HINDUSTHAN INSTITUTE OF TECHNOLOGY

Autonomous Institution affiliated to Anna University, Approved by AICTE, New Delhi

Accredited with 'A' Grade by NAAC, Accredited by NBA (Aero, CSE, ECE and MECH)

Valley Campus, Pollachi Highway, Coimbatore - 641 032

OUTCOME BASED EDUCATION MANUAL

AUG 2024

HINDUSTHAN INSTITUTE OF TECHNOLOGY

COIMBATORE – 641 032

OUTCOME BASED EDUCATION – MANUAL

ABOUT THE INSTITUTION

Hindusthan Institute of Technology (Hitech) was started in the year of 2007 by the great industrialist and philanthropist, Thiru.T.S.R.Khannaiyann. The primary objective of the Hindusthan Institute of Technology is to educate and prepare men and women for leadership in industry, government, and educational institutions; to advance the knowledge base of the engineering professions; and to influence the future directions of engineering education and practice.

Our college is accredited by NAAC with A grade, permanently affiliated to Anna University Chennai and the four Departments including Aeronautical Engineering, Computer Science and Engineering, Electronics and Communication Engineering and Mechanical Engineering are accredited by NBA. Also, the three departments namely CSE, ECE and Physics are recognized research center by Anna University, Chennai.

The College has well-furnished classrooms, state-of- the-art laboratories, computer centers and a well-stocked library. Separate Hostels with all the modern amenities are provided for men and women. The campus consists of lush green lawns, a playground, GYM and also facilities for indoor games. A fleet of vehicles caters to the transport needs.

HITECH believes not only in educating the students, but also grooming characters, with moral and ethical values, thus building the nation. Since its inception, the college has been providing world-class facilities & infrastructure for high quality education and learning. The emphasis is on transformational leadership rather than directional leadership. The aim is to establish new trends, introduce innovative training methodologies, and thus guide students towards the road to success.

The College provides ample facilities for the development of an integrated personality. It has a fine library containing more than thirty thousand books and more than 500 national & international journals. Our library also digitalized by holding IIT-NPTEL Video Library in it. The facilities for playing tennis, basketball and cricket are available on the College Campus. The

Gymnasium, the Junior Common Room and the Ladies Common Room provide facilities for gymnastics, badminton, table tennis and other indoor games.

The educational programs in the college emphasize the understanding of fundamental principles and prepare an individual for a lifetime of learning and professional growth.

Programs offered.

Under Graduate Courses (Full –Time)

B.E. – Aeronautical Engineering

B.E. – Automobile Engineering

B.E. – Computer Science and Engineering

B.E. – Electronics and Communication Engineering

B.E. – Mechanical Engineering

B.Tech. - Information Technology

B.Tech - Pharmaceutical Technology

B.Tech – Artificial Intelligent and data Sciences

Post Graduate Courses (Full – Time)

M.E. – Computer Science and Engineering

M.E. – VLSI Design

Master of Business Administration (MBA)

PREFACE

This manual is a reference to help faculty members and Stakeholders to understand the Outcome Based Education (OBE) system implemented at Hindusthan Institute of Technology (HITECH) since 2014. This manual provides a detailed description of Outcome Based Education implementation at all the four stages of educational process including Curriculum design, Teaching and Learning process, Assessment & Evaluation and Continuous quality improvement. Also it provides suitable guidelines for the faculty members to develop the course plan, assessment plan etc., in the process to measure the outcome of the students during their course of study and also after their graduation.

VISION OF THE INSTITUTION

Hindusthan Institute of Technology pursues a philosophy of perpetual acquisition of Knowledge. Apart from academic curriculum, equally important is our policy to provide value based education and to exhibit the hidden potentials in students, which empower them to approach life with optimism

MISSION OF THE INSTITUTION

Hindusthan Institute of Technology conveys revolutionary technical education and inculcates great outlines of discipline through our dedicated staff, who shall set global standards, making our students technologically superior and ethically strong with the help of state-of–art laboratories in all disciplines has received greater recognition for its efforts. Our objective is to educate students to uplift them as enlightened individuals, improving their living standards.

TABLE OF CONTENT

1. PRIMARY DEFINITIONS AND NOMENCLATURE

Vision: A vision statement is a document that states the current and future objectives of a Department. The vision statement is intended as a guide to help the department make decisions that align with its philosophy and declared set of goals.

Mission: The mission statement should define the broad purposes the program /department is aiming to achieve, describe the community the program /department is designed to serve, and state the values and guiding principles which define its standards.

Program educational objectives (PEOs): PEOs are broad statements that describe the career and professional accomplishments that the program is preparing graduates to achieve. Knowledge, Skill and Attitude are the three behavioral elements based on which PEOs are constructed.

Program Outcomes (POs): Program outcomes are statements that describe what students are expected to know and be able to do upon graduating from the program. These relate to the skills, knowledge, analytical ability, attitude and behavior that students acquire through the program.

Program Specific Outcomes (PSOs): Program Specific Outcomes are statements that describe what the graduates of a specific engineering program should be able to do.

Course Outcomes (COs) : It is a detailed description of what a student must be able to do at the conclusion of a course.

Course Information Sheet (CIS): This sheet summarizes the information of a particular course and it gives the overall view of how the COs and POs are mapped in each unit.

Continuous Internal Assessment (CIA): Continuous Internal assessment is a form of educational examination that evaluates a student's progress throughout a prescribed course.

End Semester Examinations (ESE): ESE means the examinations to be held at the end of

each semester separately for theory & practical part on such dates as the University/College may determine**.**

2. OUTCOME BASED EDUCATION (OBE):

It is a process that involves the restructuring of curriculum, assessment and reporting practices in education to reflect the achievement of higher order learning and mastery rather than the accumulation of course credits.

Outcome-Based Education (OBE) model is being adopted in Engineering colleges now-a-days as per AICTE guidelines. It is considered as a giant leap forward to improve technical education in India and help Engineers compete with their global counterparts.

Outcome based education (OBE) is student-centered instruction model that focuses on measuring student performance through outcomes. Outcomes include knowledge, skills and attitudes. Its focus remains on evaluation of outcomes of the program by stating the knowledge, skill and behavior a graduate is expected to attain upon completion of a program and after 4 – 5 years of graduation. In the OBE model, the required knowledge and skill sets for a particular engineering degree is predetermined and the students are evaluated for all the required parameters (Outcomes) during the course of the program.

The induction of India in the Washington Accord in 2014 with the permanent signatory status of the National Board of Accreditation (NBA) is considered a big leap forward for the higher-education system in India. It means that an Engineering graduate from India can be employed in any one of the other countries who have signed the accord. For Indian Engineering Institutions to get accredited by NBA according to the pacts of the accord, it is compulsory that engineering institutions follow the Outcome Based Education (OBE) model. So, for an Engineering Institution to be accredited by NBA it should compulsorily follow the OBE model.

Features of OBE

- OBE is an educational process that focuses on what students can do or the qualities they should develop after they are taught.
- OBE involves the restructuring of curriculum, assessment and reporting practices in education to reflect the achievement of higher order learning and mastery rather than accumulation of course credits.
- Both structures and curricula are designed to achieve those capabilities or qualities.

- Discourages traditional education approaches based on direct instruction of facts and standard methods.
- It requires that the students demonstrate that they have learnt the required skills and content.

Deficiencies in Traditional education

- Provides students with a learning environment with little attention to whether or not students ever learn the material.
- Students are given grades and rankings compared to each other – students become exam oriented or CGPA driven.
- Graduates are not completely prepared for the workforce.
- Lack of emphasis on soft skills needed in jobs e.g. communication skills, interpersonalskills, analytical skills, working attitude etc.

Expectations of students under OBE – the outcome

- Students are expected to be able to do more challenging tasks other than memorize and reproduce what was taught.
- Students should be able to: write project proposals, complete projects, analyze case studies, give case presentations, show their abilities to think, question, research, and make decisions based on the findings.
- Be more creative, able to analyze and synthesize information.
- Able to plan and organize tasks, able to work in a team as a community or in entrepreneurial service teams to propose solutions to problems and market their solutions.
- Students should be enriched on three dimensional scales of knowledge, skill and attitude throughout the course.

3. PROCESS OF DEFINING VISION AND MISSION OF THE DEPARTMENT

The following steps are followed to establish Vision and Mission of Department.

Step 1: The Vision & Mission of the Institute is taken as the basis.

Step 2: The Department conducts brain-storming sessions with the faculty on the skill-set required by the local and global employers, Industry Advances in Technology and R & D, and

the draft copy of the Vision and Mission of the Department is drafted.

Step 3: The views from Parents, Professional Bodies, Industry representatives, Board of Studies (BOS) and Department Advisory Committee (DAC) are collected and incorporated to revise the draft version based on their inputs.

Step 4: The accepted views are analyzed and reviewed to check the consistency with the vision and mission of the institute.

4. PROCESS OF DEFINING PSOs AND PEOs OF THE DEPARTMENT

- The Program curriculum is designed by incorporating inputs from members of Board of Studies, Curriculum Development Council and Academic council constituted by members from various academic institutions, R&D organizations and industry.
- Inputs are obtained from alumni and other stake holders. Also the inputs are considered from reports like WEF's Future of Jobs, India skills, FICCI and Deloitte.
- Besides, a skill in demand analysis is carried out periodically at the Academic council, Programme Assessment Committee and Department Advisory committee to identify the core areas in the Program domain that are consistent with industry needs.
- The Centre of Excellence in the department is established based on core areas in the program.
- PSOs are defined based on the Centre of Excellence of the Department. A list of 2 to 4 Program Specific Outcomes (PSOs) that the graduates of the program will attain will be listed here.
- The PEOs are established to reflect the career and professional accomplishments of the graduates based on the three behavioral elements of Knowledge, Skill and Attitude.

5. THE PROGRAM OUTCOMES (POS) DEFINED BY NATIONAL BOARD OF ACCREDITATION (NBA)

The POs essentially indicate what the students can do from subject-wise knowledge acquired by them during the program. As such, POs define the professional profile of an engineering graduate. NBA has defined the following twelve POs for an engineering graduate. These are in line with the Graduate Attributes as defined by the Washington Accord.

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

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

4. **Conduct Investigations of Complex Problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions for complex problems.

5. **Modern Tool Usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

6. **The Engineer and Society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

7. **Environment and Sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

8. **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

9. **Individual and Team Work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

10. **Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and

write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

11. **Project Management and Finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
12. **Life-long Learning:** Recognize the need for, and have the preparation and ability to engage in independent and lifelong learning in the broadest context of technological change.

6. PUBLICATION AND DISSEMINATION:

The Vision, Mission statement of the Department and Institution, CO statements, PSO statements, PO and PEO statements are reached to all the students and stake holders of the department. The process of publication and dissemination is described below.

- College Website
- Principal Room
- Department
- HOD Chamber
- Laboratories
- Department Library
- Classrooms
- Curriculum and Syllabi
- Lab Manuals
- Course files
- News Letter
- Department Magazines

The OBE model measures the progress of the graduate in four parameters, which are

- Program Educational Objectives (PEO)
- Program Specific Outcomes (PSO)
- Program Outcomes (PO)
- Course Outcomes (CO)

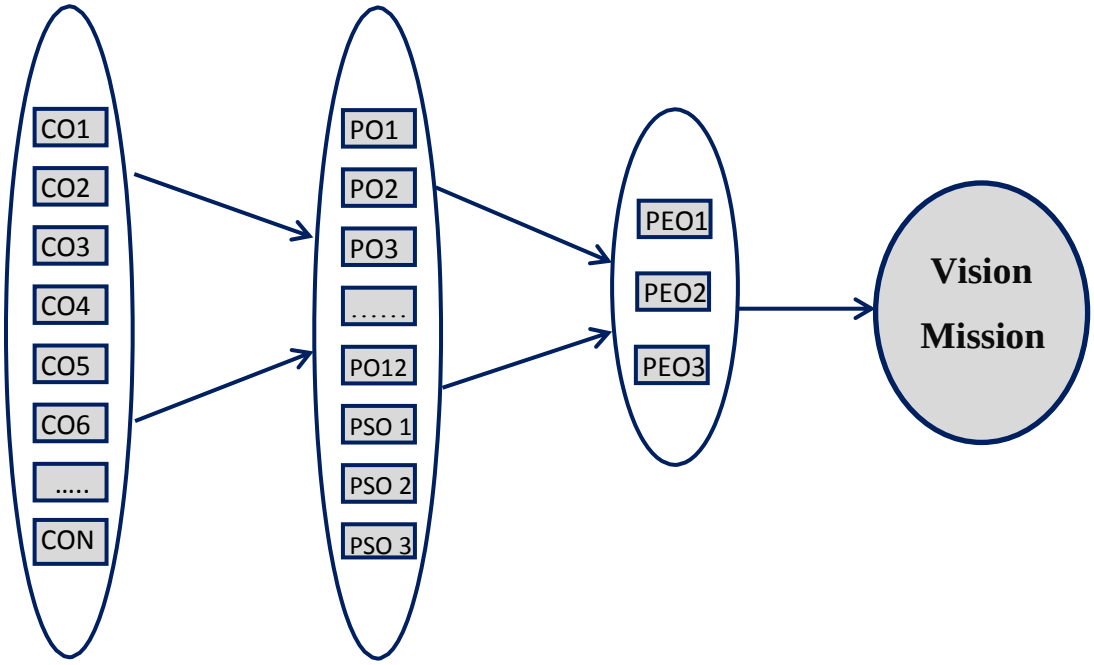


Figure 1. Parameters of Outcome Based Education (OBE)

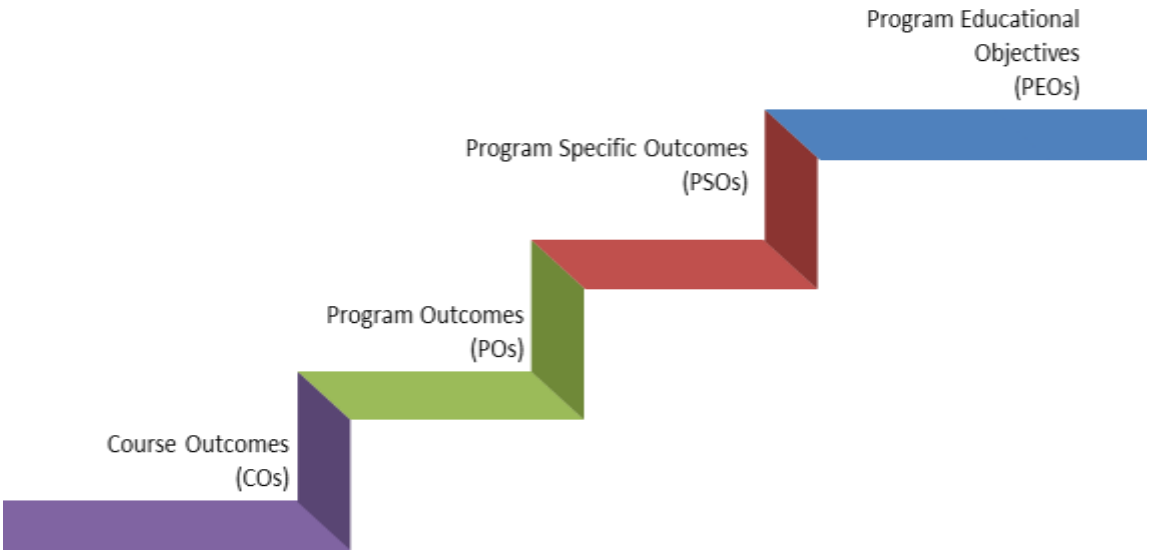


Figure 2 : Process for the evaluation of Programme Outcomes POs, PSOs and PEOs

7. COURSE OUTCOME STATEMENTS

Course Outcomes (COs): Statements indicate , what a student can do after the successful completion of a course. Every Course leads to some Course Outcomes. The CO statements are defined by considering the course content covered in each module of a course. For every course there may be 5 or 6 COs. The keywords used to define COs are based on Bloom's Taxonomy.

CO – PO and CO – PSO mapping of courses

All the courses in the curriculum must cover all the POs (and PSOs). For a course, we map the COs to POs through the CO-PO matrix and to PSOs through the CO-PSO matrix in Course Information Sheet (CIS). The various correlation levels are:

- "1" – Slight (Low) Correlation
- "2" – Moderate (Medium) Correlation
- "3" – Substantial (High) Correlation
- "-" indicates there is no correlation.

***** Course Information Sheet (CIS) is attached as Annexure I

PROCESS INVOLVED IN CO-PO MAPPING

The role of CO-PO mapping will be assigned to the faculty involved in the teaching-learning process of that particular course. After the course (subject) allotment by the department, the course co-ordinator of the course has to write appropriate COs for their corresponding course discussing with subject handling faculty members. It should be narrower and measurable statements. By using the action verbs of learning levels (Bloom's Taxonomy), CO's will be designed. CO statements should describe what the students are expected to know and able to do at the end of each course, which are related to the skills, knowledge and behavior that students will acquire through the course.

After writing the CO statements, CO will be mapped with PO of the department. The Course Outcome attainment coordinator has to consolidate the CO's of the respective year and maintain the documentation of the CO attainment level of the respective year courses as well as

documentation of the individual students extra-curricular and co-curricular activities for PO attainment evaluation.

BLOOM'S TAXONOMY

Bloom's Taxonomy was created in 1956 under the leadership of educational psychologist Dr. Benjamin Bloom in order to promote higher forms of thinking in education, such as analyzing and evaluating concepts, processes, procedures, and principles, rather than just remembering facts. It is most often used when designing educational, training, and learning processes.

BLOOM'S TAXONOMY		
Domains	**Keywords**	**Example**
Remembering: Recall or retrieve previous learned information.	Defines, describes, identifies, knows, labels, lists, matches, names, outlines, recalls, recognizes, reproduces selects, states	Recite a policy. Quote prices from memoryto a customer. Recite the safety rules.
Understanding: Comprehending the meaning, translation, interpolation, and interpretation of instructions and problems. State a problem in one's own words.	Comprehends, converts, defends, estimates, explains, extends, generalizes, gives an example, infers, interprets, distinguishes, paraphrases, predicts, rewrites, summarizes, translates	Rewrite the Principles of test writing. Explain in one's own words the steps for performing a complex task. Translate an equation into a computer spreadsheet.
Applying: Use a concept in a new situation or unprompted use of an abstraction. Applies what was learned in the classroom into novel situations in the workplace.	Applies, changes, computes, constructs, demonstrates, shows, discovers, modifies, manipulate, operates, predicts, produces, prepares, relates, solves, uses	Use a manual to calculate an employee's vacation time. Apply laws of statistics to evaluate the reliability of a written test.
Analyzing: Separates material or concepts into component parts so that its organizational structure may be understood. Distinguishes between facts and inferences.	Analyzes, breaksdown, relates, compares, contrasts, diagrams, differentiates, identifies, illustrates, discriminates, distinguishes, infers, outlines, selects, separates deconstructs,	Troubleshoot a piece of equipment by using logical deduction. Recognize logical fallacies in reasoning. Gathers information from a department and selects

		the required tasks for training.
Evaluating: Make judgments about the value of ideas or materials.	Appraises, compares, concludes, contrasts, criticizes, critiques, defends, describes, evaluates, explains, interprets, justifies, discriminates, summarizes, supports, relates,	Select the most Effective solution. Hire the most qualified candidate. Explain and justify a new budget.
Creating: Builds a structure or pattern from diverse elements. Put parts together to form a whole, with emphasis on creating a new meaning or structure.	Categorizes, combines, compiles, composes, creates, devises, designs, explains, generates, modifies, organizes, plans, rearranges, reconstructs, relates, reorganizes, revises, rewrites, summarizes, tells, writes	Write a company Operations or process manual. Design a machine to perform a specific task. Integrates training from several sources to solve a problem. Revises and process to improve the outcome.

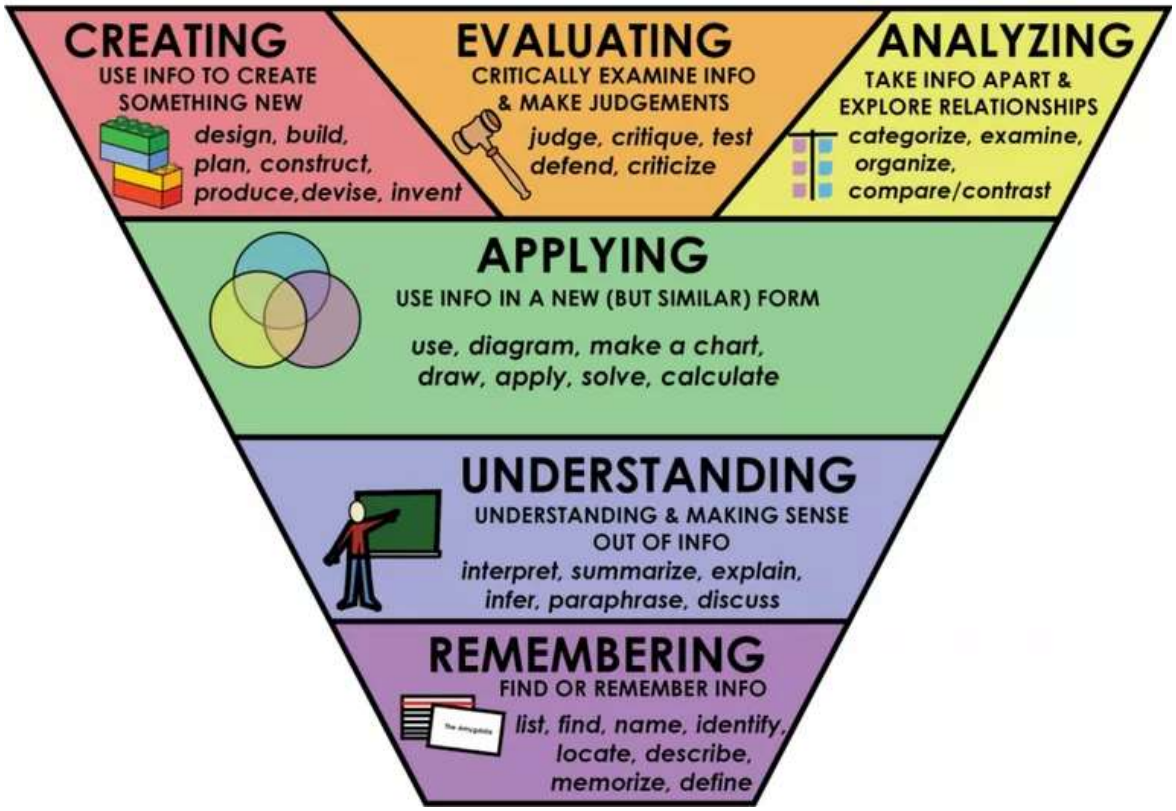
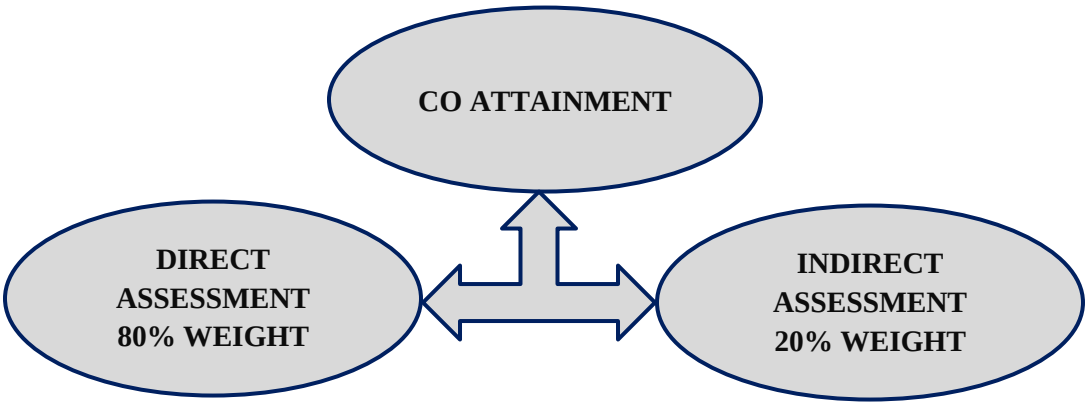


Figure 3: BLOOM'S TAXONOMY

Methods of CO attainment assessment

Both direct and indirect method of assessment is followed for Course Outcome (CO) attainment assessment. The weightage for direct attainment is 80% while that for indirect attainment is 20%. The various assessment tools for direct attainment assessments are Internal Tests, Mid -Semester and End Semester Examination and Assignments .The indirect tool used is Course Exit survey.



CO assessment process for various courses in the curriculum

The curriculum is a bundle of various components like Theory courses, Theory with Lab components, Laboratory courses, Mini-Projects, Projects and Internships /Implant training / Technical seminar

THEORY COURSES				REGULATION
METHOD	**ASSESSMENT TOOLS**	**MARKS**	**WEIGHTAGE**	
Direct Assessment	a) Internal Examinations CO1 & CO2 – Internal Exam I CO2 & CO3 – Internal Exam II CO4 & CO5 – Internal Exam III	20	80%	R-2017
	b) End Semester Examinations	80		
	Total Marks	100		

Indirect Assessment	Course Exit Survey	5	20%	

PRACTICAL COURSES				**REGULATION**
METHOD	**ASSESSMENT TOOLS**	**MARKS**	**WEIGHTAGE**	
Direct Assessment	a) Continuous Laboratory Assessment	10	80%	R-2017
	b) Model Examination	10		
	c) End Semester Examinations	80		
	Total Marks	100		
Indirect Assessment	Course Exit Survey	5	20%	

MINI PROJECTS				**REGULATION**
METHOD	**ASSESSMENT TOOLS**	**MARKS**	**WEIGHTAGE**	
Direct Assessment	a) CO1, CO2 & CO3 is assessed through Continuous Internal Assessment from Review I, Review II & Review III based on Rubrics.	20	80%	R-2017
	b) End Semester Exam	80		
Indirect Assessment	Course Exit Survey	5	20%	

MAIN PROJECTS				**REGULATION**
METHOD	**ASSESSMENT TOOLS**	**MARKS**	**WEIGHTAGE**	
Direct Assessment	a) CO1, CO2 & CO3 is assessed through Continuous Internal Assessment from Review I, Review II & Review III based on Rubrics.	20	80%	R-2017
	b) End Semester Exam	80		
Indirect Assessment	Course Exit Survey	5	20%	

THEORY COURSES				REGULATION
METHOD	**ASSESSMENT TOOLS**	**MARKS**	**WEIGHTAGE**	
Direct Assessment	a) Internal Examinations CO1 & CO2 – Internal Exam I CO2 & CO3 – Internal Exam II CO4 & CO5 – Internal Exam III	20	80%	R-2020
	b) Continuous Assessment like seminar, Assignments, Quiz etc…	20		
	c) End Semester Examinations	60		
	Total Marks	100		
Indirect Assessment	Course Exit Survey	5	20%	

PRACTICAL COURSES				REGULATION
METHOD	**ASSESSMENT TOOLS**	**MARKS**	**WEIGHTAGE**	
Direct Assessment	a) Continuous Laboratory Assessment	10	80%	R-2020
	b) Model Examination	10		
	c) End Semester Examinations	60		
	Total Marks	100		
Indirect Assessment	Course Exit Survey	5	20%	

MINI PROJECTS				REGULATION
METHOD	**ASSESSMENT TOOLS**	**MARKS**	**WEIGHTAGE**	
Direct Assessment	a) CO1, CO2 & CO3 is assessed through Continuous Internal Assessment from Review I, Review II & Review III based on Rubrics.	**50**	**80%**	R-2020
	b) End Semester Exam	50		

Indirect Assessment	Course Exit Survey	5	20%	

MAIN PROJECTS				**REGULATION**
METHOD	**ASSESSMENT TOOLS**	**MARKS**	**WEIGHTAGE**	
Direct Assessment	a) CO1, CO2 & CO3 is assessed through Continuous Internal Assessment from Review I, Review II & Review III based on Rubrics.	**50**	**80%**	R-2020
	b) End Semester Exam	50		
Indirect Assessment	Course Exit Survey	5	20%	

INTERNSHIP/INPLANT TRAINING &TECHNICAL SEMINAR				**REGULATION**
METHOD	**ASSESSMENT TOOLS**	**MARKS**	**WEIGHTAGE**	
Direct Assessment	End Semester Exam	100	80%	R-2020
Indirect Assessment	Course Exit Survey	5	20%	

Attainment Levels:

Course outcomes of all courses are assessed with the help of above mentioned assessment tools and attainment level is evaluated based on set attainment rubrics. The target (or set) attainment level should be fixed by the Course coordinator based on the previous year results and quality of current batch of students.

If 80% and more students scored above set attainment level then the Course attainment level is 3. If 70 to 79 % of students scored above set attainment level, then the Course attainment level is 2. If less than 60 % of students scored above set attainment level, then the Course attainment level is 1.

If the average attainment of a particular course in the previous two consecutive years is greater than 80% of the maximum attainment value (i.e. 80% of 3 = 2.4), then for that particular course the current rubrics for attainment must be changed to analyze continuous improvement.

8. PROGRAM OUTCOME (PO)/PROGRAM SPECIFIC OUTCOME (PSO) Assessment

At the end of the each program, the PO/PSO assessment is done from the CO attainment of all curriculum components. As per NBA guidelines, program can appropriately define the attainment level. The attainment level may be set by the particular program or commonly by the institution. The attainment can be made as best the choice by the institution or the program by analyzing the student's knowledge. This can be achieved by using different supporting activities. This attainment is mainly for the purpose of making an esteemed engineer with good analytical, practical and theoretical knowledge about the program by attaining the PO's and PSO's of the program and the institution. For the evaluation and assessment of PO's and PSO's, assessment tools are used.

The figure 5 depicts the assessment tools used for the evaluation of program outcomes.

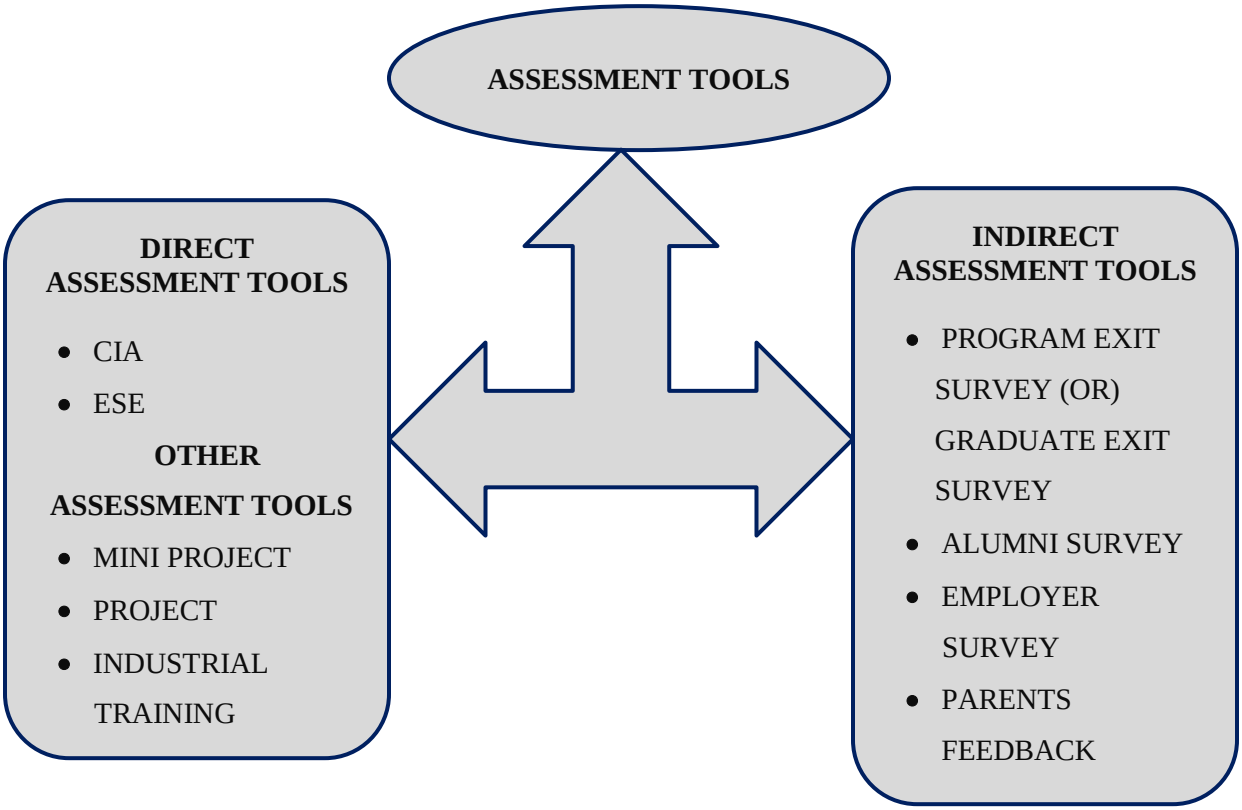


Figure 5 : Assessment Tools for Evaluation of Program Outcomes

The Program Outcome (PO) attainment and Program Specific Outcome (PSO)

attainments are evaluated by direct method with 80% weightage and indirect method with 20% weightage. The Direct attainment level of Particular PO /PSO is determined by taking average of all course outcomes mapping that program Outcome. Indirect attainment level of PO/PSO is determined based on Surveys and Co-curricular activities. Out of 100%, 30% weightage is given to co-curricular activities and 70% weightage to Surveys. This 100% weightage is converted to 20 % scale for PO attainment calculation. The various Surveys taken are Student exit survey, Employer survey, Alumni survey and Parents feedback. The co-curricular activities are Value added Courses, Workshops etc related to the unattained POs(less mapped POs in CO-PO matrix). The PO/PSO Attainment Level is fixed as Maximum level of 3 & Minimum level of 1.

Course – end Survey:

The course –end survey is based on the feedback taken from the students after studying each course.

*Attached as ANNEXURE VIII

Graduate Exit survey:

The graduate exit survey is based on the feedback collected from graduates at the end of the program.

*Attached as ANNEXURE IX

Alumni Feedback

This feedback is about how effectively they can able to implement their knowledge acquired through BE- Programme in their workplace.

*Attached as ANNEXURE X

Employer Feedback:

This feedback is about how alumni of department can able to implement their knowledge in the company.

*Attached as ANNEXURE XI

Parent's Feedback:

This feedback is collected from the parents about their satisfaction in the knowledge, skill and employment level of their wards.

*Attached as ANNEXURE XII

Co-curricular activities:

- Workshops

- Placement training programs
- Value added courses in Modern trends

9. PROGRAM EDUCATIONAL OBJECTIVE(PEO) ASSESSMENT

Assessment of achievement of the program educational objectives (PEOs) is done by indirect measurements. Placement record, higher studies and survey forms like alumni survey and employer survey are used to assess the attainment of PEOs. The PEOs are formally reviewed by the Department advisory committee every year. As described above, we solicit feedback from alumni and their employer through formal and informal mechanisms.

ANNEXURE - I

HINDUSTHAN INSTITUTE OF TECHNOLOGY
Approved by AICTE, New Delhi, Accredited with 'A'
Grade by NAAC Coimbatore – 641 032

COURSE INFORMATION

1. **Academic Year** : **2021- 2022(Odd)**
2. **Name of the Faculty** :
3. **Department** : **Computer Science and Engineering**
4. **Programme** : **B.E - CSE**
5. **Class and Semester** : **II Year – III Semester**
6. **Course code and title** :**20CS401 – Data Structures**
7. **Regulations** : **R2020(Autonomous)**
8. **Core / Elective** : **Core**
9. **Contact Hours** : **45 hours**
10. **Type of Course (Analytical/Theoretical)** : **Analytical**
11. **Number of credits** : **3**
12. **Course Pre-requisites** : **Python Programming**
13. **Course Learning objectives:**
    - To learn about the implementation and applications of basic data structure , Array
    - To impart a thorough understanding of linear data structures such as stack, queues and their applications.
    - To impart a thorough understanding of non-linear data structures such as trees, graphs and their applications.
    - To study about various sorting and searching techniques and their applications.
    - To learn various hashing techniques
14. **Course outcomes:**

    Upon completion of the course, the students will be able to:

    CO1: To implement and perform various operations using arrays.

    CO2: To explain and implement real time applications using linear data structures.

    CO3: To experiment various applications using tree data structures

CO4: To apply graph algorithms for variety of real time problems.

CO5: To implement basic sorting and searching algorithms

CO6: To illustrate various hashing techniques.

15. Course Syllabus

UNIT I : INTRODUCTION AND ARRAYS		**9**
CO1 &CO5	Basic terminology – classification of data structures -Data structure - operations – Abstract Data Types (ADT) – Running time analysis - Linear Array – Arrays as ADT Representation - Searching: Sequential (linear) search and Binary Search - Record structures – representation.	
UNIT II : LINEAR DATA STRUCTURE		**9**
CO2	Linked List - Representation – Singly and Doubly Linked List - Operations - Header Linked List - Circular Linked List – Operations - Stack ADT – application of stack – recursion – tower of Hanoi - Queue ADT – circular queue – Dequeue – priority Queue-Application of Queues.	
UNIT III : NON-LINEAR DATA STRUCTURE - TREES		**9**
CO3	Trees – Terminologies -Binary Trees - representation – Tree Traversal techniques - Binary search tree – Operations - AVL Trees – B-Tree – B+ Trees - Heaps.	
UNIT IV: NON-LINEAR DATA STRUCTURES –GRAPHS		**9**
CO4	Introduction – Terminology – Representation - Graphs Traversal - Breadth first search- Depth first search – Topological sort - Shortest-path algorithm- Dijkstra's Algorithm - Minimum spanning trees – Prim's and Kruskal's algorithms	
UNIT V: HASHING AND SORTING		**9**
CO5 & CO6	Hashing- Separate Chaining - Open Addressing –Double Hashing - Rehashing – Extendible Hashing - Sorting – Bubble Sort – Insertion Sort - Selection Sort – Quick Sort – Merge Sort – Heap Sort – Radix Sort – Shell Sort	

16. Text and Reference Books:

Text Books:

1 Mark Allen Weiss, "Data Structures and Algorithm Analysis in C", 2nd Edition, Pearson Education,1997

2 Alfred V. Aho, John E. Hopcroft, Jeffrey D. Ullman, "Data Structures and Algorithms", Pearson Education, 2009

References:

1 Ellis Horowitz, SartajSahni, Susan Anderson-Freed, “Fundamentals of Data Structures in C”, Second Edition, University Press, 2008

2 Robert Sedgewick, Kevin Wayne, “Algorithms”, Fourth Edition, Pearson Education, 2011

3 Steven S.Skiena, “ The Algorithm Design manual”, Second Edition, Springer, 2012

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Web References

1. https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6046jintroduction-to-algorithms-sma-5503-fall-2005/video-lectures/
2. http://www.nptelvideos.in/2012/11/data-structures-and-algorithms.html
3. https://www.cs.usfca.edu/~galles/visualization/Algorithms.html

17. Course Plan

S.No	Topic	Text / Ref Book	Time Required	Teaching Methods	Teaching Aids	Delivery	
						Date	Period
UNIT I INTRODUCTION AND ARRAYS							
Group I							
1	Basic Terminology	T1	1	PPT with Discussion			
2	Classification of Data Structures-Data Structure-Operation	T1	1	PPT with Discussion			
3	Abstract Data Type (ADT) – Run time analysis	T1	1	PPT with Discussion			
Group II							
4	Linear Array	T1	1	PPT with Discussion			
5	Arrays as ADT Representation	T1	1	PPT with Discussion			
Group III							
6	Searching: Sequential (Linear) Search	T1	1	PPT with Discussion			
7	Binary Search	T1	2	PPT with Discussion			

8	Record Structures – representation	T1	1	PPT with Discussion			
Planned date of completion of Unit: **Actual date of completion of Unit:**							
S.No	**Topic**	**Text / Ref Book**	**Time Required**	**Teaching Methods**	**Teaching Aids**	**Delivery**	
						Date	**Period**
UNIT-II LINEAR DATA STRUCTURE							
Group I							
1	Linked List Representation-Singly Linked List	T1	2	PPT with Discussion			
2	Doubly Linked List	T1	1	PPT with Discussion			
3	Header Linked List - Circular Linked List	T1	1	PPT with Discussion			
Group II							
4	Stack ADT	T1	1	PPT with Discussion			
5	Application of Stack: Recursion – tower of Hanoi	T1	1	PPT with Discussion			
Group III							
6	Queue ADT	T1	1	PPT with Discussion			
7	Circular queue – Dequeue	T1	1	PPT with Discussion			
8	Priority Queue-Application of Queues	T1	1	PPT with Discussion			
Planned date of completion of Unit: **Actual date of completion of Unit:**							

S.No	**Topic**	**Text / Ref Book**	**Time Required**	**Teaching Methods**	**Teaching Aids**	**Delivery**	
						Date	**Period**
UNIT-III NON-LINEAR DATA STRUCTURE-TREES							
Group I							

1	Trees-Terminol gies	T1	1	Chalk talk			
2	Binary Trees – Representation	T1	1	PPT with discussion			
Group II							
3	Tree Traversal Techniques	T1	1	PPT with discussion			
4	Binary Search Tree- Operations	T1	1	PPT with discussion			
5	AVL Trees	T1	2	PPT with discussion			
Group III							
6	B-Tree	T1	1	PPT with discussion			
7	B+ Trees	T2	1	PPT with discussion			
8	Heaps	T1	1	PPT with discussion			
Planned date of completion of Unit: **Actual date of completion of Unit:**							

S.No	Topic	Text / Ref Book	Time Required	Teaching Methods	Teaching Aids	Delivery	
UNIT-IV NON LINEAR DATA STRUCTURES –GRAPHS							
Group I							
1	Introduction – Terminology – Representation	T1	1	PPT with discussion			
2	Graphs Traversal - Breadth first search	T1	1	PPT with discussion			
Group II							
3	Depth first search	T1 & T2	1	PPT with discussion			
4	Topological sort	T1	2	PPT with discussion			
5	Shortest-path algorithm-	T1	2	PPT with discussion			

	Dijkstra‟s Algorithm						
Group III							
6	Minimum spanning trees – Prim's and Kruskal's algorithms	T1	2	PPT with discussion			
Planned date of completion of Unit: **Actual date of completion of Unit:**							

S.No	Topic	Text / Ref Book	Time Required	Teaching Methods	Teaching Aids	Delivery	
UNIT-V HASING AND SORTING							
Group I							
1	Hashing- Separate Chaining	T1	1	PPT with discussion			
2	Open Addressing – Double Hashing	T1	1	PPT with discussion			
Group II							
3	Rehashing – Extendible Hashing	T1	1	PPT with discussion			
4	Sorting – Bubble Sort – Insertion Sort	T1&T2	2	PPT with discussion			
Group III							
5	Selection Sort – Quick Sort	T1&T2	2	PPT with discussion			
6	Merge Sort – Heap Sort	T1&T2	1	PPT with discussion			
7	Radix Sort – Shell Sort	T1&T2	1	PPT with discussion			

S.no	Name of the topic	No of Hours	Cum Hours	Level
UNIT-I INTRODUCTION AND ARRAYS			**TARGET HOURS: 09**	

1	Basic Terminology –	1	1	K1
2	Classification of Data Structures- Data Structure- Operation	1	2	K1
3	Abstract Data Type (ADT) – Run time analysis	1	3	K2
4	Linear Array	1	4	K1
5	Arrays as ADT Representation	2	6	K2
6	Searching: Sequential (Linear) Search	1	7	K2
7	Binary Search	1	8	K2
8	Record Structures – representation	1	9	K1
UNIT-II LINEAR DATA STRUCTURE			**TARGET HOURS: 09**	
1	Linked List Representation- Singly Linked List	1	10	K1,K2 K3
2	Doubly Linked List	1	11	K3
3	Header Linked List - Circular Linked List	1	12	K3
4	Stack ADT	1	13	K2
5	Application of Stack: Recursion – tower of Hanoi	1	14	K3
6	Queue ADT	1	15	K2
7	Circular queue – Dequeue	2	17	K2
8	Priority Queue-Application of Queues	1	18	K3
UNIT-III NON-LINEAR DATA STRUCTURE-TREES			**TARGET HOURS: 09**	
1	Trees-Terminologies	1	19	K1,K2
2	Binary Trees – Representation	1	20	K1
3	Tree Traversal Techniques	1	21	K3
4	Binary Search Tree- Operations	1	22	K1
5	AVL Trees	2	24	K2
6	B-Tree	1	25	K2
7	B+ Trees	1	26	K2
8	Heaps	1	27	K2
UNIT-IV NON LINEAR DATA STRUCTURES –GRAPHS			**TARGET HOURS: 09**	
1	Introduction – Terminology – Representation	1	28	K1

2	Graphs Traversal - Breadth first search	1	29	K3
3	Depth first search	1	30	K3,K4
4	Topological sort	2	32	K3
5	Shortest-path algorithm- Dijkstra‟s Algorithm	2	34	K3,K4
6	Minimum spanning trees – Prim's and Kruskal's algorithms	2	36	K3
UNIT-V HASING AND SORTING				**TARGET HOURS: 09**
1	Hashing- Separate Chaining	1	37	K3
2	Open Addressing –Double Hashing	1	38	K3,K4
3	Rehashing – Extendible Hashing	1	39	K3,K4
4	Sorting – Bubble Sort – Insertion Sort	1	40	K3,K4, K5
5	Selection Sort – Quick Sort	1	41	K3,K4, K5
6	Merge Sort – Heap Sort	2	43	K3,K4, K5
7	Radix Sort – Shell Sort	2	45	K3,K4, K5

Mapping Syllabus with Bloom's Taxonomy LOT and HOT:

Lower Order Thinking		
K1	Remembering	Students are expected to **Recall** the information through recognizing, listing, describing, retrieving, naming, finding
K2	Understanding	Students are expected to **Explain** an ideas or concepts through Interpreting, summarizing, paraphrasing, classifying, explaining
K3	Applying	Students are expected to **Use** the information in another familiar situation through implementing, carrying out, using, executing
Higher Order Thinking		
K4	Analyzing	Students are expected to **Break** the information into parts to explore understandings and relationships through comparing, organizing,deconstructing, interrogating, finding
K5	Evaluating	Students are expected to **Evaluate** the justifying a decision or course ofaction through checking, hypothesizing, experimenting, judging
K6	Creating	Students are expected to **Generate** new ideas, products, or ways of viewing things through Designing, constructing, planning, producing,inventing.

18. Weightage of Unit Contents:

Factors considered,

- F1 - Number of periods allotted for teaching the unit and weightage per hour is equal to 1
- F2 - Usefulness of the content matter of the unit in the student's learning point of view and its weightage is equal to 1 if useful otherwise zero
- F3 - Usefulness of the content matter of the unit in understanding other units of thesame subject and its weightage is equal to 1 if useful otherwise zero
- F4 - Usefulness of the content matter of the unit in understanding other subjects prescribedfor the programme and its weightage is equal to 1 if useful otherwise zero

Topic	F_1	F_2	F_3	F_4	A_1 (Weightage)	A_2 (%)
Unit- I						
Basic Terminology –	9	1	1	0	**26**	**18.05%**
Classification of Data Structures- Data Structure- Operation		1	1	1		
Abstract Data Type (ADT) – Run time analysis		1	1	1		
Linear Array		1	1	1		
Arrays as ADT Representation		1	1	1		
Searching: Sequential (Linear) Search		1	1	1		
UNIT-II LINEAR DATA STRUCTURE						
Linked List Representation- Singly Linked List	9	1	1	1	**33**	
Doubly Linked List		1	1	1		
Header Linked List - Circular Linked List		1	1	1		
Stack ADT		1	1	1		
Application of Stack: Recursion – tower of Hanoi		1	1	1		
Queue ADT		1	1	1		
Circular queue – Dequeue		1	1	1		
Priority Queue-Application of Queues		1	1	1		

						22.92%
UNIT-III NON-LINEAR DATA STRUCTURE-TREES						
Trees-Terminologies	9	1	1	1	**30**	**20.83%**
Binary Trees – Representation		1	1	1		
Tree Traversal Techniques		1	1	1		
Binary Search Tree- Operations		1	1	1		
AVL Trees		1	1	1		
B-Tree		1	1	1		
B+ Trees		1	1	1		
UNIT-IV NON LINEAR DATA STRUCTURES –GRAPHS						
Introduction – Terminology – Representation	9	1	1	1	**27**	**18.75%**
Graphs Traversal - Breadth first search		1	1	1		
Depth first search		1	1	1		
Topological sort		1	1	1		
Shortest-path algorithm- Dijkstra‟s Algorithm		1	1	1		
Minimum spanning trees – Prim's and Kruskal's algorithms		1	1	1		
UNIT-V HASING AND SORTING						
Hashing- Separate Chaining	9	1	1	1	**28**	**19.44%**
Open Addressing –Double Hashing		1	1	1		
Rehashing – Extendible Hashing		1	1	1		
Sorting – Bubble Sort – Insertion Sort		1	1	1		
Selection Sort – Quick Sort		1	1	1		
Merge Sort – Heap Sort		1	1	1		
Radix Sort – Shell Sort		1	1	1		