-2: Understand concurrent processes and demonstrate how to solve classical problems in concurrency using synchronization mechanisms.
3. CO-3: Analyse and Evaluate CPU scheduling algorithms, analyze their performance criteria, and describe deadlock prevention, detection, and recovery mechanisms.
4. CO-4: Understand and assess memory management techniques and discuss virtual memory concepts, and solve problems related to paging, segmentation, and page replacement algorithms.
5. CO-5: Understand I/O management techniques, compare different disk scheduling algorithms, and discuss file system organization, implementation, and security.

Q. No.	Question	Marks	CO	Bloom's Knowledge Level (KL)
Section A Attempt All the parts (No Choice)		**(6X1 = 06)**		
A1	Which OS component is responsible for "Managing drivers for specific hardware devices"?	1	1	K1
A2	Define the following: (i) SMP (ii) POST	1	1	K1
A3	Discuss the Von-Neumann principle. Where it is applicable?	1	1	K1
A4	Which of the following is not true? (Multiple options may be correct) a) kernel is the program that constitutes the central core of the operating system b) kernel is the first part of the operating system to load into memory during booting c) kernel is made of various modules which cannot be loaded in running operating system d) kernel remains in the memory during the entire computer session	1	1	K2
A5	List the objectives of scheduling.	1	2	K1
A6	What do you understand by graceful degradation in OS?	1	1	K2
Section B Attempt any 03 Questions from this section.		**(3X5 =15)**		
B1	Differentiate between Multiprogramming, Multitasking, and Multiprocessing OS with a suitable diagram.	5	1	K2
B2	Elaborate the concept of System Call? Explain any three system calls. Differentiate between System Call and Interrupt.	5	1	

RAJEEV KUMAR UPADHYAY

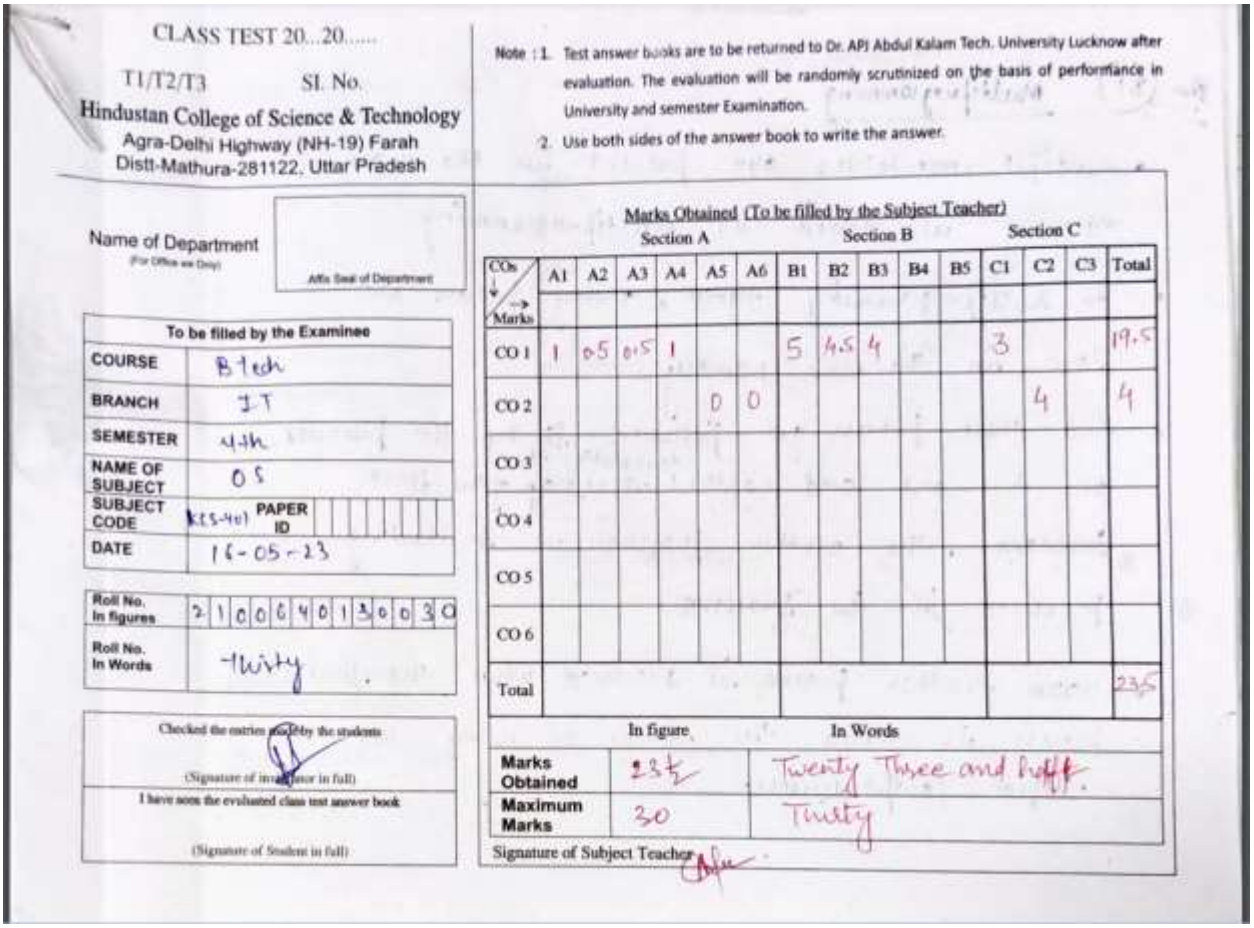
Digitally signed by RAJEEV KUMAR UPADHYAY
DN: C=IN, O=Personal, PostalCode=282001, S=Uttar Pradesh, SERIALNUMBER=AA3E8C12CFAA9098785ACF2B07E25E09D7F5B87ADCA301247D08CBAEE03B9A3, CN=RAJEEV KUMAR UPADHYAY
Reason: I am the author of this document
Location: your signing location here
Date: 2023.09.06 16:51:45+05'30'
Foxit PhantomPDF Version: 10.1.1

B3	Briefly explain the Microkernel Architecture of OS with a diagram. Also differentiate between Microkernel and Monolithic Architectures.	5	1	K2
B4	List some common file types in OS with their extensions, and functions. Also, explain at least 05 attributes of a file.	5	5	K1
B5	Which data structures serves as a central repository of information that the operating system uses to manage the process, and essential for implementing multitasking and time-sharing capabilities in modern operating systems. Explain with suitable diagram. Once the process is assigned to the CPU and starts executing, what are the possible scenarios that could occur and how OS deals with it?	5	2	K4
Section C Attempt <u>any 02</u> Questions from this section			**(2X4.5 =09)**	
C1	How OS deals with Interrupt that occurs while it is running a process, explain with the help of suitable diagram. Differentiate between Trap, Interrupt & Polling.	4.5	1	K2
C2	Why it is called that program is a passive entity while the process is an active entity? Draw and explain the state transition diagram for the process.	4.5	2	K2
C3	Write short note on: a) Disk based systems b) Blocking c) Free Space Management	4.5	5	K1

RAJEEV KUMAR UPADHYAY

Digitally signed by RAJEEV KUMAR UPADHYAY
DN: C=IN, O=Personal, PostalCode=282001, S=Uttar Pradesh, SERIALNUMBER=AA3E8C12CFAA9098785ACF2B07E25E09D7F5B87A4DCA301247D08CBAEE03B9A3, CN=RAJEEV KUMAR UPADHYAY
Reason: I am the author of this document
Location: your signing location here
Date: 2023.09.06 16:51:46+05'30'
Foxit PhantomPDF Version: 10.1.1

Appendix-3: First page of the Answer sheet for recording the CO level marks form



CLASS TEST 20...20.....

T1/T2/T3 Sl. No.

Hindustan College of Science & Technology
Agra-Delhi Highway (NH-19) Farah
Distt-Mathura-281122, Uttar Pradesh

Note : 1. Test answer books are to be returned to Dr. APJ Abdul Kalam Tech. University Lucknow after evaluation. The evaluation will be randomly scrutinized on the basis of performance in University and semester Examination.
2. Use both sides of the answer book to write the answer.

Name of Department (For Office use Only)

Affix Seal of Department

To be filled by the Examinee	
COURSE	B Tech
BRANCH	I T
SEMESTER	4th
NAME OF SUBJECT	O S
SUBJECT CODE	KCS-401 PAPER ID
DATE	16-05-23

Roll No. In figures	2 1 0 0 6 4 0 1 3 0 0 3 0
Roll No. In Words	Thirty

Checked the entries made by the students

(Signature of invigilator in full)

I have seen the evaluated class test answer book

(Signature of Student in full)

Marks Obtained (To be filled by the Subject Teacher)

	Section A						Section B					Section C			
COs → / Marks	A1	A2	A3	A4	A5	A6	B1	B2	B3	B4	B5	C1	C2	C3	Total
CO 1	1	0.5	0.5	1			5	4.5	4			3			19.5
CO 2					0	0							4		4
CO 3															
CO 4															
CO 5															
CO 6															
Total															23.5

	In figure	In Words
Marks Obtained	23½	Twenty Three and half
Maximum Marks	30	Thirty

Signature of Subject Teacher

RAJEEV KUMAR UPADHYAY

Digitally signed by RAJEEV KUMAR UPADHYAY
DN: C=IN, O=Personal, PostalCode=282001, S=Uttar Pradesh, SERIALNUMBER=AA3E8C12CFAA9098785ACF2B07E25E09D7F5B87A4DCA301247D08CBAEE03B9A3, CN=RAJEEV KUMAR UPADHYAY
Reason: I am the author of this document
Location: your signing location here
Date: 2023.09.06 16:51:47+05'30'
Foxit PhantomPDF Version: 10.1.1

Appendix-4: Informal Feedback on POs and PSOs

Hindustan College of Science & Technology

Farah, Mathura

(Affiliated to Dr. A.P.J. Abdul Kalam Technical University, Lucknow)

26 km milestone, Agra-Delhi Highway, Farah, Mathura – 281122 (UP)

DEPARTMENT OF INFORMATION TECHNOLOGY

Level of Attainment of PSOs (Program Specific Outcomes) : Excellent (E) Good (G) Average (A)

S.NO.	PSO	(E)	(G)	(A)
1	Equip students with the latest IT knowledge and skills to tackle real-world challenges.			
2	Foster leadership, critical thinking, problem-solving, and communication skills for IT careers.			
3	Encourage entrepreneurship and innovation through research, start-up projects, industry collaborations, and business skills.			

Level of Attainment of POs (Program Outcomes): Excellent (E) Good (G) Average (A)

S.NO.	PO	(E)	(G)	(A)
1	**Engineering Knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and computing to solve Computer Science and Engineering related problems.			
2	**Problem Analysis:** Demonstrate the ability to identify, formulate and solve engineering problems related to Computer Science and Engineering.			
3	**Design / Development of Solutions:** Demonstrate the ability to design, analyze and interpret data and implement solutions for software based real life problems.			
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.			
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 related to Computer Science and Engineering 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 to 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 life-long learning in the broadest context of technological change.			

Name: **Semester:**

RAJEEV KUMAR UPADHYAY

Digitally signed by RAJEEV KUMAR UPADHYAY
DN: C=IN, O=Personal, PostalCode=282001, S=Uttar Pradesh, SERIALNUMBER=AA3E8C12CFAA9098785ACF2B07E25E09D7F5B87A4DCA301247D08CBAEE03B9A3, CN=RAJEEV KUMAR UPADHYAY
Reason: I am the author of this document
Location: your signing location here
Date: 2023.09.06 16:51:47+05'30'
Foxit PhantomPDF Version: 10.1.1