COURSE HANDBOOK

ON

ALGORITHM DESIGN-1 (CSE3131)

(B.Tech. 3rd Semester)

DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

Faculty of Engineering and Technology,

Institute of Technical Education and Research

SIKSHA 'O' ANUSANDHAN (DEEMED TO BE) UNIVERSITY

Bhubaneswar, Odisha, India

(SEPTEMBER 2023)

TABLE OF CONTENTS

PREFACE

This course handbook contains all the necessary details of the concerned subject, i.e., ALGORITHM DESIGN-1 (CSE3131). It is designed in order keep up with the Outcome Based Education **(OBE)**. The handbook provides necessary details about the Grading Pattern, Grading System, Course Assessment, Assessment Rubrics, the Outcomes (POs, PEOs, PSOs), Bloom's Taxonomy, Graduation CGPA requirements, Minimum Requirements for Passing Grade and Appearing the (Deemed to be University) Examination.

1. Course Details

Name of the Course : ALGORITHM DESIGN-1

Course Code : CSE3131

Course Credits : 4

Grading Pattern : 1

Branch and Semester : Computer Science and Engineering,

3rd Semester B.Tech.

Name of the Instructor: Kartik Sahoo

Contact Details : 7504255721

Email : kartiksahoo@soa.ac.in

SUBJECT CODE	SUBJECT NAME	CREDIT	GRADING PATTERN
	➢ Introduction to algorithm design ➢ Basics of algorithm analysis ➢ Basic Concepts of Data Structures ➢ Graphs and related algorithms ➢ Greedy approach ➢ Divide-and-conquer ➢ Dynamic Programming	**Text Book:** 1. Algorithm Design by Jon Kleinberg and Eva Tardos, Pearson Publication 2. Problem Solving in Data Structures & Algorithms Using Java by Hemant Jain **Course Format:** 4 Credits; 3 Classes/Week, 1 hr/Class; 1 Lab/Week, 2 hrs/Lab	

2. Course Outcomes (COs) and Mapping Course Outcomes with Program Outcomes (POs)

Course Outcomes		Program Outcomes
CO1	to apply **knowledge of computing and mathematics** to algorithm design; (i) to understand computational tractability condidering polynomial time as a definition of efficiency of an algorithm; (ii) to analyze worst-case **running times of algorithms (both recursive and iterative)** using asymptotic analysis;	PO1, PO2
CO2	to understand various types and aspects of basic data structures (array, linked list, stack, queue, binary tree) and **advanced data structures like priority queue (implementation using heap)**.	PO1
CO3	to explain the major **graph algorithms** and their analyses. Employ graphs to model engineering problems, when appropriate.	PO2, PO3
CO4	to describe the **greedy paradigm** and explain when an algorithmic design situation calls for it. Recite algorithms that employ this paradigm. Synthesize greedy algorithms. Derive and describe the performance of greedy algorithms.	PO2, PO3, PO4
CO5	to describe the **divide-and-conquer paradigm** and explain when an algorithmic design situation calls for it. Recite algorithms that employ this paradigm. Synthesize divide-and-conquer algorithms. Derive and solve recurrences describing the performance of divide-and-conquer algorithms.	PO2, PO3, PO4
CO6	to describe the **dynamic programming paradigm** and explain when an algorithmic design situation calls for it. Recite algorithms that employ this paradigm. Synthesize dynamic programming algorithms. Derive and solve recurrences describing the performance of dynamic programming algorithms.	PO2, PO3, PO4

*Refer Appendix for list of Pos

3. Course Articulation Matrix

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	0	0	0	0	0	0	0	0	0	0	3	0
CO2	2	0	0	0	0	0	0	0	0	0	0	0	0	0
CO3	0	2	1	0	0	0	0	0	0	0	0	0	3	0
CO4	0	2	2	2	0	0	0	0	0	0	0	0	3	0
CO5	0	2	2	2	0	0	0	0	0	0	0	0	2	3
CO6	0	2	2	2	0	0	0	0	0	0	0	0	0	3

*0: No correlation, 1: Slight (Low), 2: Moderate, 3: Substantial (High)

*Refer Appendix for list of POs

4. Justifications of Mapping

Justification about the correlation between COs Vs POs & PSOs mentioned in the Articulation Matrix. Please describe the justifications.

5. Grading Pattern and Components of Evaluation

The Subject, ALGORITHM DESIGN-1 (CSE3131), has 4 Credits, and belongs to Grading Pattern 1. The **First Grading Pattern** will be for those Subjects which are of 4 credits and which combinations of theory and laboratory components are. The breakdown required for the calculation of the Numeric Score (out of 100) for Grading Pattern 1 is given below.

ATTENDANCE	5
THEORY ASSIGNMENTS / QUIZZES	10
LAB ASSIGNMENTS	10
MID TERM	15
TOTAL INTERNAL	40

IN LAB EXAM	15
THEORY EXAM	45
TOTAL EXTERNAL	60

6. Tentative Lesson Plan

Contact Hour	Topics To Be Covered	Remarks(if any)	CO	PO
Week # 1:				
L 01	Introduction to the course/subject: Program Outcomes; Course Outcomes; Lesson plan; Teaching methodology; Evaluation strategy etc.	Course Overview with OBE awareness		
L 02	**Introduction to Algorithm Design:** Importance of problem solving using algorithms; Characteristic features of an algorithm(input, output, finiteness, definiteness, effectiveness, correctness, efficiency);			
L 03	**Introduction to Algorithm Design:** Expressing algorithms (pseudocode); Basic aspects of algorithms (correctness, design and analysis)			
P 01	*Approach to solve algorithm design problems*	*To be referred from T2*		
Week # 2:				
L 04	**Computational tractability:** Polynomial time as a definition efficiency of an algorithm; Worst case Running times and Brute-Force Search	To be referred from T1	CO1	
L 05	**Asymptotic order of growth** (Big-Oh, Big-Omega, Big-Theta)			
L 06	**Asymptotic order of growth** (Big-Oh, Big-Omega, Big-Theta)			
P 02	*Abstract data type (Array) – iterative implementation* *1. Sum of n numbers* *2. Finding maximum and minimum* *3. Rotating array by k positions* *4. Finding the largest sum contiguous subarray* *5. Smallest positive missing number* *6. Maximum minimum array (I/p: 1 2 3 4 5, O/p: 5 1 4 2 3)* *7. Factorial of a number* *8. Generating nth fibonacci number*	*To be referred from T2*		
Week # 3:				
L 07	**Recurrences** (Iterative, Substitution and Master method)	To be referred from R2 and T1	CO1	
L 08	**Recurrences** (contd..)			
L 09	**Priority Queue Implementation using Heap data structure**			
P 03	*Abstract data type (Array) – recursive implementation* *1. Sum of n numbers* *2. Finding maximum and minimum* *3. Factorial of a number* *4. Generating nth fibonacci number* *5. Find ing the GCD* *6. Conversion from decimal number to hexadecimal equivalent number* *7. Computing nth power of a number* *8. Smallest positive missing number*	*To be referred from T2*		
Week # 4:				
L 10	**Priority Queue Implementation using Heap data structure**	To be referred from T1	CO2, CO3	
L 11	**Graph:** Basic definitions, applications and representations			
L 12	**Graph:** Basic definitions, applications and representations (contd..)			
P 04	*Sorting (Bubble sort, Insertion sort, Selection sort, etc..)* *1. Bubble sort* *2. Insertion sort* *3. Selection sort*	*To be referred from T2*		

Week # 5:				
L 13	**Graph:** Graph connectivity and graph traversal (BFS, DFS)	To be referred from T1 and R2	CO3	
L 14	**Graph:** Graph connectivity and graph traversal (BFS, DFS)			
L 15	**Graph:** Testing bipartiteness – an application of BFS		CO3	
P 05	*Sorting* *1. Array reduction* *2. Merging two sorted arrays* *3. check reverse*	*To be referred from T2*		
Week # 6:				
L 16	**Graph:** Connectivity in directed graph; Directed-Acyclic-Graph and Topological ordering	To be referred from T1 and R2	CO3	
L 17	**Graph:** Connectivity in directed graph; Directed-Acyclic-Graph and Topological ordering			
L 18	**Graph:** MST using Kruskal's algorithm—the union-find data structure			
P 06	*Searching* *1. Linear search without recursion* *2. Linear search using recursion* *3. Binary search without recursion* *4. Binary search using recursion*	*To be referred from T2*		
Week # 7:				
L 19	**Graph:** MST using Kruskal's algorithm—the union-find data structure (contd..)	To be referred from T1 and R2	CO3, CO4	
L 20	**Graph:** MST using Prim's algorithm			
L 21	**Graph:** Shortest path problem (Dijkstra' algorithm)			
P 07	*Searching (Linear Search, Binary Search, Hashing and Symbol tables)* *1. Finding first repeated elements in an array* *2. Print duplicates in a list* *3. Find the missing number in an array* *4. Given an array of integers, find the element pair with minimum/maximum difference* *5. Given a list n numbers, find the element which appears maximum number of times.*	*To be referred from T2*		
Week # 8:				
L 22	**Greedy Method:** Interval Scheduling with proof of optimality using the Greedy Algorithm Stays Ahead	To be referred from T1(Chapter 4)	CO4	
L 23	**Greedy Method:** Interval Scheduling with proof of optimality using the Greedy Algorithm Stays Ahead			
L 24	**Greedy Method:** Scheduling to Minimize Lateness with proof of optimality using An Exchange Argument			
P 08	*Linked list* *1. Create* *2. Insertion (at any position including start and end)* *3. Delete (at any position including start and end)* *4. Traversal* *5. Reverse*	*To be referred from T2*		
Week # 9:				
L 25	**Greedy Method:** Optimal Caching: A More Complex Exchange Argument (no discussion on proof of optimality)		CO4	

L 26	**Greedy Method:** Huffman Codes and Data Compression (no discussion on proof of optimality)	To be referred from T1(Chapter 4)		
L 27	**Greedy Method:** Huffman Codes and Data Compression (no discussion on proof of optimality) contd..			
P 09	*Java collections*	*To be referred from T2*		
Week # 10:				
L 28	**Divide and Conquer:** Control abstraction	To be referred from T1	CO5	
L 29	**Divide and Conquer:** Merge sort			
L 30	**Divide and Conquer:** Counting inversions			
P 10	*Stack*	*To be referred from T2*		
Week # 11:				
L 31	**Divide and Conquer:** Quick sort	To be referred from T1 and R2	CO5	
L 32	**Divide and Conquer:** Quick sort			
L 33	**Divide and Conquer:** Fast integer multiplication (Karatsuba algorithm)			
P 11	*Queue*	*To be referred from T2*		
Week # 12:				
L 34	**Dynamic Programming:** Principles of Dynamic Programming (Memoization or Iteration over Subproblems)	To be referred from T1	CO6	
L 35	**Dynamic Programming:** Weighted Interval Scheduling			
L 36	**Dynamic Programming:** Subset Sums and Knapsacks			
P 12	*Tree*	*To be referred from T2*		
Week # 13:				
L 37	**Dynamic Programming:** RNA Secondary Structure	To be referred from T1	CO6	
L 38	**Dynamic Programming:** Sequence Alligment			
L 39	**Dynamic Programming:** Shortest Paths in a Graph (Bellman-Ford algorithm); Negative-Weight-Cycles			
P 13	*Priority Queue/Heaps*	*To be referred from T2*		
Week # 14:				
L 40	**Revision class**	Discussions on CO1, CO2, CO3		
L 41	**Revision class**			
L 42	**Revision class**			
P 14	*Graphs*	*To be referred from T2*		
Week # 15:				
L 43	**Revision class**	Discussions on CO4, CO5, CO6		
L 44	**Revision class**			

L 45	**Revision class**			
P 15	*Hash Table*	*To be referred from T2*		

7. Assessment Rubric for the Course

Method: Assignments, Lab Report and Mid-Semester and End-Semester Exam

Outcomes Assessed:

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

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

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

PO4 – 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.

PSO1- The ability to understand and develop computer programs in the areas related to business intelligence, big data analytics, web design and networking for efficient design of computer-based system of varying complexity.

PSO2- The ability to apply standard practices and strategy in software project development using open ended programming environments to deliver a quality product for business success.

Mid-Semester and End-Semester Examination Rubrics			
Performance	**High (2 Marks)**	**Medium (1-1.5 Marks)**	**Low (0.5 Marks)**
Theoretical representation of concepts	Properly able to define, represent, and interpret the physical significance.	Minor errors in definition, representation and interpretation of physical significance.	Incomplete or poor definition, representation and interpretation of physical significance.
Pictorial representation of ideas	Neat, clean and proper sketches, graphs with proper labelling and interpretation.	Sketches and Graphs are drawn but interpretation of significance is not done or labelling is missing.	The pictures are unclear/not labelled and the interpretation is inappropriate.
Solving mathematical and/or design problems and interpreting the results	Selection of appropriate concepts to formulate. Ability to solve problems, represent them pictorially and interpret the results.	Able to select correct concepts, formulate, represent and solve, but error in interpreting	Erroneous selection of concepts, able to represent and formulate only, but error in solving.

Rubrics for Lab Component			
Performance	**High (9-10 Marks)**	**Medium (7-8 Marks)**	**Low (4-6 Marks)**
Lab Experiments and Report	Student demonstrates an accurate understanding of the lab objectives and concepts. Questions are answered completely and correctly. Graphs are neat, creative and include complete titles and accurate units. Errors, if any, are minimal.	Student has a basic knowledge of content, but may lack some understanding of the same concepts. Questions are answered fairly well and/or graphs could have been done more neatly, accurately or with more complete information.	Student has problems with both the graphs and the answers. Student appears to have not fully grasped the lab content, and the graphs(s) possess multiple errors. Student turns in lab report late or the report is so incomplete and/or so inaccurate that it is unacceptable.
Lab Participation and Presentation	Student demonstrates an accurate understanding of the lab objectives and concepts. The student	Student arrives on time to lab, but maybe unprepared. Answers to questions are basic and superficial suggesting	The unpreparedness of student makes it impossible to fully participate. If able to participate, student

	can correctly answer questions and if appropriate, can explain concepts to fellow classmates. Student is eager to participate and assist when needed. The student has attended all labs.	that concepts are not fully grasped. The student has missed few (2-3) lab classes.	has difficulty explaining key lab concepts. The student has missed many (5-6) lab classes.
Viva-voice	The student is able to answer all the asked questions pleasingly, and explains all the concepts reasonably well, and in details.	Is able to answer some of the asked questions satisfactorily, and explains the concepts well.	The student doesn't understand the concepts and hence answers the questions but the logic or is concept explanation provided is improper.

Rubrics for Quiz			
Performance	**High (9-10 Marks)**	**Medium (7-8 Marks)**	**Low (4-6 Marks)**
Short/Long Answer Type Questions	The student has answered all the questions correctly and depicted them in a neat and clean manner, with appropriate explanation.	The student has answered most of the questions correctly and depicted them in a satisfactory manner.	The student has answered some of the questions correctly, though, with improper /erroneous/incomplete justification of the same.
MCQ Type Questions	The student has attended all the quizzes and attempted all the questions correctly.	The student has attended most of the quizzes and attempted most of the questions correctly.	The student has attended some of the quizzes and answers few of the questions correctly.

Rubrics for Assignments			
Performance	**High (9-10 Marks)**	**Medium (7-8 Marks)**	**Low (4-6 Marks)**
Completion and Submission of Assignments	Completed and submitted all assignments within deadline. The answers are depicted correctly, completely and in a neat and clean manner. The answers maybe unique/innovative.	Completed and submitted above 80% of the assignments. Submission is by the due date. The answers were fairly represented.	Completed 60% of the assignments. The submissions were made after repeated reminders, and in the extended deadline period. The answers were fairly represented.

Rubrics for Mini Project			
Performance	**High (9-10 Marks)**	**Medium (7-8 Marks)**	**Low (4-6 Marks)**
Articulate problem statements and identify objectives	Problem statement is clear and objectives are completely defined.	Problem statement is clear and objectives are not in line with problem statement.	Problem statement and objectives are not clear.
Identify engineering systems, variables, and parameters to solve the problems	Engineering systems are identified. Variables, and parameters to solve the problems are completely defined .	Engineering systems are clear. Variables, and parameters to solve the problems are not defined.	Engineering systems are identified but not clear. Variables, and parameters to solve the problems are not defined
Apply formal idea generation tools to develop multiple engineering design solutions	Able to generate engineering designs with justification.	Able to use the tool but not able to generate engineering designs.	Able to identify but not able to use it effectively.
Build models/ prototypes to develop diverse set of design solutions	Able to generate and justify the best solution.	Able to use the tool but not able to generate alternatives.	Able to choose the tool but not able to use it effectively.
Generate information through appropriate tests to improve or revise design	Able to apply information for the improvement.	Able to follow testing procedures but not able to collect information.	Able to identify but not able to follow testing procedure.

Rubrics for Assignments			
Performance	**High (9-10 Marks)**	**Medium (7-8 Marks)**	**Low (4-6 Marks)**
Completion and Submission of Assignments	Completed and submitted all assignments within deadline. The answers are depicted correctly, completely and in a neat and clean manner. The answers maybe unique/innovative.	Completed and submitted above 80% of the assignments. Submission is by the due date. The answers were fairly represented.	Completed 60% of the assignments. The submissions were made after repeated reminders, and in the extended deadline period. The answers were fairly represented.

Rubrics for Mini Project			
Performance	**High (9-10 Marks)**	**Medium (7-8 Marks)**	**Low (4-6 Marks)**
Articulate problem statements and identify objectives	Problem statement is clear and objectives are completely defined.	Problem statement is clear and objectives are not in line with problem statement.	Problem statement and objectives are not clear.
Identify engineering systems, variables, and parameters to solve the problems	Engineering systems are identified. Variables, and parameters to solve the problems are completely defined .	Engineering systems are clear. Variables, and parameters to solve the problems are not defined.	Engineering systems are identified but not clear. Variables, and parameters to solve the problems are not defined
Apply formal idea generation tools to develop multiple engineering design solutions	Able to generate engineering designs with justification.	Able to use the tool but not able to generate engineering designs.	Able to identify but not able to use it effectively.
Build models/ prototypes to develop diverse set of design solutions	Able to generate and justify the best solution.	Able to use the tool but not able to generate alternatives.	Able to choose the tool but not able to use it effectively.
Analyze data for trends and correlations, stating possible errors and limitations	Able to identify errors and limitations.	Able to analyze data but not able to correlate them.	Able to understand but not able to analyze data.

Rubrics for Assignments			
Performance	**High (9-10 Marks)**	**Medium (7-8 Marks)**	**Low (4-6 Marks)**
Completion and Submission of Assignments	Completed and submitted all assignments within deadline. The answers are depicted correctly, completely and in a neat and clean manner. The answers maybe unique/innovative.	Completed and submitted above 80% of the assignments. Submission is by the due date. The answers were fairly represented.	Completed 60% of the assignments. The submissions were made after repeated reminders, and in the extended deadline period. The answers were fairly represented.

Rubrics for Mini Project			
Performance	**High (9-10 Marks)**	**Medium (7-8 Marks)**	**Low (4-6 Marks)**
Articulate problem statements and identify objectives	Problem statement is clear and objectives are completely defined.	Problem statement is clear and objectives are not in line with problem statement.	Problem statement and objectives are not clear.
Identify engineering systems, variables, and parameters to solve the problems	Engineering systems are identified. Variables, and parameters to solve the problems are completely defined .	Engineering systems are clear. Variables, and parameters to solve the problems are not defined.	Engineering systems are identified but not clear. Variables, and parameters to solve the problems are not defined
Apply formal idea generation tools to develop multiple engineering design solutions	Able to generate engineering designs with justification.	Able to use the tool but not able to generate engineering designs.	Able to identify but not able to use it effectively.
Build models/ prototypes to develop diverse set of design solutions	Able to generate and justify the best solution.	Able to use the tool but not able to generate alternatives.	Able to choose the tool but not able to use it effectively.
Present results as a team, with smooth integration of contributions from all individual efforts.	Contribution from an individual to a team is good and results in an integrated team presentation.	Contributions from an individual to a team is moderate.	Contributions from an individual to a team is minimal.

Note – For specific assessments, specific rubrics may be followed.

8. Course Related Surveys

Pre-requisite Survey: The objective of this survey is to know the basic understanding and different skills relevant to the subject, i.e., ALGORITHM DESIGN-1 (CSE3131). Please respond to the questions by clicking any one of the options against each of the following questions.

1. Ability to apply theoretical knowledge in day-to-day life (PO3, PO7).

(a) Low Understanding (b) Medium (c) Adequate/High

2. Multidisciplinary skills and ability to work in a team (PO11).

(a) Low Understanding (b) Medium (c) Adequate/High

3. Communication and project management skills (PO10, PO11).

(a) Low Understanding (b) Medium (c) Adequate/High

4. Ability to solve numericals and to plot graphs (PO1, PO2).

(a) Low Understanding (b) Medium (c) Adequate/High

5. Coding/Pseudocoding skills (PO5).

(a) Low Understanding (b) Medium (c) Adequate/High

6. Basic knowledge about the method of induction (PO1).

(a) Low Understanding (b) Medium (c) Adequate/High

7. Understanding of basic principles of iteration and recursion (PO1).

(a) Low Understanding (b) Medium (c) Adequate/High

8. Knowledge of algorithm based problem-solving processes (PO1).

(a) Low Understanding (b) Medium (c) Adequate/High

9. Understanding of basics of asymptotic notations (PO1).

(a) Low Understanding (b) Medium (c) Adequate/High

10. Knowledge about the principles of sorting and searching (PO1).

(a) Low Understanding (b) Medium (c) Adequate/High

Interim Course Progress Survey: The objective of this survey is to know the students' progress in basic understanding and attaining different outcomes relevant to the subject, i.e., ALGORITHM DESIGN-1 (CSE3131). Please respond to the questions by clicking any one of the options against each of the following questions. The outputs will be shared with the respective Faculty Advisors for further necessary actions.

Course End Survey: The objective of this survey is to know the attainment of the outcomes relevant to the subject, i.e., ALGORITHM DESIGN-1 (CSE3131). Please respond to the questions by clicking any one of the options against each of the given questions.

APPENDIX I – VISION

The Siksha 'O' Anusandhan will be a leading institution of higher learning in its chosen areas of concentration, preparing future generations through quality teaching and innovative research and will emerge as a comprehensive and socially inclusive University in the country for professional advancements in related disciplines.

APPENDIX II – MISSION

- Educate students to become responsible, enlightened, and productive citizens;
- Conduct scholarship and promote entrepreneurship that improve the human condition;
- Serve business, education, government, health care systems, and community; and
- Enhance the cultural environment of the region.

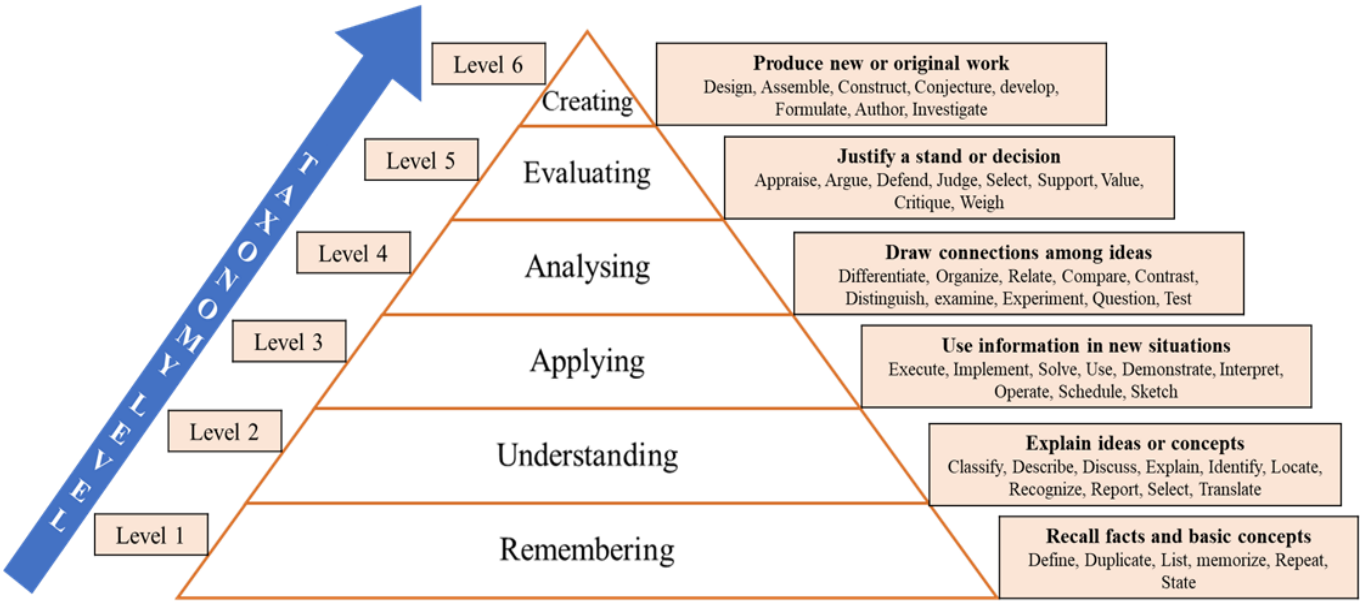
APPENDIX III – PROGRAM EDUCATIONAL OBJECTIVES (PEO)	
1	Our Graduates will have successful professional careers in industry, government, academia or non-profit organisations.
2	Our Graduates will effectively lead, work and communicate in multidisciplinary teams and apply sound engineering principles and design methodology to solve societal problems.
3	Our Graduates will maintain currency in their chosen field through higher study, through organizational participation and through participation in professional developmental activities.

APPENDIX IV – PROGRAM SPECIFIC OUTCOMES (PSO)	
PSO1	Graduates of Computer Science and Engineering will achieve excellence in product design, thermal engineering and manufacturing system, innovation and entrepreneurship by acquiringknowledge in mathematics, science and designing principles.
PSO2	Graduates will be able to design an experiment as well as to analyse, interpret and provide solutions to the real-life Computer Science and engineering problems.

APPENDIX V – PROGRAM OUTCOMES (PO)	
POs	**Description**
PO1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2	**Problem analysis:** Identify, formulate, review research literature, and analyse complexengineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3	**Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4	**Conduct investigations of complex problems:** Use research-based knowledge andresearch methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5	**Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

PO6	**The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues, and the consequent responsibilitiesrelevant to the professional engineering practice.
PO7	**Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, andneed for sustainable development.
PO8	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO9	**Individual and teamwork:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO10	**Communication:** Communicate effectively on complex engineering activities with theengineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and giveand receive clear instructions.
PO11	**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.
PO12	**Life-long learning:** Recognize the need for and have the preparation and ability to engagein independent and life-long learning in the broadest context of technological change.

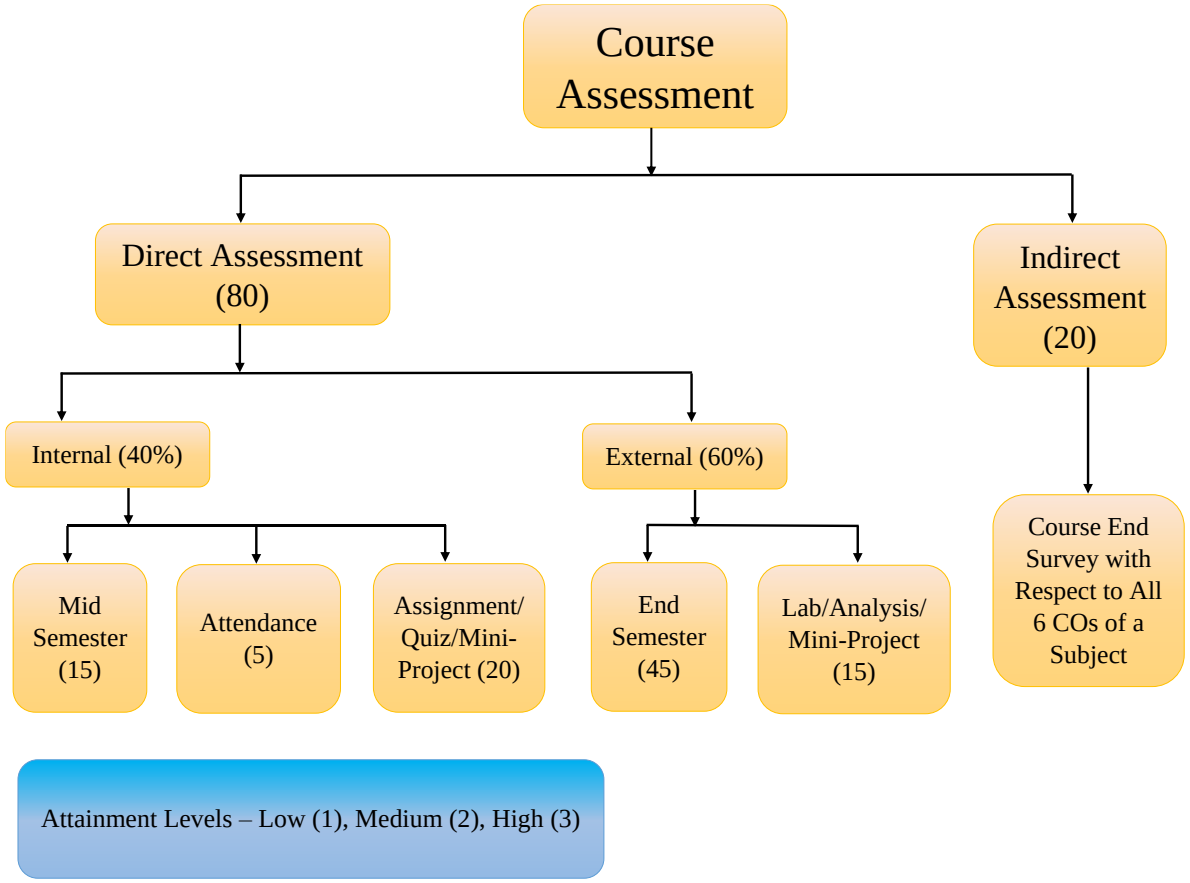
APPENDIX VI – BLOOM'S TAXONOMY



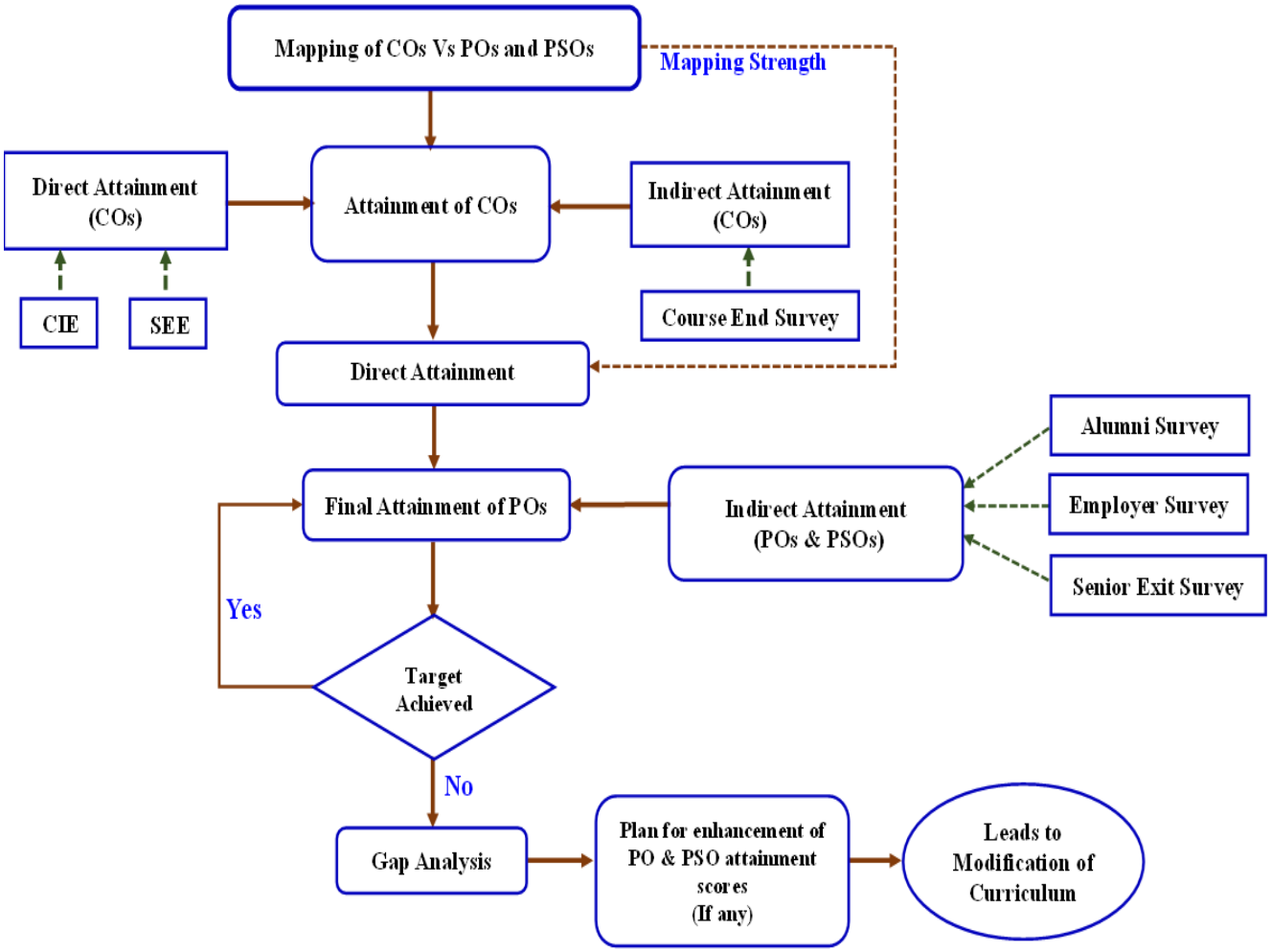
In this subject, Levels 1–4 of Bloom's Taxonomy, i.e., Remembering–Analysing are covered.

APPENDIX VII – COURSE ASSESSMENT

(FOR GRADING PATTERN 1)



APPENDIX VIII – ATTAINMENT OF COs, POs, & PSOs



APPENDIX IX – GRADING SYSTEM

Performance	Letter grade	Grade Point Per Credit
Outstanding	O	10
Accomplished	A	9.5
Impressive	B	8.5
Encouraging	C	7.5
Acceptable	D	6.5
Must do better	E	5.5
Fail	F	0

PERCENTAGE EQUIVALENCE CONVERSION FOR CGPA:

Percentage of Marks = CGPA Multiplied by 10

APPENDIX X – 9.1.2 RELATIVE GRADING

LETTER GRADE	STUDENTS RANGE	GRADE POINT
O	Top 5%	10
A	Next 10%	9.5
B	Next 20%	8.5
C	Next 30%	7.5
D	Next 20%	6.5
E	Remaining Students having Numeric Score >= 40	5.5
F	Numeric Score < 40	0

The minimum possible cutoff used for “E” grade is 40 (Internal + External), i.e., if the marks

obtained are less than 40 (Internal + External) then the student won't be given an "E" grade (or above) in a particular instance of the Subject irrespective of value of cutoff for “E” grade.

The Relative Grading System will only be applicable for those subjects which follow Grading Patterns 1,2, and 6. For Relative grading to be applicable, the number of students in the subject will need to be at least 12. Absolute Grading will be applicable otherwise.

APPENDIX XI – 10. GRADUATION CGPA REQUIREMENTS

The Minimum Cumulative Grade Point Average required for Graduation is **6.0**, i.e., a student can only be considered for graduation if and only if his/her Cumulative Grade Point Average (after complying with all the requirements of the (Deemed to be University) and the Constituent College required for graduation) is **greater than or equal to 6.0 (six point zero)**.

APPENDIX XII – 12. MINIMUM REQUIREMENTS FOR A PASSING GRADE

The Minimum Attendance and Numeric Score Requirements for a passing grade at Institute of Technical Education and Research (ITER), Siksha ‘O’ Anusandhan (Deemed to be University) which will be followed from admission year 2018-2019.

NUMERIC SCORE REQUIREMENTS	
INTERNAL	16
EXTERNAL	24
TOTAL	40

ATTENDANCE REQUIREMENTS	
ATTENDANCE	75%

APPENDIX XIII – 15. APPEARING THE (DEEMED TO BE UNIVERSITY) EXAM

The Minimum Numeric Score and Attendance Requirements forappearing the External Exam of a subject are as mentioned below.

NUMERIC SCORE REQUIREMENTS (For External Exam)	
INTERNAL COMPONENT	16

ATTENDANCE REQUIREMENTS (For External Exam)	
ATTENDANCE	75%