



Maharashtra State Board of Technical Education, Mumbai
Teaching and Examination Scheme for Post S.S.C. Diploma Courses

Program Name : Diploma in Computer Hardware & Maintenance

Program Code : HA

Duration of Program : 6 Semesters

Semester : Third

Pattern : Semester

With Effect From Academic Year: 2021 – 22

Duration : 16 Weeks

Scheme : I

S. N.	Course Title	Course Abbreviation	Course Code	Teaching Scheme			Credit (L+T+P)	Examination Scheme												Grand Total	
				L	T	P		Theory				Practical				Total	Total				
								ESE		PA		ESE		PA				Total	Total		
								Max Marks	Min Marks	Max Marks	Min Marks	Max Marks	Min Marks	Max Marks	Min Marks						
1	Object Oriented Programming Using C++	OOP	22316	3	2	2	7	3	70	28	30*	00	100	40	25@	10	25	10	50	20	150
2	Data Structures Using 'C'	DSU	22317	3	-	2	5	3	70	28	30*	00	100	40	25#	10	25	10	50	20	150
3	Database Management System	DMS	22319	4	2	2	8	3	70	28	30*	00	100	40	25#	10	25	10	50	20	150
4	Digital Techniques	DTE	22320	4	-	2	6	3	70	28	30*	00	100	40	25#	10	25	10	50	20	150
5	Computer Hardware Systems	CAR	22394	3	-	2	5	3	70	28	30*	00	100	40	25@	10	25	10	50	20	150
Total				17	4	10	31	--	350	--	150	--	500	--	125	--	125	--	250	--	750

Student Contact Hours Per Week: **31 Hrs.**

Theory and practical periods of 60 minutes each.

Abbreviations: ESE- End Semester Exam, PA- Progressive Assessment, L - Lectures, T - Tutorial, P - Practical

@ Internal Assessment, # External Assessment, *# On Line Examination, ^ Computer Based Assessment

* Under the theory PA, Out of 30 marks, 10 marks are for micro-project assessment to facilitate integration of COs and the remaining 20 marks is the average of 2 tests to be taken during the semester for the assessment of the cognitive domain LOs required for the attainment of the COs.

~ For the courses having ONLY Practical Examination, the PA marks Practical Part - with 60% weightage and Micro-Project Part with 40% weightage

> **If Candidate not securing minimum marks for passing in the "PA" part of practical of any semester then the candidate shall be declared as "Detained" for that semester.**



Program Name : Computer Engineering Program Group / Diploma in Computer Hardware & Maintenance/Diploma in Cloud Computing and Big Data

Program Code : CO/CM/IF/CW/HA/BD

Semester : Third

Course Title : Object Oriented Programming using C++

Course Code : 22316

1. RATIONALE

In the modern world of Information technology, the Object Oriented Programming has become the most preferred approach for software development. It offers a powerful way to cope up with complexity of real world problems. Among the OOP languages available, C++ is the primitive language which develops fundamental understanding of Object Oriented Concepts. This course enables students to develop programs in 'C++' using Object Oriented Programming approach.

2. COMPETENCY

The aim of this course is to help the student to attain the following industry identified competency through various teaching learning experiences:

- **Develop applications Using OOPs concepts in C++.**

3. COURSE OUTCOMES (COs)

The theory, practical experiences and relevant soft skills associated with this course are to be taught and implemented, so that the student demonstrates the following *industry oriented* COs associated with the above mentioned competency:

- Develop C++ programs to solve problems using Procedure Oriented Approach.
- Develop C++ programs using classes and objects.
- Implement Inheritance in C++ program.
- Use Polymorphism in C++ program.
- Develop C++ programs to perform file operations.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme			Credit (L+T+P)	Examination Scheme												
L	T	P		Theory						Practical						
				Paper Hrs.	ESE		PA		Total		ESE		PA		Total	
Max	Min	Max	Min		Max	Min	Max	Min	Max	Min	Max	Min	Max	Min		
3	2	2	7	3	70	28	30*	00	100	40	25@	10	25	10	50	20

(*): Under the theory PA; Out of 30 marks, 10 marks of theory PA are for micro-project assessment to facilitate integration of COs and the remaining 20 marks is the average of 2 tests to be taken during the semester for the assessment of the UOs required for the attainment of the COs.

Legends: L-Lecture; T – Tutorial/Teacher Guided Theory Practice; P - Practical; C – Credit, ESE - End Semester Examination; PA - Progressive Assessment

5. COURSE MAP (with sample COs, PrOs, UOs, ADOs and topics)



This course map illustrates an overview of the flow and linkages of the topics at various levels of outcomes (details in subsequent sections) to be attained by the student by the end of the course, in all domains of learning in terms of the industry/employer identified competency depicted at the centre of this map.

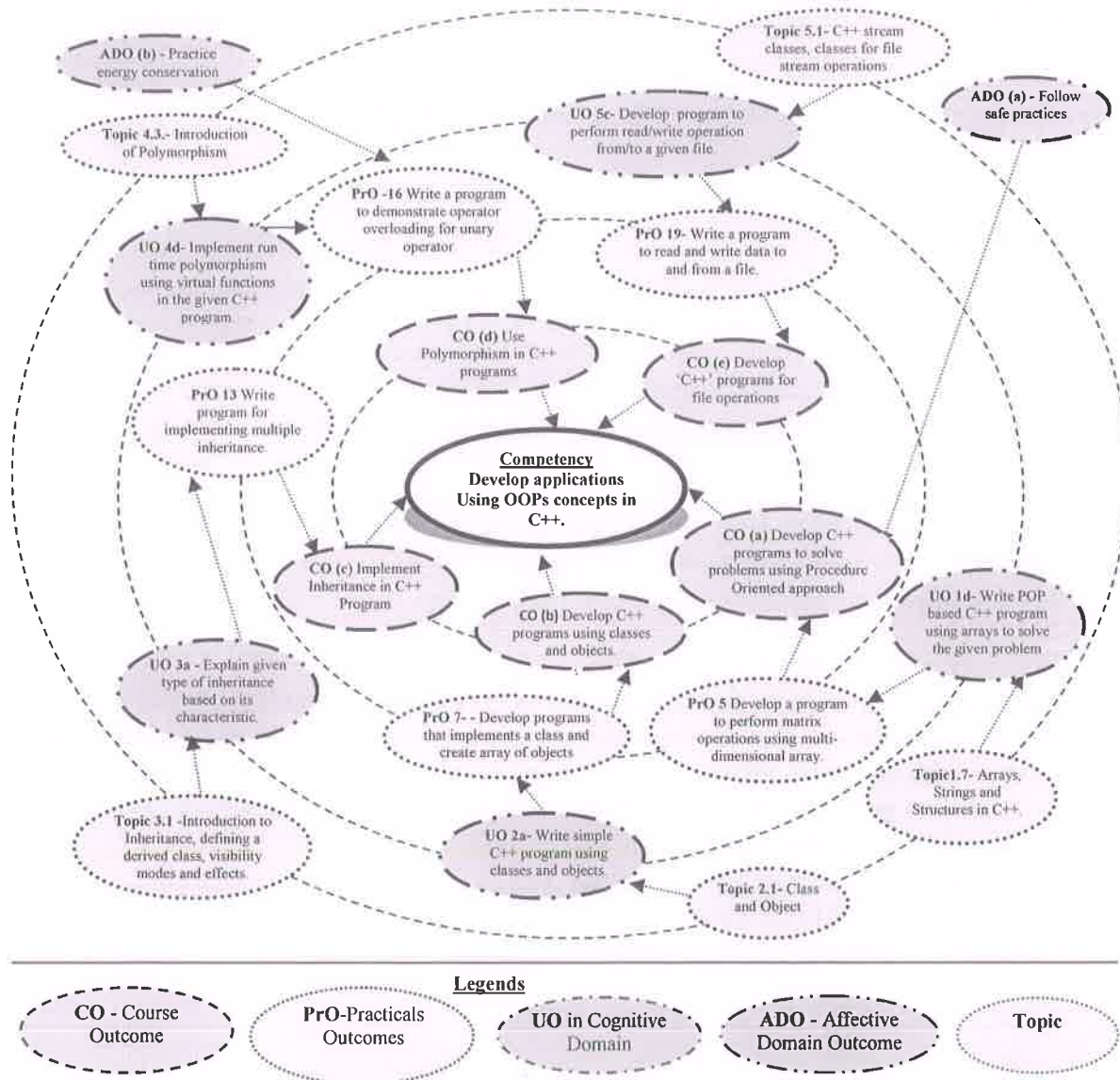
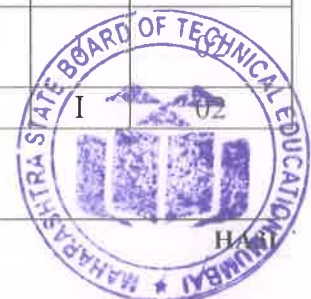


Figure 1 - Course Map

6. SUGGESTED PRACTICALS/ EXERCISES

The practicals in this section are PrOs (i.e. sub-components of the COs) to be developed and assessed in the student for the attainment of the competency:

Sr. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
1	Develop minimum 2 programs using constants, variables, arithmetic expression, operators, exhibiting data type conversion.	I	02*
2	Develop a program to implement decision making statements (If-else, switch).		
3	Develop a program to demonstrate control structures (for,	I	02



Sr. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
	while, do-while).		
4	Develop a program to implement 1-dimension array.	I	02 *
5	Develop a program to perform matrix operations using multi-dimensional array.	I	02
6	Develop programs that implements a class and use it with objects.	II	02*
7	Develop programs that implements a class and create array of objects.	II	02*
8	Write a program to implement friend function.	II	02*
9	Write a program to implement inline function.	II	02
10	Write a program to implement all types of constructors (constructor overloading) with destructor.	II	02*
11	Write a program for implementing single inheritance	III	02*
12	Write a program for implementing multi level inheritance.	III	02
13	Write a program for implementing multiple inheritance.	III	02*
14	Develop minimum 1 program to demonstrate Pointer to object.	IV	01 *
15	Develop minimum 1 program to demonstrate Pointer to derived class	IV	01 *
16	Write a program to demonstrate operator overloading for Unary operator.	IV	02
17	Write a program to demonstrate operator overloading for Binary operator	IV	02
18	Write a program to demonstrate function overloading	IV	02*
19	Write a program to read and write data to and from a file.	V	02
	Total		38

Note

- i. A suggestive list of **PrOs** is given in the above table. More such PrOs can be added to attain the COs and competency. A judicious mix of minimum 12 or more practical need to be performed, out of which, the practicals marked as '*' are compulsory, so that the student reaches the 'Precision Level' of Dave's 'Psychomotor Domain Taxonomy' as generally required by the industry.
- ii. The 'Process' and 'Product' related skills associated with each PrO is to be assessed according to a suggested sample given below:

S. No.	Performance Indicators	Weightage in %
a.	Correctness of algorithm	40
b.	Debugging ability	20
c.	Quality of input and output displayed (messaging and formatting)	10
d.	Answer to sample questions	20
e.	Submit report in time	10
	Total	100



The above PrOs also comprise of the following social skills/attitudes which are Affective Domain Outcomes (ADOs) that are best developed through the laboratory/field based experiences:

- Follow safety practices.
- Practice good housekeeping.
- Demonstrate working as a leader/a team member.
- Follow ethical practices.

The ADOs are not specific to any one PrO, but are embedded in many PrOs. Hence, the acquisition of the ADOs takes place gradually in the student when s/he undertakes a series of practical experiences over a period of time. Moreover, the level of achievement of the ADOs according to Krathwohl's 'Affective Domain Taxonomy' should gradually increase as planned below:

- 'Valuing Level' in 1st year
- 'Organising Level' in 2nd year and
- 'Characterising Level' in 3rd year.

7. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED

The major equipment with broad specification mentioned here will usher in uniformity in conduct of experiments, as well as aid to procure equipment by authorities concerned.

S. No.	Equipment Name with Broad Specifications	PrO S. No.
1	Computer system (Any computer system with basic configuration)	All
2	'C++' Compiler (Turbo C++ compiler/GCC compiler or any other C++ compiler)	

8. UNDERPINNING THEORY COMPONENTS

The following topics are to be taught and assessed in order to develop the sample UOs given below for achieving the COs to attain the identified competency. More UOs could be added:

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
Unit – I Principles of Object Oriented Programm ing	1a. Write simple C++ program for solving the given expression using POP approach. 1b. Write POP based C++ program using decision making and loop structure for the given situation. 1c. Write POP based C++ program using arrays to solve the given problem. 1d. Use the structure in C++ program for solving the given problem.	1.1 Procedure Oriented Programming (POP) verses Object Oriented Programming (OOP), 1.2 Basic concepts of Object Oriented Programming, Object Oriented Languages, Applications of OOP. 1.3 C verses C++, Structure of C++ program, Simple C++ Program. 1.4 Tokens, keywords, variables, constants, basic data types, User defined data types, type casting, operators, expressions. 1.5 Control structures: Decision making statements and Loops 1.6 Scope resolution operator, memory management operators. 1.7 Arrays, Strings and Structures in C++.



Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
Unit- II Classes and Objects	2a. Develop relevant friend functions to solve the given problem. 2b. Write C++ program to use array of given objects. 2c. Write C++ program to create the given object using constructor. 2d. Write program to delete the given object using destructor in C++ program.	2.1 Class & Object: Introduction, specifying a class, access specifiers, defining member functions, creating Objects, memory allocations for objects. 2.2 Static data members, static member function, friend Function 2.3 Array of Objects, Object as function arguments. 2.4 Concepts of Constructors, Types of constructors. 2.5 Multiple Constructors in a Class, Constructors with default arguments. 2.6 Destructors.
Unit-III Extending classes using Inheritance	3a. Explain given type of inheritance based on its characteristic. 3b. Implement given type of inheritance in C++ program. 3c. Write C++ program using virtual base class. 3d. Use constructor in the given derived class.	3.1 Introduction to Inheritance, defining a derived class, visibility modes and effects. 3.2 Types of Inheritance : Single, multilevel, multiple, hierarchical, hybrid 3.3 Virtual base class, abstract class, constructors in derived class.
Unit -IV Pointers and Polymorphism in C++	4a. Create C++ programs to perform the given arithmetic operations using pointers. 4b. Use function overloading to solve the given problem 4c. Use operator overloading to solve the given problem 4d. Implement run time polymorphism using virtual functions in the given C++ program.	4.1 Concepts of Pointer: Pointer declaration, Pointer operator, address operator, Pointer arithmetic. 4.2 Pointer to Object: Pointer to Object, this pointer, Pointer to derived class. 4.3 Introduction of Polymorphism, Types of Polymorphism. 4.4 Compile time Polymorphism: Function overloading, operator overloading, overloading of unary and binary operators, Rules for operator overloading. 4.5 Run time polymorphism: Virtual functions, rules for virtual functions, pure virtual function
Unit-V File operations	5a. Identify relevant class for performing the given file operation. 5b. Write statement to open and close the given file in C++. 5c. Develop C++ program to perform read/write operation	5.1 C++ stream classes, Classes for file stream operations. 5.2 Opening files, closing files, reading from and writing to files. 5.3 Detection of end of file.



Unit	Unit Outcomes (UOs) (in cognitive domain) from/to the given file.	Topics and Sub-topics
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Note: To attain the COs and competency, above listed UOs need to be undertaken to achieve the 'Application Level' of Bloom's 'Cognitive Domain Taxonomy'.

9. SUGGESTED SPECIFICATION TABLE FOR QUESTION PAPER DESIGN

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Principles of Object Oriented Programming	08	2	4	8	14
II	Classes and Objects	14	2	4	12	18
III	Inheritance: Extending classes	10	2	4	10	16
IV	Pointers and Polymorphism in C++	10	-	4	10	14
V	Working with files	06	-	2	6	08
Total		48	6	18	46	70

Legends: R=Remember, U=Understand, A=Apply and above (Bloom's Revised taxonomy)

Note: This specification table provides general guidelines to assist student for their learning and to teachers to teach and assess students with respect to attainment of UOs. The actual distribution of marks at different taxonomy levels (of R, U and A) in the question paper may vary from above table.

10. SUGGESTED STUDENT ACTIVITIES

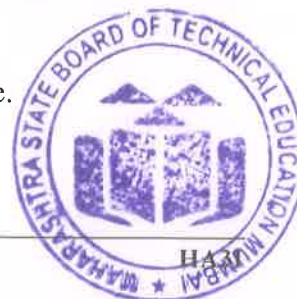
Other than the classroom and laboratory learning, following are the suggested student-related *co-curricular* activities which can be undertaken to accelerate the attainment of the various outcomes in this course: Students should conduct following activities in group and prepare reports of about 5 pages for each activity, also collect/record physical evidences for their (student's) portfolio which will be useful for their placement interviews:

- Prepare journal of practicals.
- Undertake micro-projects using Object Oriented Concepts.

11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

These are sample strategies, which the teacher can use to accelerate the attainment of the various learning outcomes in this course:

- Massive open online courses (**MOOCs**) may be used to teach various topics/sub topics.
- '**L**' in item No. 4 does not mean only the traditional lecture method, but different types of teaching methods and media that are to be employed to develop the outcomes.
- About **15-20% of the topics/sub-topics** which is relatively simpler or descriptive in nature is to be given to the students for **self-directed learning** and assess the development of the COs through classroom presentations (see implementation guideline for details).
- With respect to item No.10, teachers need to ensure to create opportunities and provisions for **co-curricular activities**.
- Guide student(s) in undertaking micro-projects.
- Demonstrate students thoroughly before they start doing the practice.



- g. Encourage students to refer different websites to have deeper understanding of the subject.
- h. Observe continuously and monitor the performance of students in Lab.

12. SUGGESTED MICRO-PROJECTS

Only one micro-project is planned to be undertaken by a student that needs to be assigned to him/her in the beginning of the semester. In the first four semesters, the micro-project are group-based. However, in the fifth and sixth semesters, it should be preferably be **individually** undertaken to build up the skill and confidence in every student to become problem solver so that s/he contributes to the projects of the industry. In special situations where groups have to be formed for micro-projects, the number of students in the group should **not exceed three**.

The micro-project could be industry application based, internet-based, workshop-based, laboratory-based or field-based. Each micro-project should encompass two or more COs which are in fact, an integration of PrOs, UOs and ADOs. Each student will have to maintain dated work diary consisting of individual contribution in the project work and give a seminar presentation of it before submission. The total duration of the micro-project should not be less than **16 (sixteen) student engagement hours** during the course. The student ought to submit micro-project by the end of the semester to develop the industry oriented COs.

A suggestive list of micro-projects are given here. Similar micro-projects could be added by the concerned faculty:

- a. Develop library management application.
- b. Develop hotel management application.
- c. Develop bank management application.
- d. Develop store management application.
- e. Develop hospital management application.
- f. Any other micro-projects suggested by subject faculty on similar line.

(Use Object Oriented concepts and may also use file handling features of 'C++' to develop above listed applications)

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication
1	Object Oriented Programming with C++	Balgurusamy, E.	McGraw Hill Education, New Delhi 2015, ISBN: 9781259029936
2	The C++ Programming Language	Stroustrup, B.	Pearson Education, New Delhi 2015, ISBN: 9780201889543
3	Object Oriented Programming in C++	Lafore, R.	Sams Publication, New Delhi 2015, ISBN: 9780672323089
4	C++ The Complete Reference	Schildt, H.	McGraw Hill Professional, New Delhi 2015, ISBN: 9780072226805
5	Object Oriented Programming in C++	Subburaj, R.	Vikas Publication, New Delhi 2015, ISBN: 9789325969964
6	C++ Programming	Dr. Rajendra Kawale	Devraj Publications

14. SUGGESTED SOFTWARE/LEARNING WEBSITES

- a. https://www.tutorialspoint.com/cplusplus/cpp_object_oriented.htm
- b. <http://www.studytonight.com/cpp/cpp-and-oops-concepts.php>
- c. https://www3.ntu.edu.sg/home/ehchua/programming/cpp/cp3_OOP.html



- d. <https://www.hscripts.com/tutorials/cpp/cpp-oops-concepts.php>
- e. <https://www.khanacademy.org/>
- f. <http://www.nptel.ac.in>



Program Name : Computer Engineering Program Group / Diploma in Computer Hardware & Maintenance / Diploma in Cloud Computing and Big Data

Program Code : CO/CM/IF/CW/HA/BD

Semester : Third

Course Title : Data Structures Using 'C'

Course Code : 22317

1. RATIONALE

Data structure is an important aspect for Computer Engineering and Information Technology Diploma graduates. Data structure is a logical & mathematical model of storing & organizing data in a particular way in a computer. The methods and techniques of Data Structures are widely used in industries. After learning this subject student will be able to identify the problem, analyze different algorithms to solve the problem & choose most appropriate data structure to represent the data.

2. COMPETENCY

The aim of this course is to help the student to attain the following industry identified competency through various teaching learning experiences:

- **Implement relevant algorithms using Data Structures.**

3. COURSE OUTCOMES (COs)

The theory, practical experiences and relevant soft skills associated with this course are to be taught and implemented, so that the student demonstrates the following *industry oriented* COs associated with the above mentioned competency:

- Perform basic operations on arrays.
- Apply different searching and sorting techniques.
- Implement basic operations on stack and queue using array representation.
- Implement basic operations on Linked List.
- Implement program to create and traverse tree to solve problems.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme			Credit (L+T+P)	Examination Scheme												
L	T	P		Theory						Practical						
				Paper Hrs.	ESE		PA		Total		ESE		PA		Total	
			Max		Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	
3	-	2	5	3	70	28	30*	00	100	40	25#	10	25	10	50	20

(*): Under the theory PA; Out of 30 marks, 10 marks of theory PA are for micro-project assessment to facilitate integration of COs and the remaining 20 marks is the average of 2 tests to be taken during the semester for the assessment of the UOs required for the attainment of the COs.

Legends: L-Lecture; T – Tutorial/Teacher Guided Theory Practice; P - Practical
 ESE - End Semester Examination; PA - Progressive Assessment



5. **COURSE MAP** (with sample COs, PrOs, UOs, ADOs and topics)

This course map illustrates an overview of the flow and linkages of the topics at various levels of outcomes (details in subsequent sections) to be attained by the student by the end of the course, in all domains of learning in terms of the industry/employer identified competency depicted at the center of this map.

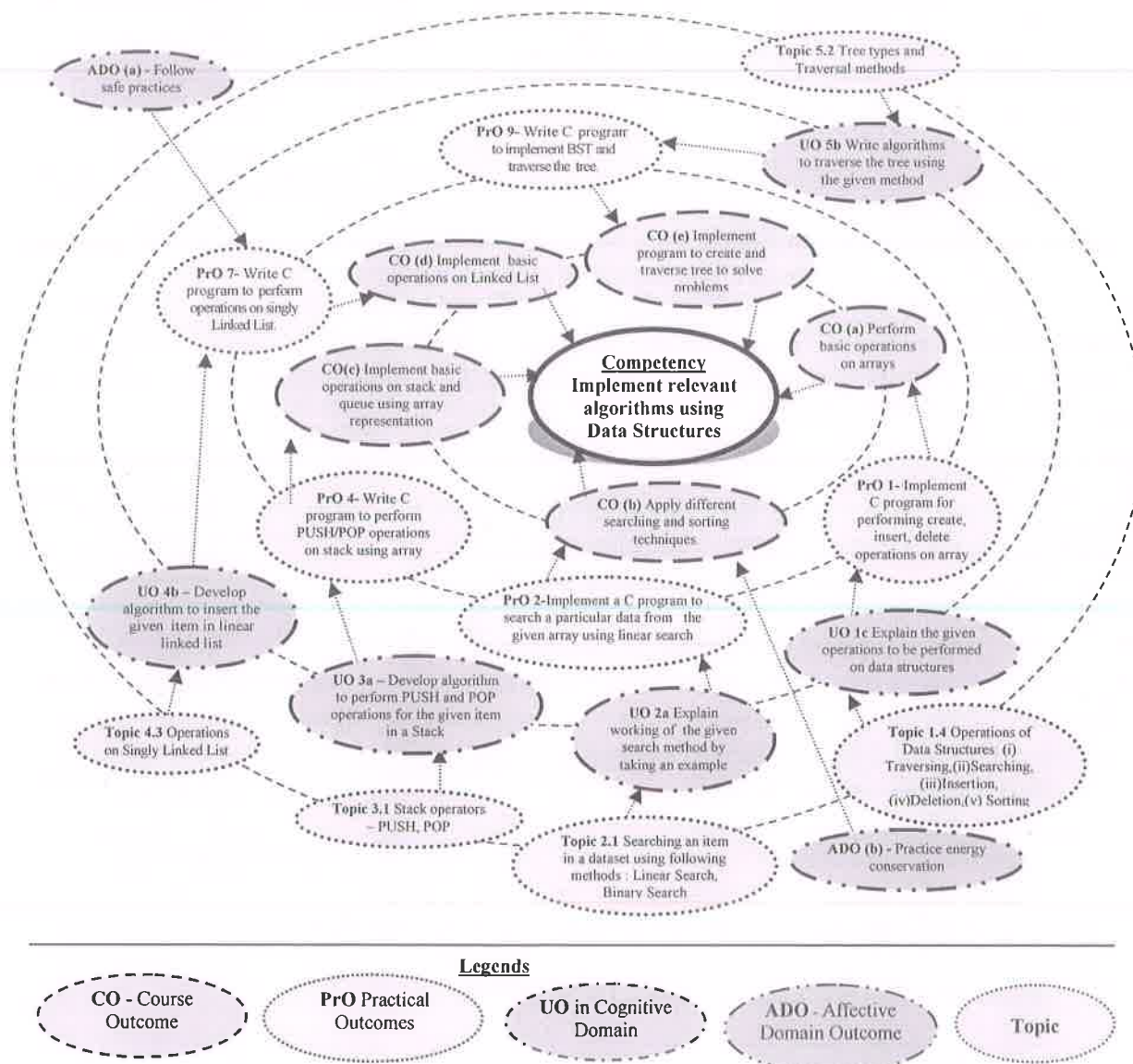


Figure 1 - Course Map

6. **SUGGESTED PRACTICALS/ EXERCISES**

The practicals in this section are PrOs (i.e. sub-components of the COs) to be developed and assessed in the student for the attainment of the competency:

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
1	Implement a 'C' program for performing following operations on 'Array: Creation, Insertion, Deletion, Display	I	02*
2	Implement a 'C' program to search a particular data from the given	II	02*

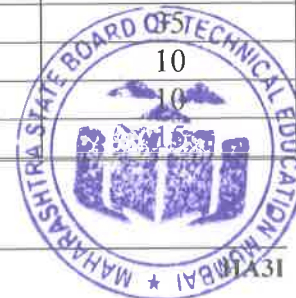


S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
	Array using: (i)Linear Search,		
3	Implement a 'C' program to search a particular data from the given Array using Binary Search	II	02*
4	Implement a 'C' program to sort an array using following methods: (i)Bubble Sort, (ii) Selection Sort (iii) Insertion Sort	II	02*
5	Implement a 'C' program to sort an array using following methods: (ii) Selection	II	02
6	Implement a 'C' program to sort an array using following methods: (iii) Insertion Sort	II	02
7	Write C program to perform PUSH and POP operations on stack using array.	III	02*
8	Write C program to perform INSERT and DELETE operations on Linear Queue using array. Part - I	III	02
9	Write C program to perform INSERT and DELETE operations on Linear Queue using array. Part - II	III	02
10	Write C program to perform INSERT and DELETE operations on Circular Queue using array. Part - I	III	02
11	Write C program to perform INSERT and DELETE operations on Circular Queue using array. Part - II	III	02
12	Write C program to perform the operations (Insert, Delete, Traverse, and Search) on Singly Linked List. Part - I	IV	02*
13	Write C program to perform the operations (Insert, Delete, Traverse, and Search) on Singly Linked List. Part - II	IV	02
14	Write C program to perform the operations (Insert, Delete, Traverse, and Search) on Circular Singly Linked List. Part - I	IV	02*
15	Write C program to perform the operations (Insert, Delete, Traverse, and Search) on Circular Singly Linked List. Part - II	IV	02
16	Write C program to Implement BST (Binary Search Tree) and traverse the tree (Inorder, Preorder, Post order).	V	02*
	Total		32

Note

- i. A suggestive list of **PrOs** is given in the above table. More such **PrOs** can be added to attain the **COs** and competency. A judicious mix of minimum 12 or more practical need to be performed, out of which, the practicals marked as '*' are compulsory, so that the student reaches the 'Precision Level' of Dave's 'Psychomotor Domain Taxonomy' as generally required by the industry.
- ii. The 'Process' and 'Product' related skills associated with each **PrO** is to be assessed according to a suggested sample given below:

S. No.	Performance Indicators	Weightage in %
a.	Correctness of data structure representation	20
b.	Correctness of algorithm	
c.	Debugging ability	10
d.	Quality of input and output displayed	10
e.	Answer to sample questions	10



S. No.	Performance Indicators	Weightage in %
f.	Submit report in time	10
Total		100

The above PrOs also comprise of the following social skills/attitudes which are Affective Domain Outcomes (ADOs) that are best developed through the laboratory/field based experiences:

- Follow safety practices.
- Practice good housekeeping.
- Demonstrate working as a leader/a team member.
- Follow ethical practices.

The ADOs are not specific to any one PrO, but are embedded in many PrOs. Hence, the acquisition of the ADOs takes place gradually in the student when s/he undertakes a series of practical experiences over a period of time. Moreover, the level of achievement of the ADOs according to Krathwohl's 'Affective Domain Taxonomy' should gradually increase as planned below:

- 'Valuing Level' in 1st year
- 'Organising Level' in 2nd year and
- 'Characterising Level' in 3rd year.

7. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED

The major equipment with broad specification mentioned here will usher in uniformity in conduct of experiments, as well as aid to procure equipment by authorities concerned.

S. No.	Equipment Name with Broad Specifications	PrO S. No.
1	Computer system (Any computer system which is available in laboratory)	All
2	'C' Compiler / GCC Compiler	

8. UNDERPINNING THEORY COMPONENTS

The following topics are to be taught and assessed in order to develop the sample UOs given below for achieving the COs to attain the identified competency. More UOs could be added:

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
Unit – I Introducti on to Data Structures	1a. Classify the given type of Data Structures based on their characteristics. 1b. Explain complexity of the given algorithm in terms of time and space. 1c. Explain the given operations to be performed on the given type of data structures.	1.1 Concept and need of DS, Abstract Data Type 1.2 Types of Data Structures: (i) Linear Data Structures (ii) Non-Linear Data Structures 1.3 Algorithm Complexity: (i)Time (ii)Space 1.4 Operations on Data Structures: (i) Traversing,(ii)Searching, (iii)Insertion, (iv)Deletion,(v) Sorting
Unit– II Searching and	2a. Explain working of the given search method with an example.	2.1 Searching: searching an item in a Data Set using following methods: (i) Linear Search



Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
Sorting	2b. Write an algorithm to search the given key using binary Search method. 2c. Write an Algorithm to sort data using a specified sorting method. 2d. Explain the working of given sorting method step-by-step with an example and small data set.	(ii) Binary Search 2.2 Sorting: sorting of data set in an order using following methods: (i) Bubble Sort (ii) Selection Sort (iii) Insertion Sort (iv) Quick Sort (v) Radix Sort.
Unit- III Stacks and Queues	3a. Develop an algorithm to perform PUSH and POP operations for the given item in a Stack. 3b. Convert the given expression from Infix to Prefix/Postfix using Stack. 3c. Write steps to evaluate the given expression using the stack. 3d. Develop a program to perform the given operation on a linear Queue. 3e. Write Algorithm to perform the given operations on circular queue.	3.1 Introduction to Stack - Stack representation in memory using array - Stack as an ADT - Stack Operations – PUSH, POP - Stack Operations Conditions – Stack Full / Stack Overflow, Stack Empty / Stack Underflow. - Applications of Stack <ul style="list-style-type: none"> • Reversing a list • Polish notations 3.2 Conversion of infix to postfix expression, Evaluation of postfix expression, Converting an infix into prefix expression, Evaluation of prefix expression , Recursion, Tower of Hanoi 3.3 Introduction to Queue: - Queue representation in memory using array - Queue as an ADT - Types of Queues :- Linear Queue, Circular Queue, Concept of Priority Queue - Queue Operations – INSERT, DELETE - Queue Operations Conditions – Queue Full, Queue Empty - Applications of Queue
Unit-IV Linked List	4a. Create relevant structure to represent the given node using linked list. 4b. Develop algorithm to insert the given item in linear linked list. 4c. Develop algorithm to delete the given item from linear linked list 4d. Develop algorithm to traverse a circular linked list.	4.1 Introduction to Linked List Terminologies: node, Address, Pointer, Information field / Data field, Next pointer, Null Pointer, Empty list. 4.2 Type of lists: Linear list, Circular list 4.3 Operations on a singly linked list: Traversing a singly linked list, Searching a key in linked list, Inserting a new node in a linked list, Deleting a node from a linked list



Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
Unit –V Trees and Graphs	5a. Draw Binary Search Tree for the given data set. 5b. Write algorithms to traverse the tree using the given method. 5c. Construct Expression tree for the given data. 5d. Represent the given Graph using adjacency matrix and adjacency list.	Introduction to Trees 5.1 Terminologies: tree, degree of a node, degree of a tree, level of a node, leaf node, Depth / Height of a tree, In-degree & Out-Degree, Path, Ancestor & descendant nodes 5.2 Tree Types and Traversal methods Types of Trees: General tree, Binary tree, Binary search tree (BST). Binary tree traversal : In order traversal, Preorder traversal, Post order traversal 5.3 Expression tree. 5.4 Introduction to Graph terminologies: graph, node (Vertices), arcs (edge), directed graph, undirected graph, in-degree, out-degree, adjacent, successor, predecessor, relation, path, sink, articulation point. 5.5 Adjacency List, Adjacency Matrix of directed / undirected graph.

Note: To attain the COs and competency, above listed UOs need to be undertaken to achieve the 'Application Level' of Bloom's 'Cognitive Domain Taxonomy'.

9. SUGGESTED SPECIFICATION TABLE FOR QUESTION PAPER DESIGN

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Introduction to Data Structures	04	02	02	02	06
II	Searching and Sorting	08	02	02	08	12
III	Stacks and Queues	16	02	04	14	20
IV	Linked Lists	10	02	04	10	16
V	Trees and Graphs	10	02	04	10	16
Total		48	10	16	44	70

Legends: R=Remember, U=Understand, A=Apply and above (Bloom's Revised taxonomy)

Note: This specification table provides general guidelines to assist student for their learning and to teachers to teach and assess students with respect to attainment of UOs. The actual distribution of marks at different taxonomy levels (of R, U and A) in the question paper may vary from above table.

10. SUGGESTED STUDENT ACTIVITIES

Other than the classroom and laboratory learning, following are the suggested student-related *co-curricular* activities which can be undertaken to accelerate the attainment of the various outcomes in this course: Students should conduct following activities in group and prepare reports of about 5 pages for each activity, also collect/record physical evidences for their (student's) portfolio which will be useful for their placement interviews:

- Prepare journal of practical.
- Undertake micro-projects.
- Prepare a chart to classify Data Structures.



- d. Prepare charts for logical representation of Data Structures.

11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

These are sample strategies, which the teacher can use to accelerate the attainment of the various learning outcomes in this course:

- Massive open online courses (**MOOCs**) may be used to teach various topics/sub topics.
- '**L**' in item No. 4 does not mean only the traditional lecture method, but different types of teaching methods and media that are to be employed to develop the outcomes.
- About **15-20% of the topics/sub-topics** which is relatively simpler or descriptive in nature is to be given to the students for **self-directed learning** and assess the development of the COs through classroom presentations (see implementation guideline for details).
- With respect to item No.10, teachers need to ensure to create opportunities and provisions for **co-curricular activities**.
- Guide student(s) in undertaking micro-projects.
- Demonstrate students thoroughly before they start doing the practice.
- Encourage students to refer different websites to have deeper understanding of the subject.
- Observe continuously and monitor the performance of students in Lab.

12. SUGGESTED MICRO-PROJECTS

Only one micro-project is planned to be undertaken by a student that needs to be assigned to him/her in the beginning of the semester. In the first four semesters, the micro-project are group-based. However, in the fifth and sixth semesters, it should be preferably be **individually** undertaken to build up the skill and confidence in every student to become problem solver so that s/he contributes to the projects of the industry. In special situations where groups have to be formed for micro-projects, the number of students in the group should **not exceed three**.

The micro-project could be industry application based, internet-based, workshop-based, laboratory-based or field-based. Each micro-project should encompass two or more COs which are in fact, an integration of PrOs, UOs and ADOs. Each student will have to maintain dated work diary consisting of individual contribution in the project work and give a seminar presentation of it before submission. The total duration of the micro-project should not be less than **16 (sixteen) student engagement hours** during the course. The student ought to submit micro-project by the end of the semester to develop the industry oriented COs.

A suggestive list of micro-projects is given here. Similar micro-projects could be added by the concerned faculty:

- Develop a program in 'C' to evaluate an arithmetic expression using Stack with linked list representation.
- Develop a program in 'C' that creates Queue of given persons. Shift the original position of person to a new position based on its changed priority or remove a person from the Queue using Linked List implementation.
- Develop a program in 'C' that creates tree to store given data set using linked list representation. Locate and display a specific data from the data set.
- Develop a 'C' program for performing following banking operations: Deposit, Withdraw and Balance enquiry. Select appropriate data structure for the same.

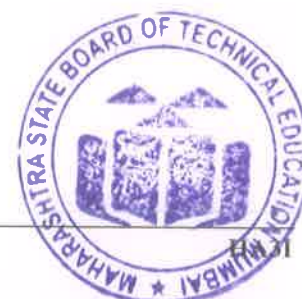
13. SUGGESTED LEARNING RESOURCES



S. No.	Title of Book	Author	Publication
1	Data Structures using 'C'	Balgurusamy, E.	McGraw Hill Education, New Delhi 2013, ISBN: 978-1259029547
2	Data Structures using 'C'	ISRD Group	McGraw Hill Education, New Delhi 2013, ISBN: 978-12590006401
3	Data Structures with 'C' (SIE) (Schaum's Outline Series)	Lipschutz	McGraw Hill Education, New Delhi 2013, ISBN: 978-0070701984
4	Practical 'C' programming	Steve Oualline	O'Reilly Media
5	Data Structures	Dr. Rajendra Kawale	Devraj Publications

14. SUGGESTED SOFTWARE/LEARNING WEBSITES

- a. <http://nptel.ac.in/courses/106102064/1>
- b. www.oopweb.com/algorithms
- c. www.studytonight.com/data-structures/
- d. www.cs.utexas.edu/users
- e. liscs.wssu.edu
- f. <http://www.academictutorials.com/data-structures>
- g. <http://www.sitebay.com/data-structure/c-data-structure>
- h. <http://www.indiabix.com>
- i. <https://www.khanacademy.org/>



Program Name : Computer Engineering Program Group / Diploma in Electronics and Computer Engineering / Diploma in Computer Hardware & Maintenance / Diploma in Artificial Intelligence and Machine Learning / Diploma in Cloud Computing and Big Data

Program Code : CO/CM/CW/TE/HA/AN/BD

Semester : Third

Course Title : Database Management System

Course Code : 22319

1. RATIONALE

Each and every organization like shopping mall, hospital, banking, institutes, industry needs to share huge amount of data in effective manner. This course aims to develop skills in students to create, store, modify, manage and extract information from a database. Database system can be used as a backend for developing database applications.

2. COMPETENCY

The aim of this course is to help the student to attain the following *industry identified* competency through various teaching learning experiences:

- Apply Database management concept using SQL.

3. COURSE OUTCOMES (COs)

The theory, practical experiences and relevant soft skills associated with this course are to be taught and implemented, so that the student demonstrates the following industry oriented COs associated with the above mentioned competency:

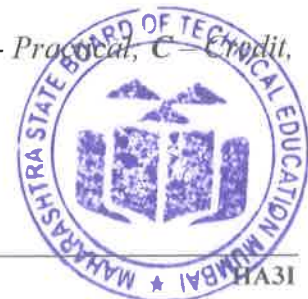
- Design Normalized database on given data.
- Create and Manage Database using SQL command.
- Write PL/SQL code for given database.
- Apply triggers on database also create procedure and function according to condition.
- Apply security and confidentiality on given Database.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme			Credit (L+T+P)	Examination Scheme												
L	T	P		Theory						Practical						
				Paper Hrs.	ESE		PA		Total		ESE		PA		Total	
Max	Min	Max	Min		Max	Min	Max	Min	Max	Min	Max	Min	Max	Min		
4	2	2	8	3	70	28	30*	00	100	40	25#	10	25	10	50	20

(*): Under the theory PA; Out of 30 marks, 10 marks of theory PA are for micro-project assessment to facilitate integration of COs and the remaining 20 marks is the average of 2 tests to be taken during the semester for the assessment of the UOs required for the attainment of the COs.

Legends: L-Lecture; T – Tutorial/Teacher Guided Theory Practice; P - Practical, C – Credit, ESE - End Semester Examination; PA - Progressive Assessment



5. COURSE MAP (with sample COs, PrOs, UOs, ADOs and topics)

This course map illustrates an overview of the flow and linkages of the topics at various levels of outcomes (details in subsequent sections) to be attained by the student by the end of the course, in all domains of learning in terms of the industry/employer identified competency depicted at the centre of this map.

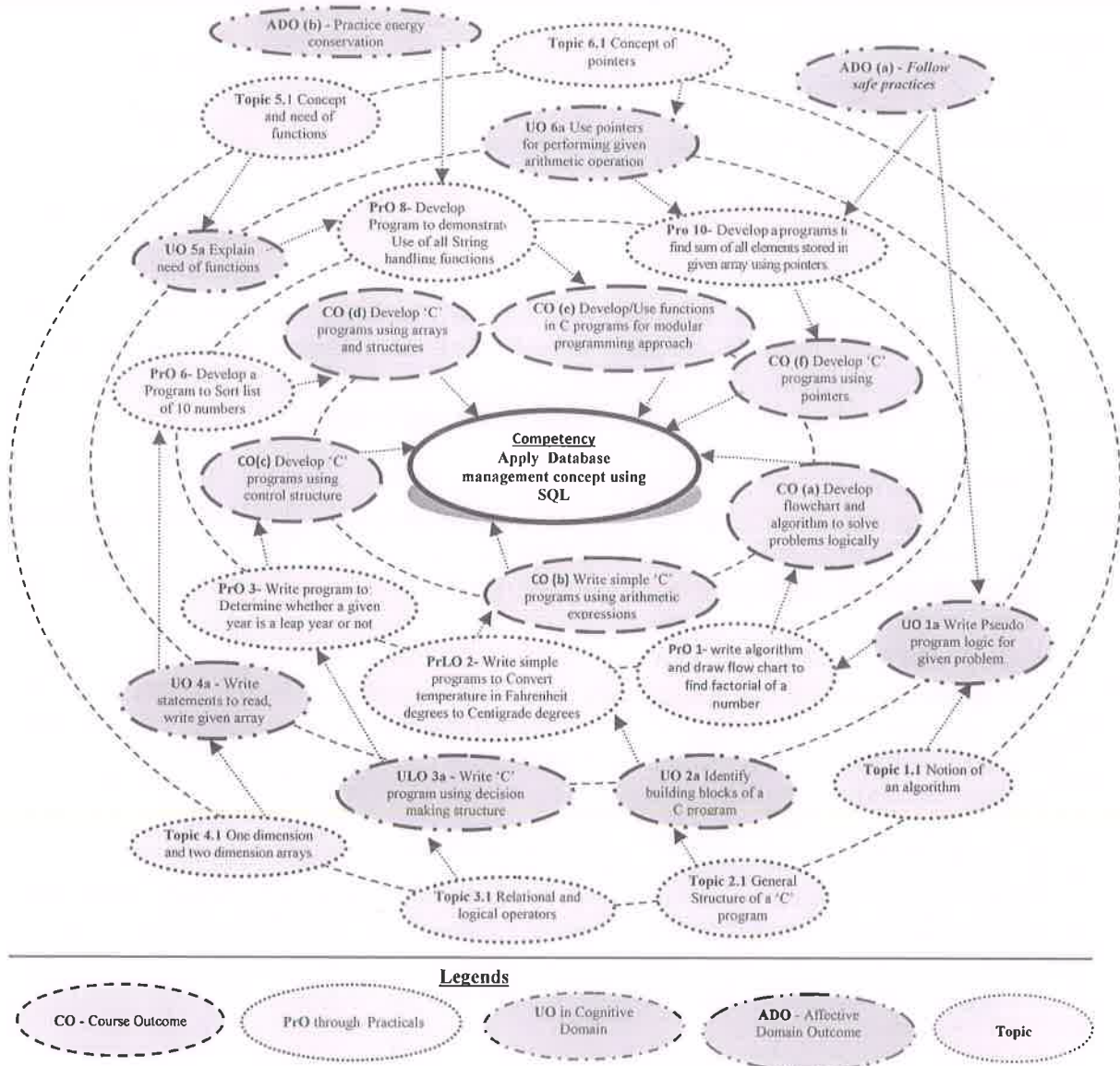
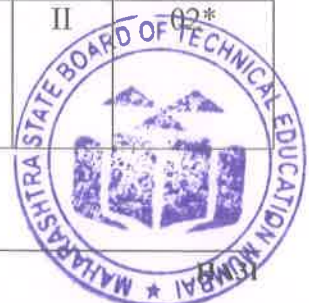


Figure 1 - Course Map

6. SUGGESTED PRACTICALS/ EXERCISES

The practicals in this section are PrOs (i.e. sub-components of the COs) to be developed and assessed in the student for the attainment of the competency:

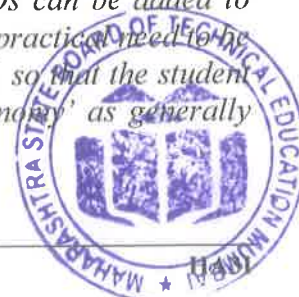
S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
1	Perform following in GUI based database software using GUI only i) Create Database ii) Create tables and assign primary key .	II	02*



S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
	iii) Modify the table structure-add column ,change the data type of column, delete the column from table. iv) Insert, update and delete the record from table. v) Retrieve data from the table according to condition given.		
2	Perform following in GUI based database using GUI only i) Apply given validation on table and set error messages. ii) Set default value for column. iii) Set and remove database password.	II	02
3	Design E-R diagram and Create Normalized Database on given data.	II	02
4	i) Create and Execute DDL commands using SQL. ii) Apply following Integrity constraints on table: iii) Primary key, Foreign key, Unique key constraint, Null , Not Null and Check constraint.	II	02*
5	Create and Execute DML commands using SQL.	II	02*
6	Write Queries using following operators: Arithmetic Operators, Comparison Operators, Logical Operators, Set Operators, Range Searching operators-Between, Pattern matching operators-Like.	II	02*
7	Write Queries using following Functions: String, Arithmetic, Date and time, Aggregate Functions.	III	02*
8	Execute Queries using the Select command with Where, Having, Group by and order by clauses.	III	02*
9	Execute the queries for implementation of Inner and Outer Join.	III	02
10	Implement Views i) Create different views ii) Insert, modify and delete records through views. iii) Delete the views.	III	02
11	Create and Execute Indexes, Sequences, and synonyms in SQL.	III	02*
12	Write a PL/SQL programs using if then else, for, while and nested loop.	IV	02*
13	Write a PL/SQL code to implement implicit and explicit cursors.	IV	02
14	Write PL/SQL Programs based on Exceptions handling.(Predefined and user-defined exceptions)	IV	02
15	Write PL/SQL code to create Procedures and functions.	IV	02
16	Write PL/SQL code to create triggers on given database.	IV	02
17	Executing DCL commands using SQL i) Create users ii) Grant privileges to users iii) Revoke privileges from users.	V	02*
	Total		34

Note

i. A suggestive list of **PrOs** is given in the above table. More such PrOs can be added to attain the COs and competency. A judicious mix of minimum 12 or more practicals need to be performed, out of which, the practicals marked as '*' are compulsory, so that the student reaches the 'Precision Level' of Dave's 'Psychomotor Domain Taxonomy' as generally required by the industry.



ii. The 'Process' and 'Product' related skills associated with each PrO is to be assessed according to a suggested sample given below:

S. No.	Performance Indicators	Weightage in %
a.	SQL queries and PL/SQL programming	60
b.	Database Integrity	10
c.	Quality result displayed by SQL queries.	10
d.	Answer to sample questions	10
e.	Submit report in time	10
Total		100

The above PrOs also comprise of the following social skills/attitudes which are Affective Domain Outcomes (ADOs) that are best developed through the laboratory/field based experiences:

- a. Follow safety practices.
- b. Practice good housekeeping.
- c. Demonstrate working as a leader/a team member.
- d. Maintain tools and equipment.
- e. Follow ethical Practices.

The ADOs are not specific to any one PrO, but are embedded in many PrOs. Hence, the acquisition of the ADOs takes place gradually in the student when s/he undertakes a series of practical experiences over a period of time. Moreover, the level of achievement of the ADOs according to Krathwohl's 'Affective Domain Taxonomy' should gradually increase as planned below:

- 'Valuing Level' in 1st year
- 'Organising Level' in 2nd year
- 'Characterising Level' in 3rd year.

7. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED

The major equipment with broad specification mentioned here will usher in uniformity in conduct of experiments, as well as aid to procure equipment by authorities concerned.

S. No.	Equipment Name with Broad Specifications	Pro. S. No.
1	Computer system (Any computer system with basic configuration)	All
2	Any GUI based database software (MS-Access/Visual Foxpro/MySQL)	1-2
3	Any RDBMS software (MySQL/SQL server)	3-16

8. UNDERPINNING THEORY COMPONENTS

The following topics are to be taught and assessed in order to develop the sample UOs given below for achieving the COs to attain the identified competency. More UOs could be added:

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
Unit – I Database System	1a State the importance of DBMS over file processing in the	1.1 Concept of Data, database, DBMS advantages of DBMS over file processing system, Application of database.



Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
Concept	given situation. 1b Describe the overall structure of the given DBMS 1c Identify the relevant database model in the given situation. 1d Draw the E-R diagram of the given database and identify relationship between the entities.	1.2 Three level Architecture for Database System. 1.3 Data abstraction: Different levels of Data abstraction, Instance and schema, Data independence - Logical and Physical Independence. 1.4 Overall Structure of DBMS. 1.5 Data Modeling: Record based logical model- Relational, Network, Hierarchical 1.6 Data Modeling Using the E-R Model: Entity Relationship Model , Strong Entity set, Weak Entity set, Types of Attributes, E-R Diagrams.
Unit- II Relational Data Model	2a Explain the concept of RDBMS also appropriateness for the given problem. 2b Design Normalized database structure in the given problem. 2c Design SQL queries to create Relational database and apply in the given data constraints. 2d Identify the operators for queries implementation of the given problem.	2.1 Fundamentals of RDBMS – Record, fields, data types, tables and database 2.2 Concept of RDBMS, E.F.Codd's Rule for RDBMS, Key concepts- Candidate key, Primary key, Foreign key. 2.3 Normalization: Normalization Concepts, Need of Normalization, Types of Normalization- 1NF,2NF,3NF 2.4 Introduction to Structured Query Language, Data Types in SQL, components of SQL- DDL,DML,DCL,DQL 2.5 DDL Commands: CREATE, ALTER, DROP, TRUNCATE, DESC, RENAME 2.6 Data Integrity Constraint: Types of Data Integrity Constraint: I/O constraint- Primary key, Foreign key, Unique key constraint, Business Rule Constraint-Null, Not Null and Check constraint. 2.7 DML Commands: INSERT, UPDATE, DELETE 2.8 DCL Commands: COMMIT, SAVEPOINT, ROLLBACK, GRANT, and REVOKE. 2.9 DQL Commands: SELECT. 2.10 SQL Operators: Arithmetic Operators, Comparison Operators, Logical Operators, Set Operators, Range Searching operators- Between, Pattern matching operators-Like.
Unit III- Interactive SQL and Advance SQL: SQL Performanc	3a. Write the given queries using relevant functions. 3b. Write query to combine the given multiple table using	3.1 In-built Functions: String, Arithmetic, 3.2 Date and time, Aggregate functions. 3.3 Queries using Group by, having and Order by clause, Joins-Inner and Outer Join, Sub queries. 3.4 Views: Concept of View, The Create, View



Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
e Tuning	Join. 3c. Design SQL queries to implement VIEWS on the given tables. 3d. Apply and drop INDEXES and SYNONYM on the given table.	Command, Updating Views, Views and Joins, Views and Sub queries, Dropping Views. 3.5 Sequences: Creating Sequences, Altering Sequences, Dropping Sequences. 3.6 Indexes: Index Types, Creating of an Index: Simple Unique, and 3.7 Composite Index, Dropping Indexes 3.8 Synonyms: Creating Synonyms, Dropping Synonyms.
Unit IV- PL/SQL Programming	4a. Write simple PL/SQL Code using control structure and handle various exceptions in the given situation. 4c. Create cursor for retrieving multiple records in the given situation. 4d. Create and Execute stored procedures and functions in the given situation. 4e. Create and apply database trigger using PL/SQL in the given situation.	4.1 Introduction of PL/SQL, Advantages of PL/SQL, The PL/SQL Block Structure, PL/SQL execution environment, PL/SQL data Types, Variables, Constants. 4.2 Control Structure: Conditional Control, Iterative Control, Sequential Control. 4.3 Exception handling: Predefined Exception, User defined Exception. 4.4 Cursors: Implicit and Explicit Cursors, Declaring, Opening and Closing a Cursor, Fetching a Record from Cursor, Cursor for loops, Parameterized Cursors. 4.5 Procedures: Advantages, Creating, Executing and Deleting a Stored Procedure. 4.6 Functions: Advantages, Creating, Executing and Deleting a Function. 4.7 Database Triggers: Use of Database Triggers, How to apply database Triggers, Types of Triggers, Syntax for Creating Trigger, Deleting Trigger.
Unit V- Database security and Transaction Processing	5a. Provide security to the given database by assigning various privileges to the user. 5b. Create and manage the given database Users. 5c. Explain the importance of Transaction in the given situation. 5d. Explain advantages of Database Backup and Recovery in the given situation.	5.1 Database security: Introduction to database security, Data security Requirements, Types of Database Users-Creating, altering and Deleting Users. 5.2 Protecting the data within database-Database Privileges: Systems privileges and object Privileges, Granting and Revoking Privileges: Grant and Revoke command. 5.3 Transaction: Concept, Properties and States of Transaction. 5.4 Database Backup -Types of Failures, Causes of failures, Database Backup Introduction, Types of Database Backups-Physical and Logical. 5.5 Database Recovery-Recovery concept, Recovery Techniques-Roll forward, Rollback



Note: To attain the COs and competency, above listed UOs need to be undertaken to achieve the 'Application Level' of Bloom's 'Cognitive Domain Taxonomy'.

9. SUGGESTED SPECIFICATION TABLE FOR QUESTION PAPER DESIGN

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Database System Concepts	10	04	04	04	12
II	Relational Data Model	16	02	04	12	18
III	Interactive SQL and Advance SQL: SQL Performance Tuning	14	02	04	08	14
IV	PL/SQL Programming	14	02	04	10	16
V	Database security and Transaction Processing	10	02	04	04	10
Total		64	12	20	38	70

Legends: R=Remember, U=Understand, A=Apply and above (Bloom's Revised taxonomy)

Note: This specification table provides general guidelines to assist student for their learning and to teachers to teach and assess students with respect to attainment of UOs. The actual distribution of marks at different taxonomy levels (of R, U and A) in the question paper may vary from above table.

10. SUGGESTED STUDENT ACTIVITIES

Other than the classroom and laboratory learning, following are the suggested student-related **co-curricular** activities which can be undertaken to accelerate the attainment of the various outcomes in this course: Students should conduct following activities in group and prepare reports of about 5 pages for each activity, also collect/record physical evidences for their (student's) portfolio which will be useful for their placement interviews:

- a. Prepare journal of practical.
- b. Undertake micro-projects.

11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

These are sample strategies, which the teacher can use to accelerate the attainment of the various learning outcomes in this course:

- a. Massive open online courses (**MOOCs**) may be used to teach various topics/sub topics.
- b. '**L**' in item No. 4 does not mean only the traditional lecture method, but different types of teaching methods and media that are to be employed to develop the outcomes.
- c. About **15-20% of the topics/sub-topics** which is relatively simpler or descriptive in nature is to be given to the students for **self-directed learning** and assess the development of the COs through classroom presentations (see implementation guideline for details).
- d. With respect to item No.10, teachers need to ensure to create opportunities and provisions for **co-curricular activities**.
- e. Guide student(s) in undertaking micro-projects.
- f. Demonstrate students thoroughly before they start doing the practice.
- g. Encourage students to refer different websites to have deeper understanding of the subject.
- h. Observe continuously and monitor the performance of students in lab.



12. SUGGESTED MICRO-PROJECTS

Only one micro-project is planned to be undertaken by a student that needs to be assigned to him/her in the beginning of the semester. In the first four semesters, the micro-project are group-based. However, in the fifth and sixth semesters, it should be preferably be **individually** undertaken to build up the skill and confidence in every student to become problem solver so that s/he contributes to the projects of the industry. In special situations where groups have to be formed for micro-projects, the number of students in the group should **not exceed three**.

The micro-project could be industry application based, internet-based, workshop-based, laboratory-based or field-based. Each micro-project should encompass two or more COs which are in fact, an integration of PrOs, UOs and ADOs. Each student will have to maintain dated work diary consisting of individual contribution in the project work and give a seminar presentation of it before submission. The total duration of the micro-project should not be less than **16 (sixteen) student engagement hours** during the course. The student ought to submit micro-project by the end of the semester to develop the industry oriented COs.

A suggestive list of micro-projects is given here. Similar micro-projects could be added by the concerned faculty:

- Survey on various database System Software and compare it.
- Design E-R Diagram for Hospital/college/medical/Jewellery Shop/Library/Blood Bank.
- Design Normalized Database for Hospital/college/medical/Jewellery Shop / Library / Blood Bank.
- Apply trigger on given database.
- Create procedure and function according to given condition.
- Any other micro-projects suggested by subject faculty on similar line.

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication
1	Introduction to Database Management Systems	ISRD Group	McGraw Hill Education, New Delhi, 2015
2	Introduction to Relational databases & SQL programming	Allen	McGraw Hill Education, New Delhi, 2015
3	Database System Concepts McGraw Hillin ANSI C	Korth	McGraw Hill Education, New Delhi, 2015
4	Complete Reference: Mysql	Vikram Vaswani	McGraw Hill Education, New Delhi, 2015

14. SUGGESTED SOFTWARE/LEARNING WEBSITES

- www.tutorialpoint.com (Important website)
- wielyIndia.com or DreamtechPress.com
- <http://phindia.com/gupta/chapter/chapter1.pdf>
- www.williamstannings.com
- www.nptel.ac.in
- <https://www.khanacademy.org/>



Program Name : Computer and Electronics Engineering Program Group / Diploma in Electronics & Computer Engineering / Diploma in Computer Hardware & Maintenance/ Diploma in Artificial Intelligence and Machine Learning

Program Code : CO/CM/CW/DE/EJ/ET/EN/EX/EQ/IE/IS/IC/MU/TE/HA/AN

Semester : Third

Course Title : Digital Techniques

Course Code : 22320

1. RATIONALE

In the present scenario most of the electronic equipment like computers, mobiles, music systems, ATM, automation and control circuits and systems are based on digital circuits which the diploma electronic engineering passouts (also called technologists) have to test them. The knowledge of basic logic gates, combinational and sequential logic circuits using discrete gates as well as digital ICs will enable the students to interpret the working of equipment and maintain them. After completion of the course, students will be able to develop digital circuits based applications.

2. COMPETENCY

The aim of this course is to help the student to attain the following industry identified competency through various teaching learning experiences:

- **Build/ test digital logic circuits consist of digital ICs.**

3. COURSE OUTCOMES (COs)

The theory, practical experiences and relevant soft skills associated with this course are to be taught and implemented, so that the student demonstrates the following industry oriented COs associated with the above mentioned competency:

- Use number system and codes for interpreting working of digital system.
- Use Boolean expressions to realize logic circuits.
- Build simple combinational circuits.
- Build simple sequential circuits.
- Test data converters and PLDs in digital electronics systems.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme				Credit (L+T+P)	Examination Scheme											
L	T	P	Theory						Practical							
			Paper Hrs.		ESE		PA		Total		ESE		PA		Total	
Max	Min	Max		Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min		
4	-	2	6	3	70	28	30*	00	100	40	25#	10	25	10	50	20

(*): Under the theory PA, Out of 30 marks, 10 marks are for micro-project assessment to facilitate integration of COs and the remaining 20 marks is the average of 2 tests to be taken during the semester for the assessment of the cognitive domain UOs required for the attainment of the COs.



Legends: *L*-Lecture; *T* – Tutorial/Teacher Guided Theory Practice; *P* - Practical; *C* – Credit, *ESE* - End Semester Examination; *PA* - Progressive Assessment.

5. COURSE MAP (with sample COs, PrOs, UOs, ADOs and topics)

This course map illustrates an overview of the flow and linkages of the topics at various levels of outcomes (details in subsequent sections) to be attained by the student by the end of the course, in all domains of learning in terms of the industry/employer identified competency depicted at the centre of this map.

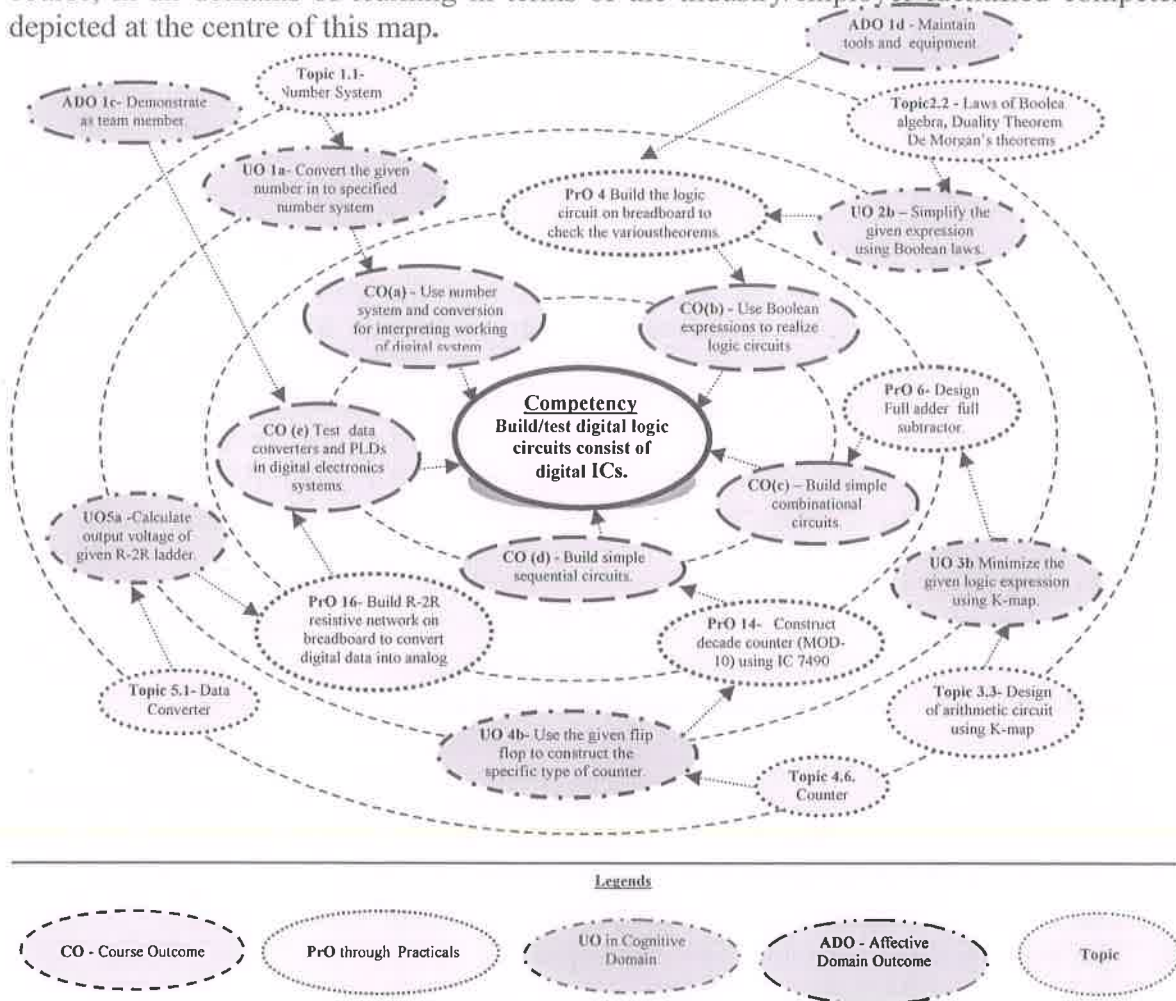
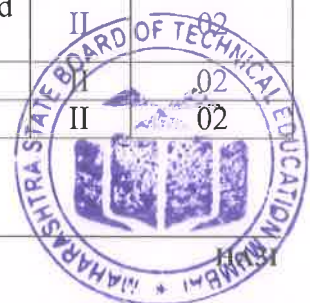


Figure 1 - Course Map

6. SUGGESTED PRACTICALS/ EXERCISES

The practicals in this section are PrOs (i.e. sub-components of the COs) to be developed and assessed in the student for the attainment of the competency.

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. required
1	Test the functionality of specified logic gates using breadboard. (IC 7404, 7408, 7432, 7486)	II	02*
2	Test the functionality of NAND and NOR gate of using breadboard (IC 7400 and 7402)	II	02
3	Construct AND, OR, NOT gates using universal gates.	II	02
4	Build the logic circuit on breadboard to check the De Morgan's	II	02



S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. required
	theorems.		
5	Design Half adder and Half subtractor using Boolean expressions.	III	02*
6	Design Full adder and full subtractor.	III	02
7	Construct and test BCD to 7 segment decoder using IC 7447/ 7448.	III	02
8	Build / test function of MUX 74151/74150/any other equivalent.	III	02
9	Build / test function of DEMUX 74155/74154/any other equivalent.	III	02
10	Build / test function of RS flip flop using NAND Gate.	IV	02*
11	Build / test function of MS JK flip flop using 7476.	IV	02
12	Use IC 7476 to construct and test the functionality of D and T flip flop.	IV	02
13	Implement 4 bit ripple counter using 7476.	IV	02
14	Use IC 7490 to construct decade counter (MOD-10).	IV	02
15	Implement 4 bit universal shift register.	IV	02
16	Build R-2R resistive network on breadboard to convert given digital data into analog.	V	02*
Total			32

Note

- i. A suggestive list of **PrOs** is given in the above table. More such **PrOs** can be added to attain the **COs** and competency. A judicious mix of minimum 12 or more practical need to be performed, out of which, the practicals marked as '*' are compulsory, so that the student reaches the 'Precision Level' of Dave's 'Psychomotor Domain Taxonomy' as generally required by the industry.
- ii. The 'Process' and 'Product' related skills associated with each **PrO** is to be assessed according to a suggested sample given below:

S. No.	Performance Indicators	Weightage in %
a.	Preparation of experimental set up	20
b.	Setting and operation	20
c.	Safety measures	10
d.	Observations and Recording	10
e.	Interpretation of result and conclusion	20
f.	Answer to sample questions	10
g.	Submission of report in time	10
Total		100

The above **PrOs** also comprise of the following social skills/attitudes which are Affective Domain Outcomes (ADOs) that are best developed through the laboratory/field based experiences:

- a. Follow safety practices.
- b. Practice good housekeeping.
- c. Demonstrate working as a leader/a team member.
- d. Maintain tools and equipment.
- e. Follow ethical practices.



The ADOs are not specific to any one PrO, but are embedded in many PrOs. Hence, the acquisition of the ADOs takes place gradually in the student when s/he undertakes a series of practical experiences over a period of time. Moreover, the level of achievement of the ADOs according to Krathwohl's 'Affective Domain Taxonomy' should gradually increase as planned below:

- 'Valuing Level' in 1st year
- 'Organising Level' in 2nd year
- 'Characterising Level' in 3rd year.

7. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED

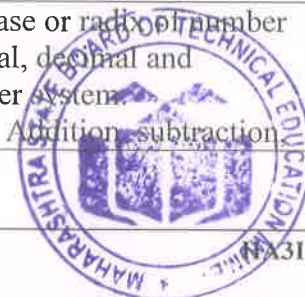
The major equipment with broad specification mentioned here will usher in uniformity in conduct of experiments, as well as aid to procure equipment by authorities concerned.

S. No.	Equipment Name with Broad Specifications	PrO. S. No.
1	Digital Multimeter: 3 and ½ digit with R, V, I measurements, diode and BJT testing.	All
2	CRO : Dual Channel, 4 Trace CRT / TFT based Bandwidth 20 MHz/30 MHz X10 magnification 20 ns max sweep rate, Alternate triggering Component tester and with optional features such as Digital Read out.	16
3	Pulse Generator: TTL pulse generator	10-15
4	DIGITAL IC tester: Tests a wide range of Analog and Digital IC's such as 74 Series, 40/45 Series of CMOS IC's.	1-15
5	Bread Board Development System: Bread Board system with DC power output 5V, +/-12V and 0-5V variable , digital voltmeter , ammeter, LED indicators 8 no, logic input switches 8 no, 7 segment display 2 no, clock generator, Manual pulser, Breadboard with about 1,600 points, Potentiometer, relay etc	1-15
6	Trainer kits for digital ICs: Trainer kit shall consists of digital ICs for logic gates, flop-flop, shift registers, counter along with toggle switches for inputs and bi-colour LED at outputs, built in power supply.	1-15
7	Regulated power supply: Floating DC Supply Voltages Dual DC : 2 x 0 -30V; 0-2 A Automatic Overload (Current Protection) Constant Voltage and Constant Current Operation Digital Display for Voltage and Current Adjustable Current Limiter Excellent Line and Load Regulation	1-16
8	Trainer kit for 4 bit Counter using Flip Flops: 4 bit ripple counter, Synchronous Counter, IC 7476 based circuit. Input given by switches and output indicated on LED. Facility to select MOD 8 or MOD 16 mode. Built in DC power supply and manual pulser with indicator.	13

8. UNDERPINNING THEORY COMPONENTS

The following topics are to be taught and assessed in order to develop the sample UOs given below for achieving the COs to attain the identified competency. More UOs could be added.

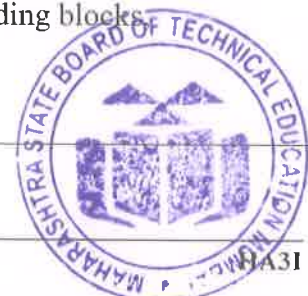
Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
Unit – I Number System and Codes	1a. Convert the given number into the specified number system. 1b. Perform the binary	1.1 Number System: base or radix of number system, binary, octal, decimal and hexadecimal number system. 1.2 Binary Arithmetic: Addition, subtraction



Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
	arithmetic operation on the given binary numbers. 1c. Convert the given coded number into the other specified code. 1d. Add the given two decimal numbers using BCD code.	multiplication, division. 1.3 Subtraction using 1's complement and 2's complement. 1.4 Codes: BCD, Gray Code, Excess-3, and ASCII code. 1.5 BCD Arithmetic: BCD Addition
Unit – II Logic gates and logic families	2a. Develop the basic gates using the given NAND/NOR gate as universal gate. 2b. Simplify the given expression using Boolean laws. 2c. Develop logic circuits using the given Boolean expressions. 2d. Compare the salient characteristics of the given digital logic families.	2.1 Logic gates: Symbol, diode/ transistor switch circuit and logical expression, truth table of basic logic gates (AND, OR, NOT), Universal gates (NAND and NOR) and Special purpose gates (EX-OR, EX-NOR), Tristate logic 2.2 Boolean algebra: Laws of Boolean algebra, Duality Theorem, De-Morgan's theorems 2.3 Logic Families: Characteristics of logic families: Noise margin, Power dissipation, Figure of merit, Fan-in and fan-out, Speed of operation, Comparison of TTL, CMOS, types of TTL NAND gate
Unit– III Combinational Logic Circuits	3a. Develop logic circuits in standard SOP/ POS form for the given logical expression. 3b. Minimize the given logic expression using K-map. 3c. Use IC 7483 to design the given adder/ subtractor. 3d. Draw MUX/DEMUX tree for the given number of input and output lines. 3e. Write the specifications of the component for the given application. 3f. Develop the specified type of code converter.	3.1 Standard Boolean representation: Sum of Product (SOP) and Product of Sum (POS), Min-term and Max-term, conversion between SOP and POS forms, realization using NAND /NOR gates 3.2 K-map reduction technique for the Boolean expression: Minimization of Boolean functions up to 4 variables (SOP and POS form) 3.3 Design of arithmetic circuits and code converter using K-map: Half and full Adder, half and full Subtractor, gray to binary and binary to gray (up to 4 bits) 3.4 Arithmetic circuits: (IC 7483) Adder and Subtractor, BCD adder 3.5 Encoder/Decoder: Basics of encoder, decoder, comparison, (IC 7447) BCD to 7 segment decoder/driver 3.6 Multiplexer and Demultiplexer: working, truth table and applications of Multiplexers and Demultiplexers and MUX tree, IC 74151 as MUX; DEMUX tree, DEMUX as decoder, IC 74155 as DEMUX



Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
		3.7 Buffer: Tristate logic, unidirectional and bidirectional buffer (IC74LS244,74LS245)
Unit– IV Sequential Logic Circuit	<p>4a. Use relevant triggering technique for the given digital circuit.</p> <p>4b. Use the given flip-flop to construct the specific type of counter.</p> <p>4c. Use excitation table of the given flip-flop to design synchronous counter.</p> <p>4d. Design the specified modulo-N counter using IC7490.</p> <p>4e. Construct ring/ twisted ring counter using the given flip-flop.</p>	<p>4.1 Basic memory cell: RS-latch using NAND and NOR</p> <p>4.2 Triggering Methods: Edge trigger and level trigger</p> <p>4.3 SR Flip Flops: SR-flip flop, clocked SR flip flop with preset and clear, drawbacks of SR flip flop</p> <p>4.4 JK Flip Flops: Clocked JK Flip flop with preset and clear, race around condition in JK flip flop, Master slave JK flip flop, D and T type flip flop Excitation table of flip flops, Block schematic and function table of IC-7474, 7475</p> <p>4.5 Shift Register: Logic diagram of 4-bit Shift registers – Serial Input Serial Output, Serial Input Parallel Output, Parallel Input Serial Output, Parallel Input Parallel Output, 4 Bit Universal Shift register</p> <p>4.6 Counters: Asynchronous counter: 4 bit Ripple counter, 4 bit up/down Counter, modulus of counter Synchronous counter: Design of 4 bit synchronous up/down counter Decade counter: Block schematic of IC 7490 Decade counter, IC 7490 as MOD-N Counter, Ring counter, Twisted ring counter</p>
Unit– V Data Converters and PLDs	<p>5a. Calculate the output voltage of the R-2R ladder for the given specified digital input.</p> <p>5b. Calculate the output voltage of the weighted resistor DAC for the given specified digital input.</p> <p>5c. Explain with sketches the working principle of the given type of ADC.</p> <p>5d. Explain with sketches the working principle of the given types of memories.</p> <p>5e. Explain with basic block diagram the working</p>	<p>5.1 Data Converter: DAC: Types, weighted resistor circuit and R-2R ladder circuit, DAC IC 0808 specifications ADC: Block Diagram, types, and working of Dual slope ADC, SAR ADC, ADC IC 0808/0809, specification</p> <p>5.2 Memory: RAM and ROM basic building blocks, read and write operation, types of semiconductor memories</p> <p>5.3 PLD: Basic building blocks and types of PLDs, PLA, PAL, GAL</p> <p>5.4 CPLD: Basic Building blocks functionality.</p>



Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
	principle of the given type of programmable logic device.	

Note: To attain the COs and competency, above listed UOs need to be undertaken to achieve the 'Application Level' and above of Bloom's 'Cognitive Domain Taxonomy'.

9. SUGGESTED SPECIFICATION TABLE FOR QUESTION PAPER DESIGN

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Number System	06	2	2	4	08
II	Logic gates and logic families	10	4	4	4	12
III	Combinational Logic Circuits	16	4	6	8	18
IV	Sequential Logic Circuit	16	4	6	8	18
V	Data Converters and PLDs	16	4	4	6	14
Total		64	18	22	30	70

Legends: R=Remember, U=Understand, A=Apply and above (Bloom's Revised taxonomy)

Note: This specification table provides general guidelines to assist student for their learning and to teachers to teach and assess students with respect to attainment of UOs. The actual distribution of marks at different taxonomy levels (of R, U and A) in the question paper may vary from above table.

10. SUGGESTED STUDENT ACTIVITIES

Other than the classroom and laboratory learning, following are the suggested student-related *co-curricular* activities which can be undertaken to accelerate the attainment of the various outcomes in this course: Students should conduct following activities in group and prepare reports of about 5 pages for each activity, also collect/record physical evidences for their (student's) portfolio which will be useful for their placement interviews:

- Prepare the survey report on the applications of different types of number system and code converters used in the design of digital system.
- Compare technical specifications and applications of various types of memory, PLDs, CPLDs and Prepare report.
- Test digital IC's using various testing equipment like digital IC tester, Digital multi-meter etc.
- Give seminar on any course relevant topic.
- Conduct library / internet survey regarding different data sheet and manuals.
- Prepare power point presentation on digital circuits and their applications.
- Undertake a market survey of different digital IC's required for different applications.
- Search for video / animations / power point presentation on internet for complex topic related to the course and make a presentation.

11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

These are sample strategies, which the teacher can use to accelerate the attainment of the various learning outcomes in this course:

- Massive open online courses (*MOOCs*) may be used to teach various topics/sub-topics.
- 'L' in item No. 4 does not mean only the traditional lecture method but different types of teaching methods and media that are to be employed to develop the outcomes.



- c. About **15-20% of the topics/sub-topics** which is relatively simpler or descriptive in nature is to be given to the students for **self-directed learning** and assess the development of the COs through classroom presentations (see implementation guideline for details).
- d. With respect to item No.10, teachers need to ensure to create opportunities and provisions for **co-curricular activities**.
- e. Guide student(s) in undertaking micro-projects.
- f. PPTs/Animations may be used to explain the construction and working of electronic circuits.
- g. Guide students for using data sheets / manuals.

12. SUGGESTED MICRO-PROJECTS

Only one micro-project is planned to be undertaken by a student that needs to be assigned to him/her in the beginning of the semester. In the first four semesters, the micro-project are group-based. However, in the fifth and sixth semesters, it should be preferably be **individually** undertaken to build up the skill and confidence in every student to become problem solver so that s/he contributes to the projects of the industry. In special situations where groups have to be formed for micro-projects, the number of students in the group should **not exceed three**.

The micro-project could be industry application based, internet-based, workshop-based, laboratory-based or field-based. Each micro-project should encompass two or more COs which are in fact, an integration of PrOs, UOs and ADOs. Each student will have to maintain dated work diary consisting of individual contribution in the project work and give a seminar presentation of it before submission. The total duration of the micro-project should not be less than **16 (sixteen) student engagement hours** during the course. The student ought to submit micro-project by the end of the semester to develop the industry oriented COs. Micro project report may be of four to five pages.

A suggestive list of micro-projects is given here. Similar micro-projects could be added by the concerned faculty:

- a. Build a Digital IC tester circuit.
- b. Build a 4bit parity generator and parity checker circuit.
- c. Build a circuit to implement 4 bit adder.
- d. Build a circuit to test 7 segment display.
- e. Build a circuit to implement debounce switch.
- f. Build a circuit for LED flasher.
- g. Build a circuit for LED BAR display
- h. Design and analyze digital arithmetic circuit

Note: Use general purpose PCB for making micro projects

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication
1	Modern Digital Electronics	Jain, R.P.	McGraw-Hill Publishing, New Delhi, 2009 ISBN: 9780070669116
2	Digital Circuits and Design	Salivahanan S.; Arivazhagan S.	Vikas Publishing House, New Delhi, 2013, ISBN: 9789325960411
3	Digital Electronics	Puri, V.K.	McGraw Hill , New Delhi, 2016 ISBN: 9780074633175
4	Digital Principles	Malvino, A.P.; Leach, D.P.; Saha G.	McGraw Hill Education, New Delhi, 2014, ISBN : 9789339203405

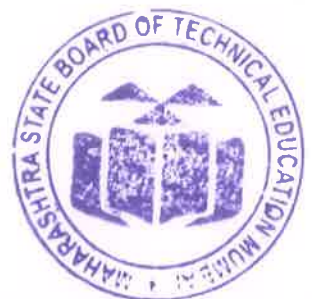


S. No.	Title of Book	Author	Publication
5	Digital Design	Mano, Morris; Ciletti, Michael D.	Pearson Education India, Delhi, 2007, ISBN: 9780131989245
6	Digital Electronics, Principles and Integrated Circuits	Maini, Anil K.	Wiley India, Delhi, 2007, ISBN: 9780470032145
7	Digital Fundamentals	Floyd, Thomas	Pearson Education India, Delhi, 2014, ISBN : 9780132737968

14. SUGGESTED SOFTWARE/LEARNING WEBSITES

- a. www.cse.yorku.ca/~mack/1011/01.NumberSystems.ppt
- b. www.people.sju.edu/~ggrevera/arch/slides/binary-arithmetic.ppt
- c. www.mathsisfun.com/binary-number-system.html
- d. www.codesandtutorials.com/hardware/electronics/digital_codes-types.php
- e. www.ee.surrey.ac.uk/Projects/Labview/gatesfunc/
- f. www.ee.surrey.ac.uk/Projects/Labview/boolalgebra/
- g. www.eng.auburn.edu/~strouce/class/elec2200/elec2200-8.pdf
- h. www.maxwell.ict.griffith.edu.au/yg/teaching/dns/dns_module3_p3.pdf
- i. www.scs.ryerson.ca/~aabhari/cps213Chapter5.ppt
- j. www.eng.wayne.edu/~singhweb/seq1.ppt
- k. www.cs.sjsu.edu/faculty/lee/Ch2Problems2.ppt
- l. www.rogtronics.net/files/datasheets/dac/SedraSmith.pdf
- m. www-old.me.gatech.edu/mechatronics_course/ADC_F04.ppt
- n. www.allaboutcircuits.com/vol_4/chpt_13/3.html
- o. www.youtube.com/watch?v=5Wz5f3n5sjs
- p. www.eee.metu.edu.tr/~cb/e447/Chapter%209%20-%20v2.0.pdf
- q. www2.cs.siu.edu/~hexmoor/classes/CS315-S09/Chapter9-ROM.ppt
- r. www.cms.gcg11.org/attachments/article/95/Memory2.ppt
- s. www.cosc.brocku.ca/Offerings/3P92/seminars/Flash.ppt
- t. www.webopedia.com/TERM/R/RAM.html
- u. www.cs.sjsu.edu/~lee/cs147/Rahman.ppt





Program Name : Diploma in Computer Hardware & Maintenance
Program Code : HA
Semester : Third
Course Title : Computer Hardware Systems
Course Code : 22394

1. RATIONALE

In today's digital world, many activities are completed with the help of various digital devices and equipment. These devices are ultimately connected with the computer system to achieve all required automation. For smooth functioning of such systems, it is required to configure and maintain computer system and its peripherals. Hence different domain skills of computer hardware architecture, configuration, and maintenance play vital role. This course focuses on the skill development towards the configuration, maintenance, and repair of computer system and required cutting edge peripherals, to make system up-and-running smoothly in given scenarios.

2. COMPETENCY

The aim of this course is to help the student to attain the following industry identified competency through various teaching learning process:

- **Maintain computing system**

3. COURSE OUTCOMES (COs)

The theory, practical experiences and relevant soft skills associated with this course are to be taught and implemented, so that the student demonstrates the following industry-oriented COs associated with the above-mentioned competency:

- Troubleshoot motherboard problem.
- Configure storage device for computing system.
- Identify peripheral components of portable devices.
- Troubleshoot given IO device problem.
- Tune performance of given computing system.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme			Credit (L+T+P)	Examination Scheme												
L	T	P		Theory						Practical						
				Paper Hrs.	ESE		PA		Total		ESE		PA		Total	
Max	Min	Max	Min		Max	Min	Max	Min	Max	Min	Max	Min	Max	Min		
3	-	2	5	3	70	28	30*	00	100	40	25@	10	25	10	50	20

()*: Under the theory PA, out of 30 marks 10 marks are for micro-project assessment to facilitate attainment of COs and the remaining 20 marks is the average of 2 test to be taken during the semester for the assessment of the cognitive domain UOs required for the attainment of the COs.

@: Internal Exam

Legends: L-Lecture; T – Tutorial/Teacher Guided Theory Practice; P - Practical; C – Credit, ESE - End Semester Examination; PA - Progressive Assessment.

5. COURSE MAP (with sample COs, PrOs, UOs, ADOs and topics)

This course map illustrates an overview of the flow and linkages of the topics at various levels of outcomes (details in subsequent sections) to be attained by the student by the end of the course, in all domains of learning in terms of the industry/employer identified competency depicted at the center of this map.



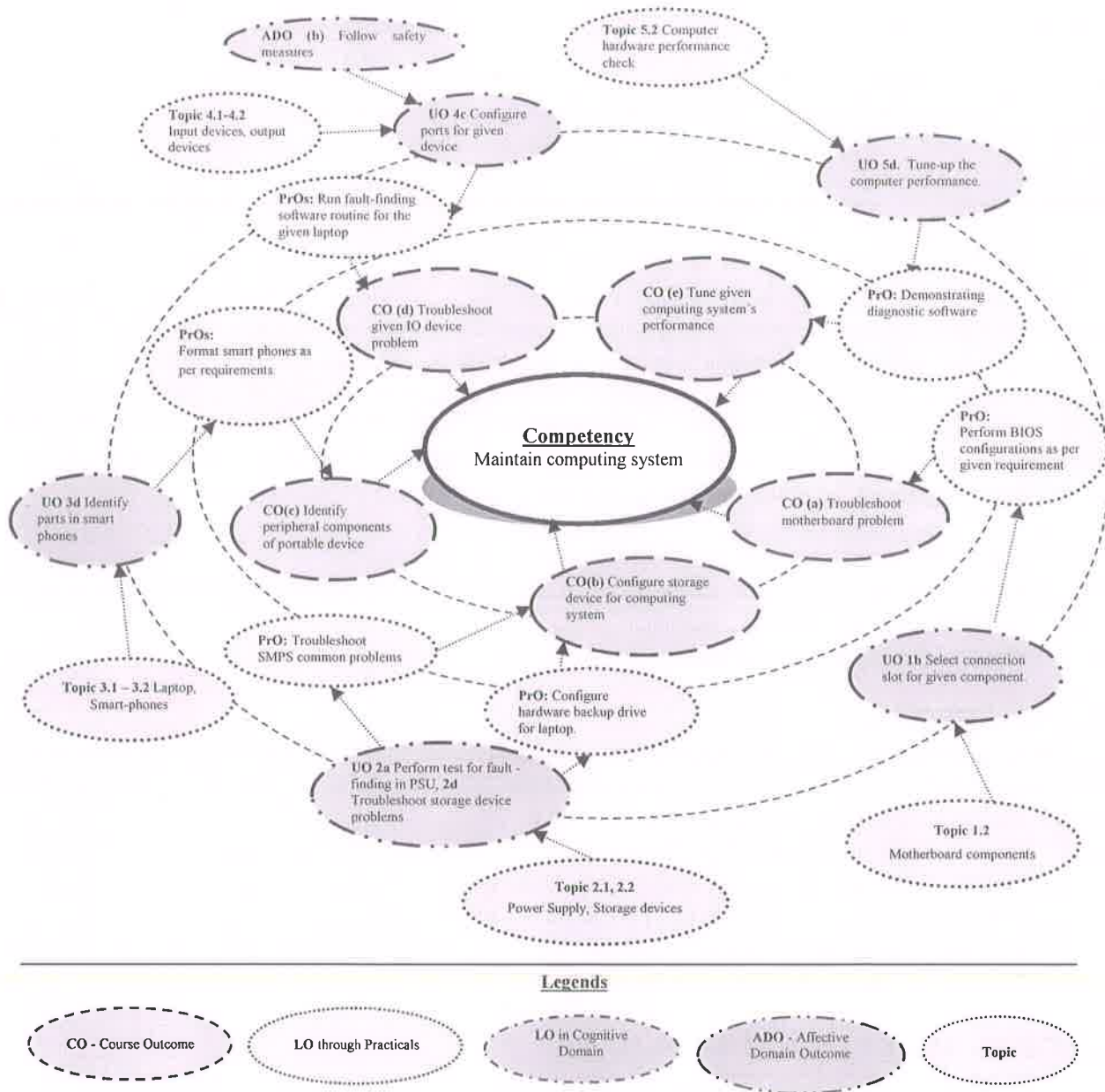
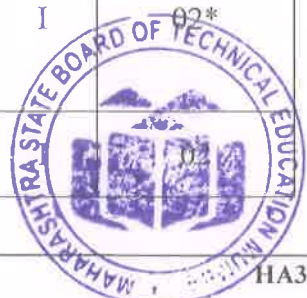


Figure 1: Course Map

6. SUGGESTED PRACTICALS

The practicals in this section are PROs (i.e., sub- components of the COs) to be developed and assessed in the student for attainment of the competency:

Sr No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
1	Locate specified component on motherboard: Processor socket, BIOS, PCI Slots, Memory slots, North Bridge, South Bridge, Power supply plug-in, IDE Connector, Fan and processor heatsink, integrated peripheral connectors and graphics card.	I	02*
2	Select chipsets of different motherboards with different OEM for the given requirements.		



3	Perform BIOS configurations as per given requirement.	I	02
4	Troubleshoot SMPS Common problems: Power doesn't come, PC Power is ON but nothing happens after that (no beep), PC Powers on runs POST but there is no response.	II	02*
5	Configure storage device for laptop.	II	02
6	Configure SSD for dual operating system booting in given computer or laptop.	II	02
7	Configure scanner with tablet for given requirements.	III	02
8	Configure hardware backup drive for laptop.	II	02
9	Troubleshoot memory issues in computer system (Blue screen error, Bad sector problem).	III	02*
10	Troubleshoot boot related issue in desktop computer or laptop.	III	02
11	Identify various hardware components of given smart phone.	III	02
12	Format smart phones to customize functionalities as per requirements.	III	02
13	Test working of in-built sensors (motion sensor, light sensor, proximity sensor, temperature sensor) in smart phones.	IV	02
14	List out specifications of given tablet.	IV	02*
15	Configure given input devices to work with laptop.	IV	02
16	Configure wi-fi printer to tablet/ smart phone.	IV	02
17	Test performance of smart phone using benchmark test application (such as anTuTu, 3D Mark, PCMark).	IV	02*
18	Install audio, graphics, network device drivers in desktop computer.	V	02
19	Run fault-finding software routine for laptop.	V	02
20	Demonstrating Windows Diagnostic Tools: System Restore, Creating Restore point, restore using Restore point.	V	02*
21	Create OS recovery media for laptop.	V	02
Total			42

Note

i. A suggestive list of PrOs is given in the above table. More such PrOs can be added to attain the COs and competency. A judicious mix of minimum 12 or more practicals need to be performed, out of which, the practicals marked as '*' are compulsory, so that the student reaches the 'Precision Level' of Dave's 'Psychomotor Domain Taxonomy' as generally required by the industry.

ii. The 'Process' and 'Product' related skills associated with each PrO is to be assessed according to a suggested sample given below:

S. No.	Performance Indicators	Weightage in %
a.	Identification of Components	20
b.	Correctness of Tools Usage	20
c.	Interpretation of result and conclusion	10
d.	Use of safety measures	20
e.	Answer to sample questions	10
f.	Submission of report in time	10
Total		100



The above PrOs also comprise of the following social skills/attitudes which are Affective Domain Outcomes (ADOs) that are best developed through the laboratory/field-based experiences:

- a. Follow safety practices.
- b. Practice good housekeeping.
- c. Demonstrate working as a leader/a team member.
- d. Maintain tools and equipment.
- e. Follow ethical practices.

The ADOs are not specific to any one PrO, but are embedded in many PrOs. Hence, the acquisition of the ADOs takes place gradually in the student as s/he undertakes a series of practical experiences over a period of time. Moreover, the level of achievement of the ADOs according to Krathwohl's 'Affective Domain Taxonomy' should gradually increase as planned below:

- 'Valuing Level' in 1st year
- 'Organizing Level' in 2nd year
- 'Characterizing Level' in 3rd year.

7. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED

The major equipment with broad specification mentioned here will usher in uniformity in conduct of experiments, as well as aid to procure equipment by authorities concerned.

Sr No.	Equipment Name with Broad Specifications	Pr. Sr. No.
1	PC TRAINER KIT FOR DEMO: Processor Core i3 or latest with mother board with 4 USB,1 serial port, 1 LPT port,2GB RAM DDR III,500 GB SATA Hard disk, 500GB SSD, 18.5" LCD/LED monitor, ATX cabinet with SMPS, DVD writer, Keyboard, USB mouse,1 Gigabit Network card	1,3,4,10
2	Desktop with all necessary components like motherboard, RAM, Graphics card, Sound Card, SSD, HDD, DVD Drive, Network Interface card (Use desktop with chipset from minimum two different chipset manufacturer)	2,3,6,9,18,20
3	Laptop with processor i3 or higher	5,6,8,9,15,19,20,21
4	Tablet with OS Android 10 or higher, processor 1.2GHz or higher	7,14,16
5	Smart Phone with OS Android 10 or higher, processor 1.2Ghz or higher	11,12,13,16,17
6	8 GB Pen Drive/ DVD/SSD/USB hard disk	6, 20, 21
7	Mobile Phone Trainer Kit for identification of different components and section in mobile phone, testing in-built sensors	11,13,17
8	Mobile Handset Tools: - Tools to repair any smart phone includes – soldering iron, soldering station, solder wire, solder paste, liquid flux, paste flux, jumper wire, tweezers, screw driver, multimeter, dc power supply, ESD-safe antistatic wrist strap, mat apron, hand gloves, LCD Tester, Battery Tester, PCB holder, PCB cleaner	11,13,17
9	Laptop repair tools kit: Case opening tools, tweezers, Screw container and organizer, Precision screw driver set, screwdriver magnetizer	6,8,9,10

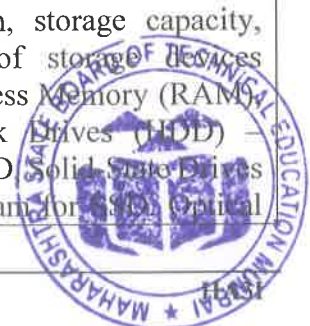


10	Utility software like HDSentinel, CCleaner, Everything KeyFinder, iolo System Mechanic, IObit Advanced SystemCare, Partition Wizard, iMonitor EAM PC Startup Master 3, NET Protector PC Optimizer 2.0 LSoft Active@ ISO Manager	9,10,17,19
11	Wireless Printer with scanner in-built: connectivity standard - Wireless/Wi-Fi/ Bluetooth, Network protocols - 9100 Direct IP, LPR, Embedded Web Server, SNMP, SLP	7,16

8. UNDERPINNING THEORY COMPONENTS

The following topics/subtopics should be taught and assessed in order to develop UOs for achieving the COs to attain the identified competency.

Unit	Major Learning Outcomes (In cognitive domain)	Topics and Sub-topics
Unit – I Computing System Motherboard	1a. Identify components on motherboard 1b. Select connection slot for given component 1c. Explain step by step procedure for troubleshooting laptop motherboard 1d. Describe functional block diagram of smartphone and tablet motherboard	1.1 Motherboard Features: Generic layout of motherboard, Form factor, chipset basics (memory specifications, expansion options, graphics compatibility, I/O specifications, package specifications), chipset INTEL R680E, chipset AMD X570, selection criteria for motherboard 1.2 Motherboard Components: Processors, types, sockets, Expansion slots – PCI, PCI express, Memory slots, Motherboard Firmware – BIOS, UEFI (Unified extensible firmware interface) 1.3 Laptop Motherboard layout: Block diagram, working of functional units 1.4 Smart Phone/ Tablet Motherboard layout: Block diagram, working of functional units
Unit– II Troubleshooting Power supply and Storage devices	2a. Perform test for fault-finding in PSU 2b. Distinguish between power supply adaptors of laptop 2c. Troubleshoot power supply port issues in smart phones 2d. Configure storage device in computer system 2e. Troubleshoot storage device problems	2.1 Power Supply Fundamentals: Functional block diagram of Power Supply Unit, Signal/pin description on functional PSU, Power supply standards, Power wattage, PSU Connectors – P1, P4, Molex, Mini Molex, serial ATX, PCI express 2.2 Power Supply in Desktop Computers: Fault checking in SMPS, Troubleshooting of basic power supply problems 2.3 Power supply in laptops: Power supply adaptors for laptop, testing power port of laptop, diagnosing basic power supply issues in laptop, Configuration of battery settings in laptop, preventive maintenance for laptop battery usage. 2.4 Power supply in smart-phones: Smart phone charger specifications, diagnose basic power supply and power port issues in smart phones. 2.5 Storage devices: Function, storage capacity, portability, and use. Types of storage devices (Primary Storage: Random Access Memory (RAM) Secondary Storage: Hard Disk Drives (HDD) – Functional block diagram of HDD, Solid State Drives (SSD) – Functional block diagram, for optical



Unit	Major Learning Outcomes (In cognitive domain)	Topics and Sub-topics
		storage drives, media Flash memory- Externally attached drives- Installing, Removing, and configuring storage devices, Storage in Systems: Desktop, Laptop, Servers, Smart phone.
<p align="center">Unit- III</p> Peripherals of Laptop, smart-phones/tablets	3a. Identification of laptop components. 3b. Identify ports in the laptop 3c. Perform HDD partitioning 3d. Identify parts in smart phones 3e. Diagnose hardware issues in smart phones	<p>3.1 Laptop: Functional block diagram of laptop with description, Comparison of laptops specifications, Components of laptop: Touchpad, Trackball, Track point, docking station, Upgrade memory, hard disk, replacing battery, configuring wireless internet in a laptop, motherboard, connectors and sockets, Laptop repair: Latest tools and gadgets available, speed-test, troubleshooting motherboard, overheat problem, blue screen problem, other hardware problems and suggested solutions.</p> <p>3.2 Smart-phones and tablets: Block diagram of smart phone, Block diagram of tablet, comparison of smart phone and tablet, Components of smart phone: Ports, Sensors, displays, GSM system, Mobile OS, PCB tracing, cold testing and hot testing, Basic computer operations, mobile processor and related problems, hotspot and Wi-Fi connections, hardware issues and it's solutions - Cracked/ shattered screen, overheating of device, Charging port failure, non-responsive buttons, Smart phone repair: Performance test tools and gadgets for troubleshooting different hardware issues.</p>
<p align="center">Unit-IV</p> Troubleshooting of Input and output devices	4a. Test connection pins of given device 4b. Identify ports for given device 4c. Configure port for given device 4d. Diagnose issues in device connection 4e. Configure device for given environment requirements	<p>4.1 Input Devices: Keyboard: Keyboard Layout, Working Principles of wired Keyboard and wireless keyboard, Keyboard Interfaces,</p> <p>Mouse: Working principles, Types of Mouses (Optical Mouse, wireless mouse), Mouse Interfaces,</p> <p>Scanner: Types of Scanners (Handheld, Flatbed, Sheetfed, Portable Scanners), Interface Cables, Ports and Connectors, Working Principles of each type</p> <p>4.2 Output Devices:</p> <p>Printer: Types of Printers (Inkjet, Laser, Thermal, All-in-One Printers), Interface Cables, Ports and Connectors,</p> <p>Monitor: Types of Monitors (LCD/LED), Working Principles of each type, Menu Configuration, Adjusting Monitor Settings, Monitor Power Supply types.</p> <p>4.3 Troubleshoot IO device: Checking the Error Log Listing All connected devices, Checking the State of a device as available or stopped, Checking the attributes of a device, Changing the attributes of a device, defining a new device</p>
<p align="center">Unit -V</p> Performance	5a. Define performance tuning 5b. Define performance	<p>5.1 Performance tuning: Performance tuning, Performance analysis (with utility software)</p>



Unit	Major Learning Outcomes (In cognitive domain)	Topics and Sub-topics
tuning of Computing System	analysis 5c. Use benchmark test tool for computer 5d. Tune up the computer performance 5e. Use benchmark test utility for smart phone/tablet 5f. Tune up smart phone performance	5.2 Computer hardware performance check: Computer hardware performance analysis, CPU benchmark test using tools (hardinfo/ nbench/ nmon etc.), CPU performance tuning using tune up utility (iolo system mechanic / AVG TuneUp / ccleaner / partition wizard and other similar) 5.3 Smart phone/ tablet benchmark test: Cross-platform benchmark test for smart phones/ tablet, Performance analysis of smartphone/ tablet using utility (anTuTu, 3D Mark, PCMark etc.), Performance tuning of smartphone/ tablet (ccleaner – phone cleaner), Use of APM (Application Performance Management) tool

9. SUGGESTED SPECIFICATION TABLE FOR QUESTION PAPER DESIGN

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R	U	A	Total
			Level	Level	Level	Marks
I	Computing System Motherboard	08	4	4	4	12
II	Troubleshooting Power supply and Storage devices	10	4	4	8	16
III	Peripherals of Laptop, smart-phones/tablets	10	4	6	4	14
IV	Troubleshooting of Input and output devices	10	4	6	4	14
V	Performance tuning of Computing System	10	4	4	6	14
Total		48	20	24	26	70

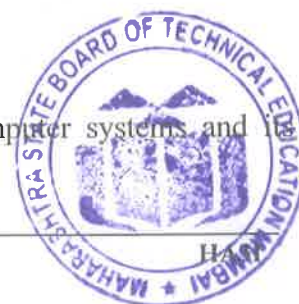
Legends: R=Remember, U=Understand, A=Apply and above (Bloom's Revised taxonomy)

Note: This specification table provides general guidelines to assist student for their learning and to teachers to teach and assess students with respect to attainment of UOs. The actual distribution of marks at different taxonomy levels (of R, U and A) in the question paper may vary from above table.

10. SUGGESTED STUDENT ACTIVITIES

Other than the classroom and laboratory learning, following are the suggested student-related *co-curricular* activities which can be undertaken to accelerate the attainment of the various outcomes in this course: Students should conduct following activities in group and prepare reports of about 5 pages for each activity, also collect/record physical evidences for their (student's) portfolio which will be useful for their placement interviews:

- Select right power supply for given server.
- Conduct a group discussion for IO devices, various peripherals, computer systems, and their relevant use.



- c) Prepare power point presentation or animation regarding the hardware in a computer and the peripherals of Laptop, smart-phones/tablets.
- d) Organize a quiz on computer components. The quiz will require students to label the parts of a computer, and fill in definitions of terms. (Hardware quiz)
- e) Prepare posters to illustrate the use of Storage devices.
- f) Survey of various computer systems like desktop, laptops, servers and peripherals available in the Institute.
- g) Industry visits to understand the industry standard maintenance workflow of computer hardware.
- h) Prepare charts of different Smartphones/Tablets.

11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

These are sample strategies, which the teacher can use to accelerate the attainment of the various outcomes in this course:

- a. Massive open online courses (MOOC's) may be used to teach various topics/sub topics.
- b. 'L' in item No. 4 does not mean only the traditional lecture method, but different types of teaching methods and media that are to be employed to develop the outcomes.
- c. About 15-20% of the topics/sub-topics which is relatively simpler or descriptive in nature is to be given to the students for self-directed learning and assess the development of the COs through classroom presentations (see implementation guideline for details).
- d. With respect to item No.10, teachers need to ensure to create opportunities and provisions for co-curricular activities.
- e. Guide student(s) in undertaking micro-projects.
- f. Demonstrate students thoroughly before they start doing the practice.
- g. Encourage students to refer different websites to have deeper understanding of the subject.
- h. Observe continuously and monitor the performance of students in Lab.
- i. Use different videos, animations to explain various I/O devices.
- j. Power point presentation to explain functioning of various devices and components.

12. SUGGESTED MICRO-PROJECTS

Only one microproject is planned to be undertaken by a group of students (**minimum 3 or maximum 5 Students/Group**) that needs to be assigned to them at the beginning of the semester. The micro-project could be industry application based, internet based, workshop- based, laboratory-based or field based. Each micro-project should encompass two or more COs which are in fact, an integration of PrOs, UOs and ADOs. Each student will have to maintain dated work diary consisting of individual contribution in the project work and give a presentation of it before submission as per course teacher's rubrics. The total duration of the micro-project should not be less than **16 (sixteen) student engagement hours** during the course. The student ought to submit micro-project by the end of the semester to develop the industry-oriented COs. A suggestive list of micro-projects is given here. Similar micro-projects could be added by the concerned faculty:

- a. Identify Motherboard Components and connections. CPU (Processor), RAM (Memory), Hard Drive, Connections, Mechanical vs. Solid State Drives, ROM Drives, Graphic Cards, Sound Cards.
- b. Suggest chipset and assemble motherboard components for requirement such as gaming application.
- c. Format portable drive to make it bootable for given operating system.
- d. Troubleshoot various computer systems like desktop, laptops, servers and peripherals available in the Institute.
- e. Install driver for audio device, Bluetooth, and wi-fi in desktop computer.
- f. Find and locate various Scanner related problems and troubleshoot them.



- g. Assemble and disassembling a laptop.
- h. Upgrade RAM, HDD and other parts.
- i. Test fault finding and troubleshooting techniques for given computer system.
- j. Clone a hard drive from one laptop to another, using cloning tools.




Any other micro-projects suggested by subject faculty on similar line.

13. SUGGESTED LEARNING RESOURCES


Sr No.	Title of Book	Author	Publication
1	PC Hardware: The Complete Reference	Craig Zacker, John Rourke	McGraw Hill Education; 1 st edition - July 2017 ISBN-10: ,9780070436060 :13-ISBN0070436060-978
2	PC Upgrading and Troubleshooting QuickSteps	Kirk Steers	McGraw-Hill Education ISBN-10::13-ISBN ,0072259612 978-0072259612
3	Upgrading and Repairing PCs,	Scott M. Mueller	Que, 22nd Edition, ISBN: 9780134057729
4	CompTIA A+ Certification All-in-One Exam Guide	Mike Meyers	McGraw-Hill, Tenth Edition (Exams 220-1001 and 220-1002), ISBN: 9781260454048
5	Mobile Phones and Tablets Repairs: A Complete Guide for Beginners and Professionals: 1 (Smartphones and Tablets Repairs)	Chukky Oparandu	Mondraim Nig. Ltd – May 2016 ISBN-10 :9789534116, ISBN-13: 9789534111-978

14. SUGGESTED SOFTWARE WEBSITES

Following websites are suggested for different programming language and/or simulation software to enhance psychomotor domain skill. Any other equivalent open-source software can be used if required.

Sr. No.	Keyword	QR Code	Web Links
1	Tune-Up Utilities		https://www.pcmag.com/picks/the-best-tune-up-utilities?test_uuid=06r4MYCu5PZzCkufjQSV3po&test_variant=b
2	Utility Software tools		https://www.techjockey.com/blog/top-10-utility-software-tools
3	Software: Speed up Windows Performance		https://www.guru99.com/windows-repair-pc-optimizer-tools.html

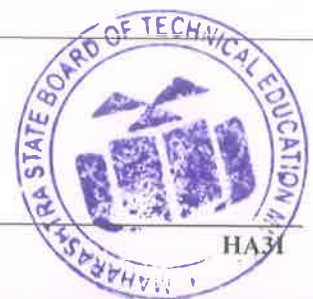








Sr. No.	Keyword	QR Code	Web Links
4	PC diagnostic tools		https://www.techadvisor.com/feature/windows/pc-diagnostic-tools-3693549/

15. SUGGESTED ONLINE TEACHING/ LERANING RESOURCES

Following learning websites are suggested to students to enhance their skill in specific learning domain. It helps student to visualize and demonstrate the concept easily using given online resources.

Sr. No.	Keyword	QR Code	Web Links
1	Fix Hard Drive Errors		https://youtu.be/xDJIKjk6wGM
2	Fix Laptop Display Problem		https://youtu.be/FUWWz0jmo8Y
3	Troubleshoot AC Adapter Issues		https://youtu.be/bh2i94bwezo
4	Speed Up Computer Windows 10		https://youtu.be/T5KLOT6LI5g
5	Open and Fix Tablet		https://youtu.be/HcEacJWZfB4
6	Tablet Screen Glass Repair		https://youtu.be/5xKbq0XAQN8
7	Computer Power		https://youtu.be/eRIRfeYy7tc



Sr. No.	Keyword	QR Code	Web Links
8	All components of PC		https://www.edutechlearners.com/download/File/CHT.pdf
9	Motherboard Components		https://turbofuture.com/computers/the-motherboard-components
10	Motherboard chipset		https://www.lifewire.com/what-is-a-chipset-on-a-motherboard-5185658
11	Mobile phone proximity sensor fixing		https://youtu.be/ZzbznNb-aXM
12	Fixing smart phone sensor issues		https://techwelkin.com/test-sensors-android-phone
13	I/O troubleshooting		https://www.ibm.com/docs/en/aix/7.2?topic=io-troubleshooting-devices

