Maharashtra State Board of Technical Education, Mumbai

Teaching and Examination Scheme for Post S.S.C. Diploma Courses

Program Name : Computer Engineering Groups

Program Code : CO/CM/CW

Duration of Program : 6 Semesters **With Effect From Academic Year: 2017 - 18**

Semester : Third **Duration : 16 Weeks**

S. N.	Course Title	Course Abbreviation	Course Code	Teaching Scheme			Credit (L+T+P)	Examination Scheme												Grand Total
								Theory								Practical						
								Exam Duration in Hrs.	ESE		PA		Total			ESE		PA		Total		
				L	T	P			Max Marks	Min Marks	Max Marks	Min Marks	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 Structure Using 'C'	DSU	22317	3	-	2	5	3	70	28	30*	00	100	40		25#	10	25	10	50	20	150
3	Computer Graphics	CGR	22318	3	-	2	5	3	70	28	30*	00	100	40		25@	10	25	10	50	20	150
4	Database Management System	DMS	22319	4	2	2	8	3	70	28	30*	00	100	40		25#	10	25	10	50	20	150
5	Digital Techniques	DTE	22320	4	-	2	6	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.** Medium of Instruction: **English**

Theory and practical periods of 60 minutes each. Total Marks : **750**

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 course of any semester then the candidate shall be declared as "Detained" for that semester.**

Program Name : **Computer Engineering Program Group**

Program Code : **CO/CM/IF/CW**

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:

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

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme			Credit (L+T+P)	Examination Scheme													
				Theory							Practical						
L	T	P		Paper Hrs.	ESE		PA		Total		ESE		PA		Total		
					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

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course, in all domains of learning in terms of the industry/employer identified competency depicted at the centre of this map.

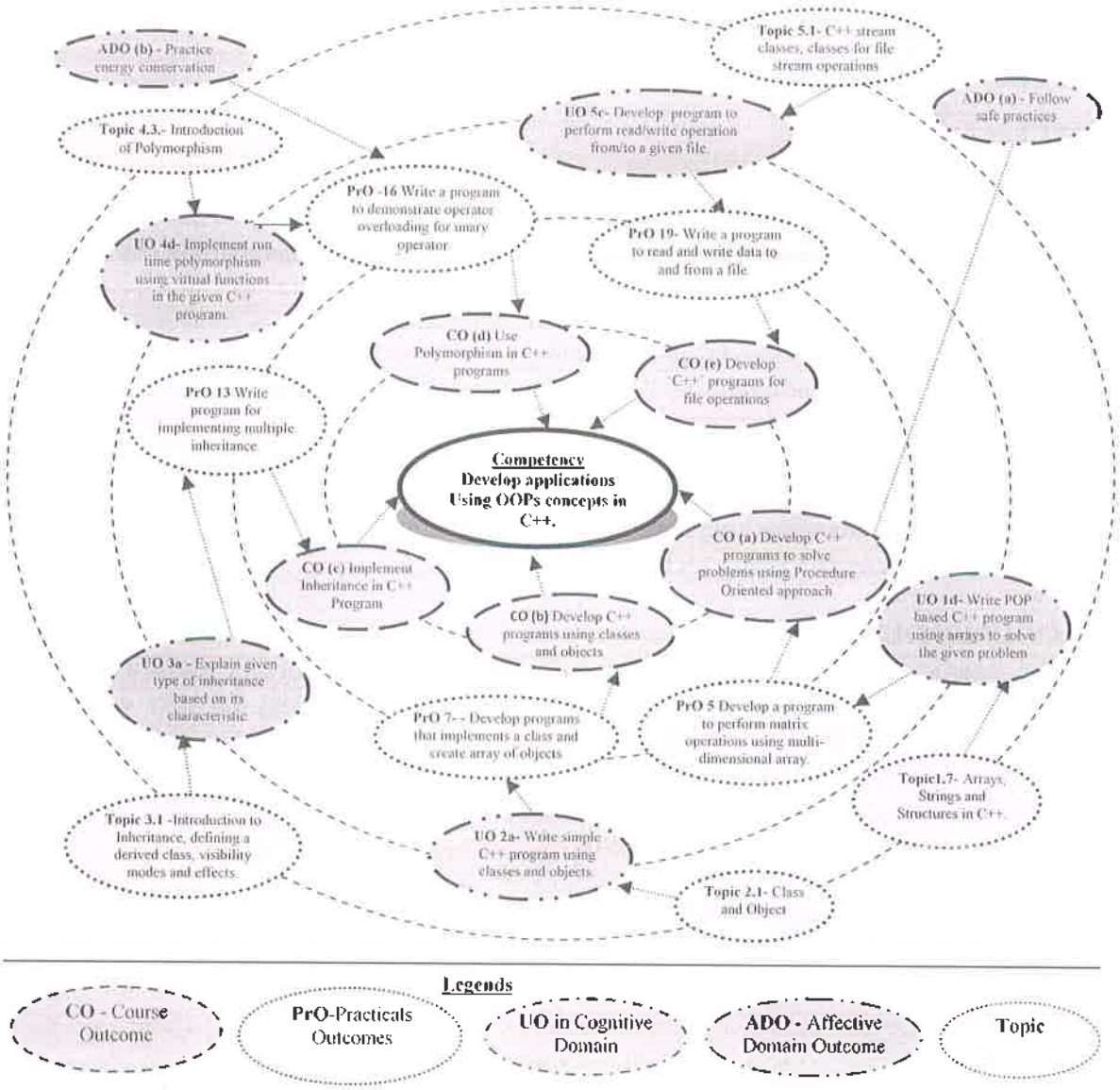

Figure 1 - Course Map

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).	I	02
3	Develop a program to demonstrate control structures (for, while, do-while).	I	02

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Sr. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
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 judicial 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:

a. Follow safety practices.
b. Practice good housekeeping.
c. Demonstrate working as a leader/a team member.
d. 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 Programming	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 specifies, 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 from/to the given file.	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, file modes.

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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
IV	Inheritance: Extending classes	10	2	4	10	16
V	Pointers and Polymorphism in C++	10	-	4	10	14
VI	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:

a. Prepare journal of practicals.
b. 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:

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

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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

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Program Name : **Computer Engineering Program Group**

Program Code : **CO/CM/IF/CW**

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:

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

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme			Credit (L+T+P)	Examination Scheme											
				Theory						Practical					
L	T	P		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;* ***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.

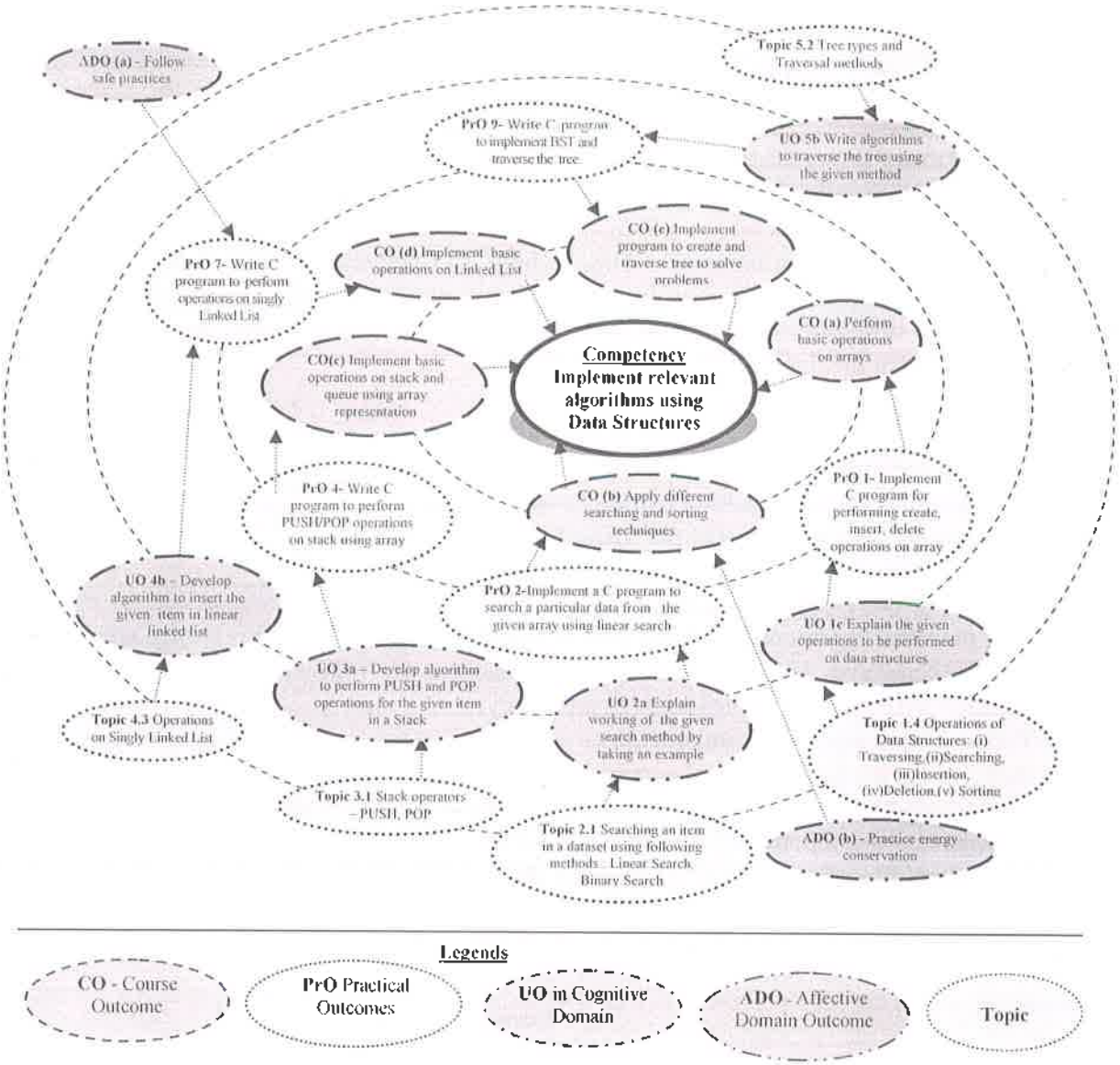

Figure 1 - Course Map

6. SUGGESTED PRACTICALS/ 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 Array using: (i)Linear Search,	II	02*
3	Implement a 'C' program to search a particular data from the given	II	02*

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S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
	Array using Binary Search		
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 judicial 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	35
c.	Debugging ability	10
d.	Quality of input and output displayed	10
e.	Answer to sample questions	15
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:

a. Follow safety practices.
b. Practice good housekeeping.
c. Demonstrate working as a leader/a team member.
d. 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 Introduction 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 Sorting	2a. Explain working of the given search method with an example. 2b. Write an algorithm to search the given key using binary Search method.	2.1 Searching: searching an item in a data set using following methods: (i) Linear Search (ii) Binary Search 2.2 Sorting: sorting of data set in an order using following methods:

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
	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.	(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 • 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 –V Trees and Graphs	5a. Draw Binary Search Tree for the given data set. 5b. Write algorithms to traverse the tree using the	**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,

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Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
	given method. 5c. Construct Expression tree for the given data. 5d. Represent the given Graph using adjacency matrix and adjacency list.	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:

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

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:

a. Develop a program in 'C' to evaluate an arithmetic expression using Stack with linked list representation.
b. 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.
c. 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.
d. 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

S. No.	Title of Book	Author	Publication
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. Iiscs.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**

Program Code : **CO/CM/CW**

Semester : **Third**

Course Title : **Computer Graphics**

Course Code : **22318**

1. RATIONALE

This course provides an introduction to the principles of computer graphics. In particular, the course will consider methods for object design, transformation, scan conversion, visualization and modeling of real world. The emphasis of the course will be placed on understanding how the various elements that underlie computer graphics (algebra, geometry, algorithms) interact in the design of graphics software systems and also enables student to create impressive graphics easily and efficiently.

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 programs using core graphical concepts.**

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:

a. Manipulate visual and geometric information of images.
b. Implement standard algorithms to draw various graphics objects using C program.
c. Develop programs for 2-D and 3-D Transformations.
d. Use projections to visualize objects on view plane.
e. Implement various clipping algorithms.
f. Develop programs to create curves using algorithms.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme			Credit (L+T+P)	Examination Scheme													
				Theory							Practical						
L	T	P		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; **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.

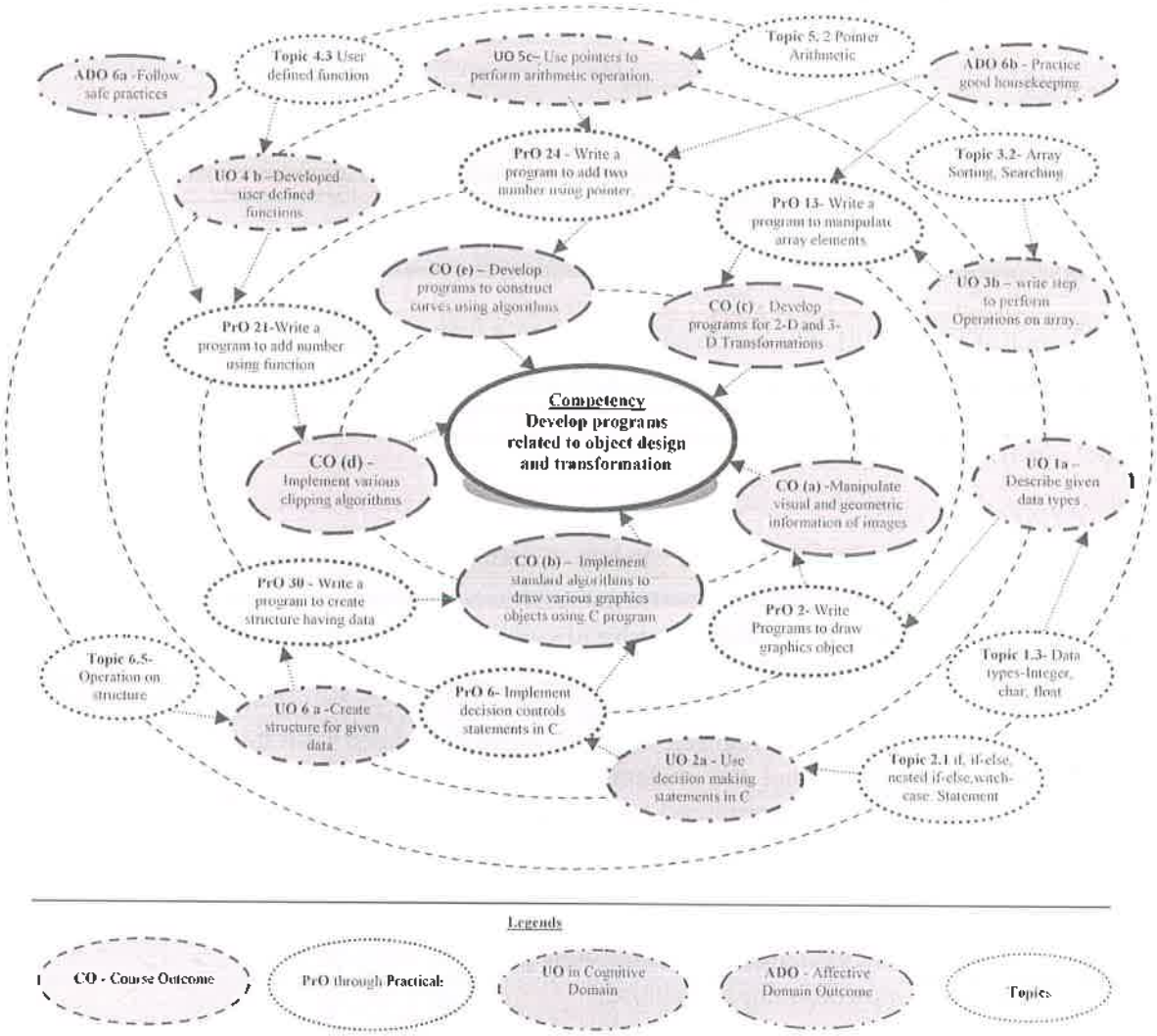

Figure 1 - Course Map

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	Write Programs to draw following graphics object using built-in "C" functions. i) Pixel ii) Lines iii) Circles iv) Rectangle v) Ellipse	I	02*
2	Implement following algorithms to draw line. i) DDA algorithm	II	02*
3	ii) Bresenham's algorithm	II	02

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S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
4	Implement Bresennham's algorithm to draw a circle.	II	02
5	Write a program to fill Polygon using following methods: i) Flood fill	II	02
6	ii) Boundary fill	II	02
7	Write a program for two-dimensional transformation i) Translation ii) Scaling	III	02*
8	iii) Rotation	III	02
9	iv) Reflection v) Shearing	III	02
10	Write a program for three-dimensional transformation i) Translation ii) Scaling	III	02
11	iii) Rotation	III	02
12	Write a program to clip line using following algorithms. Cohen- Sutherland algorithm	IV	02*
13	Write a program to clip line using following algorithms. Cohen Midpoint subdivision algorithm	IV	02
14	Write a program to clip polygon using Sutherland -Hodgeman. Algorithm.	IV	02
15	Write a program to draw (any one) following type of curves. i) Hilbert's Curve	V	02*
16	Write a program to draw (any one) following type of curves. i) Koch curve ii) Bezier curves	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 judicial 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 %
1	Write program to draw graphics objects.	20
2	Use graphics software tool for programming to create, edit, compile the programs/applications	40
3	Debug, test and execute the programs/applications	20
4	Able to answer oral questions.	10
5	Submission of report in time.	10
	Total	**100**

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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. Handle command prompt environment.
b. Experiment with graphics environment.
c. Plan, construct, compile, debug and test programs.
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 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	Hardware: Personal computer, (i3-i5 preferable), RAM minimum 2 GB onwards.	For all Experiments
2	Operating system: Windows XP/Windows 7/LINUX onwards.	
3	Software: turbo C with dosbox or Emulated C.	

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 Basics of Computer Graphics	1a. Differentiate attributes of the given mode. 1b. Compare features of the given Scan Display. 1c. Write a program to draw the given type of primitives using "C". 1d. Describe application of the given display device. 1e. Convert the given 2D co-ordinates to physical device co-ordinates.	1.1 Image and Objects, pixel and resolution, Text mode, Graphics mode, Basic Graphics Pipeline, Bitmap and Vector Based Graphics, Applications of Computer Graphics. 1.2 Display Devices: Raster-Scan Display, Random-Scan Display, Flat Panel Display, LED, LCD display, Plasma, Touch screen. 1.3 Output primitives: line, polygon, marker, text. 1.4 Graphics functions and standards. 1.5 Latest trends in Computer Graphics: Virtual reality, Augmented reality.
Unit– II	2a. Write a program to draw a	2.1 Basic concepts in line drawing: Line

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
Raster Scan Graphics	line using the given algorithm. 2b. Use the given algorithm to rasterize the given line. 2c. Apply the given algorithm to generate the circle. 2d. Draw the Polygon using the given algorithm. 2e. Apply character generation method to display the given character.	drawing algorithms: Digital Differential Analyzer (DDA) algorithm, Bresenham's algorithm. 2.2 Circle generating algorithms: Symmetry of circle, Bresenham's circle drawing algorithm. 2.4 Polygons – Types of polygons, inside –outside test, Polygon Filling : Seed fill algorithms: Flood fill, Boundary fill, scan line algorithms 2.5 Scan conversion, Frame Buffers. 2.6 Character generation methods: stroke, starburst, bitmap.
Unit– III Overview of Transformations	3a. Perform the given operation in 2D transformation. 3b. Perform the given operation in 3D transformation. 3c. Solve the given problem based on Composite Transformations. 3d. Apply the given type of projection on object.	3.1 Two Dimensional Transformations: Translation, Scaling, Rotation, Reflection, Shearing. 3.2 Matrix representations and homogeneous coordinates: Translation Scaling, Rotation, Reflection, Shearing. 3.3 Composite Transformations- rotation about an arbitrary point. 3.4 Three dimensional transformations: Translation, Scaling, Rotation. 3.5 Types of Projections: Perspective and Parallel projection.
Unit-IV Windowing and clipping	4a. Apply Window to-viewport transformation on the given object, 4b. Write a program using the given line clipping algorithms. 4c. Apply the given line clipping algorithms to clip the line. 4d. Apply text clipping on the given text. 4e. Write a program using the given polygon clipping algorithm.	4.1 Windowing and clipping concepts: Window to-viewport transformation. 4.2 Line clipping: Cohen Sutherland clipping algorithm, Cyrusbeck, Liang Barsky, Midpoint subdivision. 4.3 Polygon clipping: Sutherland -Hodgeman. 4.4 Text clipping.
Unit –V Introduction to Curves	5a. Describe the given curve generation methods. 5b. Draw curve using the given curve algorithms. 5c. State properties of the given curve. 5d. Generate arc using the given algorithm.	5.1 Curve generation: Arc generation using DDA algorithm, Interpolation 5.2 Types of curves: Hilbert's Curve, Koch curve, B-Spline, Bezier curves.

***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	Basics of Computer Graphics	06	04	04	-	08
II	Raster Scan Graphics	12	02	06	10	18
III	Overview of Transformations	12	02	06	10	18
IV	Windowing and clipping	10	-	06	08	14
V	Introduction to Curves	08	-	04	08	12
Total		**48**	**8**	**26**	**36**	**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.
This specification table also provides a general guideline for teachers to frame internal end semester practical theory exam paper which students have to undertake.

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 journals based on practical performed in laboratory.
b. Draw perspective and parallel projection for any object on view plane.
c. Give seminar on relevant topic.
d. Prepare power point presentation or animation for showing different types of graphics Applications.
e. Undertake a market survey of different graphics application and compare with the following points.
    i. Available Applications.
    ii. Application Profile.

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 (***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).

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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. No. of practical's selection to be performed should cover all units.

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:

a) Program to Design Flying Balloons - Each group will design balloons using pieslice (), ellipse () functions and apply delay operation of process.h header file.
b) Program to Display a moving car.
c) Develop a miniature tic-tac-toe game.
d) Design an analog clock.
e) Design a rotating fan.

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication
1	Computer Graphics	Donald Hearn , Baker M.Pauline	Pearson Education , New Delhi June 2012, , ISBN:817758765X.
2	Computer Graphics	Maurya Rajesh K.	Wiley-India 2011, Delhi ISBN: 978-81-265-3100-4.
3	Computer Graphics	Dr. Chopra Rajiv	S.Chand 2016, New Delhi. ISBN: 978-93-856-7633-8.
4	Computer Graphics principles and practices	Foley James	Pearson Education. New Delhi 2014, ISBN:978-0-321-39952-6.

14. SOFTWARE/LEARNING WEBSITES

a. https://www.tutorialspoint.com/computer_graphics
b. http://www.dailyfreecode.com/tutorial_simple_cpp-16/computer-graphics-215.aspx
c. http://www.newtechnologysite.com/graphics.html
d. http://www.nptelvideos.in/2012/11/computer-graphics.html
e. https://www.khanacademy.org/

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Program Name : **Computer Engineering Program Group**

Program Code : **CO/CM/CW**

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:

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

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme			Credit (L+T+P)	Examination Scheme												
				Theory							Practical					
L	T	P		Paper Hrs.	ESE		PA		Total		ESE		PA		Total	
					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.

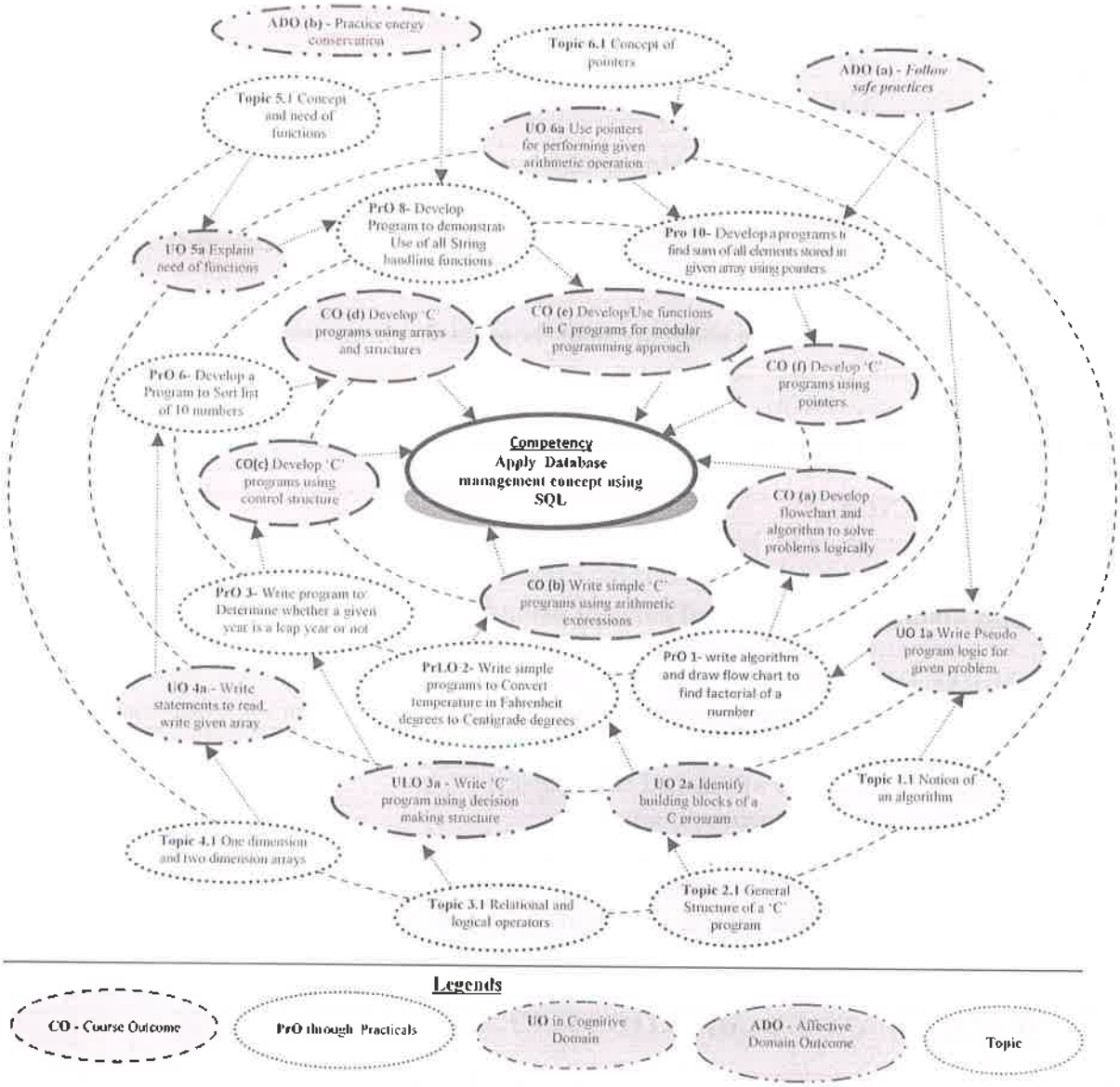

Figure 1 - Course Map

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 . 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.	II	02*
2	Perform following in GUI based database using GUI only	II	02

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
	i) Apply given validation on table and set error messages. ii) Set default value for column. iii) Set and remove database password.		
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 judicial 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 %

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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 Concept	1a State the importance of DBMS over file processing in the given situation. 1b Describe the overall structure of the given	1.1 Concept of Data, database, DBMS, advantages of DBMS over file processing system, Application of database. 1.2 Three level Architecture for Database System. 1.3 Data abstraction: Different levels of Data

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
	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.	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 Performance Tuning	3a. Write the given queries using relevant functions. 3b. Write query to combine the given multiple table using Join. 3c. Design SQL queries to implement VIEWS	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 Command, Updating Views, Views and Joins, Views and Sub queries, Dropping Views. 3.5 Sequences: Creating Sequences, Altering

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Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
	on the given tables. 3d. Apply and drop INDEXES and SYNONYM on the given table.	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

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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:

a. Survey on various database System Software and compare it.
b. Design E-R Diagram for Hospital/college/medical/Jewellery Shop/Library/Blood Bank.
c. Design Normalized Database for Hospital/college/medical/Jewellery Shop / Library / Blood Bank.
d. Apply trigger on given database.
e. Create procedure and function according to given condition.
f. 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

a. www.tutorialpoint.com (Important website)
b. wielyIndia.com or DreamtechPress.com
c. http://phindia.com/gupta/chapter/chapter1.pdf
d. www.williamstannings.com
e. www.nptel.ac.in
f. https://www.khanacademy.org/

Program Name : **Computer and Electronics Engineering Program Group**

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

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:

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

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme			Credit (L+T+P)	Examination Scheme											
				Theory							Practical				
L	T	P		Paper Hrs.	ESE		PA		Total		ESE		PA		Total	
					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.

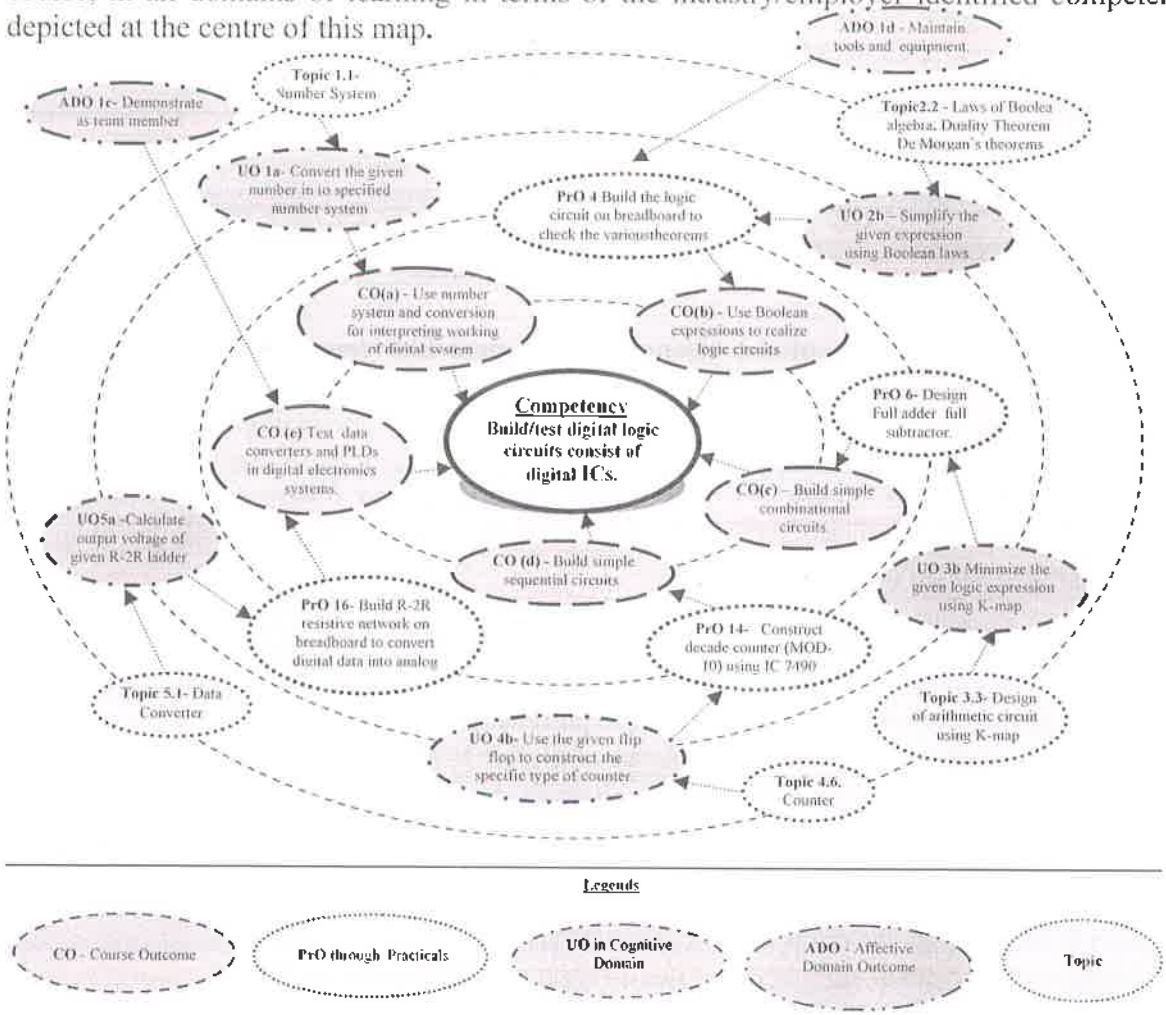

Figure 1 - Course Map

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 theorems.	II	02
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 equivalant.	III	02

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. required
9	Build / test function of DEMUX 74155/74154/any other equivalant.	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 judicial 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 arithmetic operation on the given binary numbers. 1c. Convert the given coded number into the other specified code.	1.1 Number System: base or radix of number system, binary, octal, decimal and hexadecimal number system. 1.2 Binary Arithmetic: Addition, subtraction, multiplication, division. 1.3 Subtraction using 1's complement and 2's complement. 1.4 Codes: BCD, Gray Code, Excess-3, and ASCII code.

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
	1d. Add the given two decimal numbers using BCD 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 Demultiplexures, MUX tree, IC 74151as MUX; DEMUX tree, DEMUX as decoder, IC 74155 as DEMUX 3.7 **Buffer:** Tristate logic, unidirectional and bidirectional buffer (IC74LS244,74LS245)

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
Unit– IV Sequential Logic Circuit	4a. Use relevant triggering technique for the given digital circuit. 4b. Use the given flip-flop to construct the specific type of counter. 4c. Use excitation table of the given flip-flop to design synchronous counter. 4d. Design the specified modulo-N counter using IC7490. 4e. Construct ring/ twisted ring counter using the given flip-flop.	4.1 **Basic memory cell**: RS-latch using NAND and NOR 4.2 **Triggering Methods:** Edge trigger and level trigger 4.3 **SR Flip Flops**: SR-flip flop, clocked SR flip flop with preset and clear, drawbacks of SR flip flop 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 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 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
Unit– V Data Converters and PLDs	5a. Calculate the output voltage of the R-2R ladder for the given specified digital input. 5b. Calculate the output voltage of the weighted resistor DAC for the given specified digital input. 5c. Explain with sketches the working principle of the given type of ADC. 5d. Explain with sketches the working principle of the given types of memories. 5e. Explain with basic block diagram the working principle of the given type of programmable logic device.	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 5.2 **Memory**: RAM and ROM basic building blocks, read and write operation ,types of semiconductor memories 5.3 **PLD:** Basic building blocks and types of PLDs, PLA, PAL, GAL 5.4 CPLD: Basic Building blocks, functionality.

***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:

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

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***.

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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: 97800746331751
4	Digital Principles	Malvino, A.P.; Leach, D.P.; Saha G.	McGraw Hill Education, New Delhi, 2014, ISBN : 9789339203405
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

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S. No.	Title of Book	Author	Publication
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/seql.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

MAHARASHTRA STATE BOARD OF TECHNICAL EDUCATION MUMBAI

Maharashtra State Board of Technical Education, Mumbai

Teaching and Examination Scheme for Post S.S.C. Diploma Courses

Program Name : Diploma in Information Technology

Program Code : IF

Duration of Program : 6 Semesters **With Effect From Academic Year: 2017 - 18**

Semester : Third **Duration : 16 Weeks**

S. N.	Course Title	Course Abbreviation	Course Code	Teaching Scheme			Credit (L+T+P)	Examination Scheme												Grand Total
								Theory						Practical						
								Exam Duration in Hrs.	ESE		PA		Total		ESE		PA		Total	
				L	T	P			Max Marks	Min Marks	Max Marks	Min Marks	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 Structure Using 'C'	DSU	22317	3	-	2	5	3	70	28	30*	00	100	40	25#	10	25	10	50	20	150
3	Principles of Database	POD	22321	3	-	2	5	3	70	28	30*	00	100	40	25@	10	25	10	50	20	150
4	Data Communication	DCO	22322	3	-	-	3	3	70	28	30*	00	100	40	--	--	--	--	--	--	100
5	Digital Techniques and Microprocessor	DTM	22323	4	-	2	6	3	70	28	30*	00	100	40	25@	10	25	10	50	20	150
6	Applied Multimedia Techniques	AMT	22024	2	-	4	6	--	--	--	--	--	--	--	50#	20	50~	20	100	40	100
			Total	**18**	**2**	**12**	**32**	--	**350**	--	**150**	--	**500**	--	**150**	--	**150**	--	**300**	--	**800**

Student Contact Hours Per Week: **32 Hrs.** Medium of Instruction: **English**

Theory and practical periods of 60 minutes each. Total Marks : **800**

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 (5 marks each for Physics and Chemistry) 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 course of any semester then the candidate shall be declared as "Detained" for that semester.**

MAHARASHTRA STATE BOARD OF TECHNICAL EDUCATION MUMBAI

Program Name : **Computer Engineering Program Group**

Program Code : **CO/CM/IF/CW**

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:

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

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme			Credit (L+T+P)	Examination Scheme											
				Theory							Practical				
				Paper	ESE		PA		Total		ESE		PA		Total	
L	T	P		Hrs.	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.

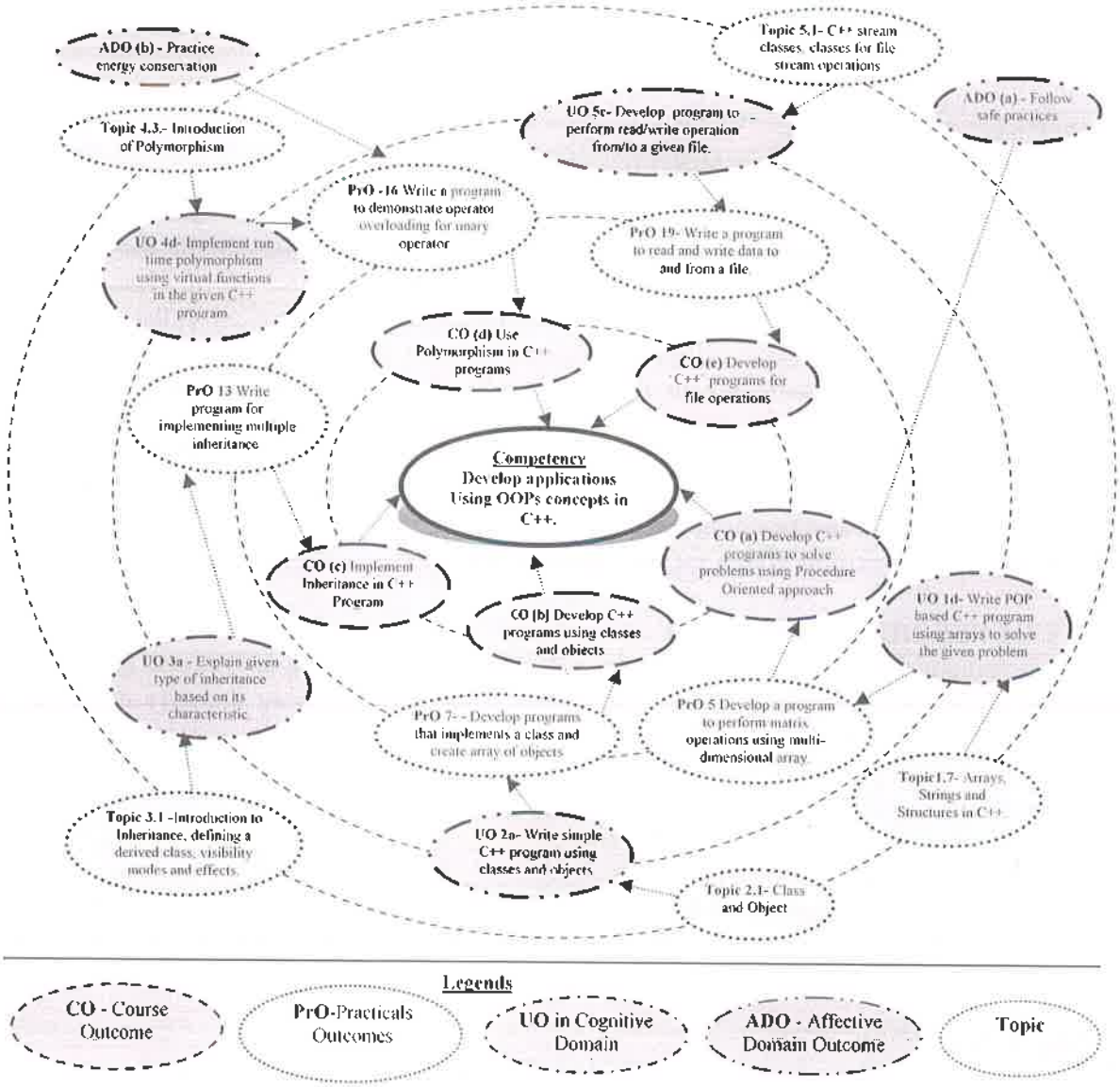

Figure 1 - Course Map

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).	I	02
3	Develop a program to demonstrate control structures (for, while, do-while).	I	02

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Sr. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
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 judicial 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:

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a. Follow safety practices.
b. Practice good housekeeping.
c. Demonstrate working as a leader/a team member.
d. 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 Programming	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 specifies, 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 from/to the given file.	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, file modes.

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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
IV	Inheritance: Extending classes	10	2	4	10	16
V	Pointers and Polymorphism in C++	10	-	4	10	14
VI	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:

a. Prepare journal of practicals.
b. 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:

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 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

MAHARASHTRA STATE BOARD OF TECHNICAL EDUCATION MUMBAI

Program Name : **Computer Engineering Program Group**

Program Code : **CO/CM/IF/CW**

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:

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

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme			Credit (L+T+P)	Examination Scheme											
				Theory						Practical					
L	T	P		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;* ***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.

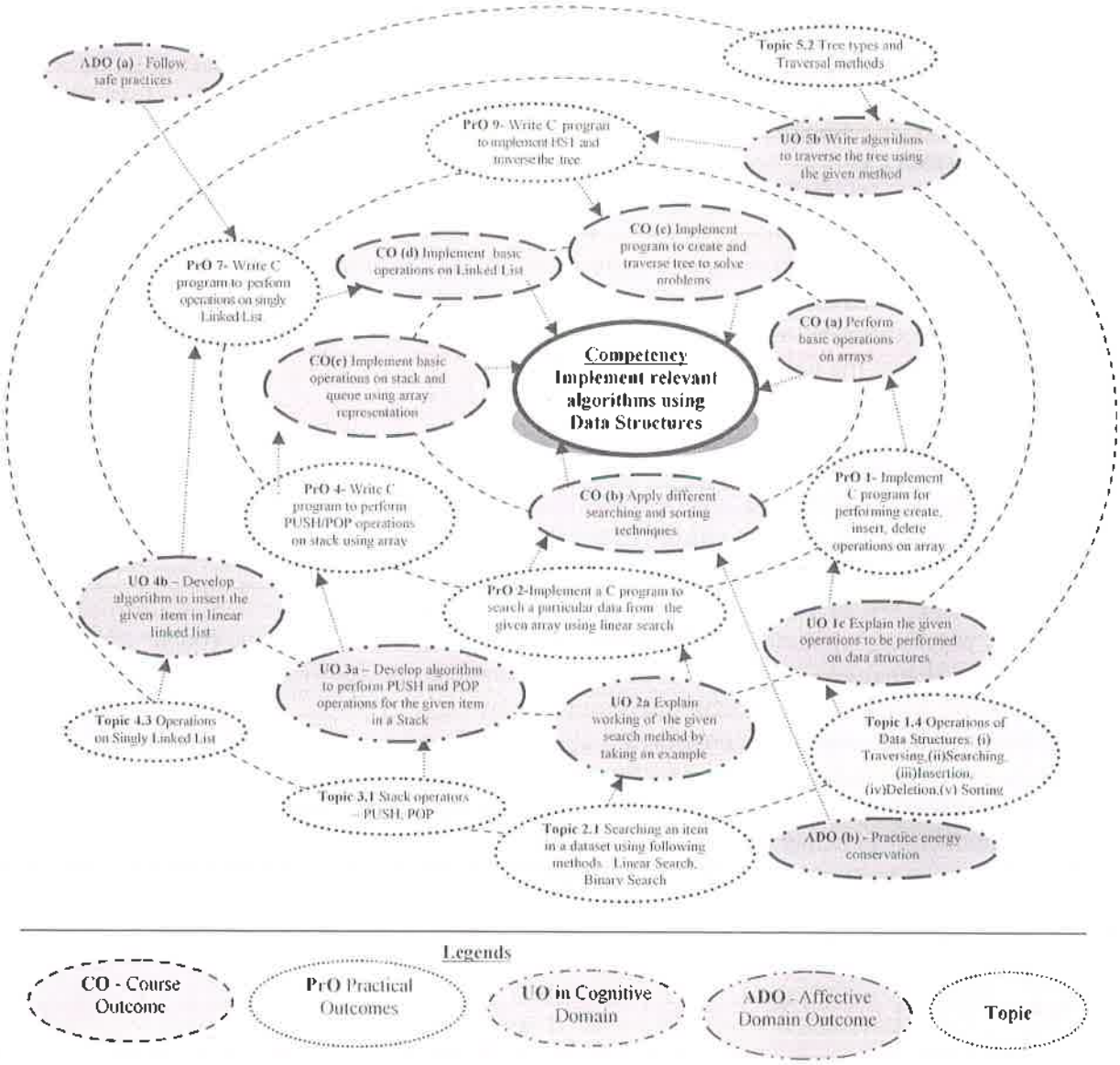

Figure 1 - Course Map

6. SUGGESTED PRACTICALS/ 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 Array using: (i)Linear Search,	II	02*
3	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 Binary Search		
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 judicial 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	35
c.	Debugging ability	10
d.	Quality of input and output displayed	10
e.	Answer to sample questions	15
f.	Submit report in time	10
	Total	**100**

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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. 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 Introduction 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 Sorting	2a. Explain working of the given search method with an example. 2b. Write an algorithm to search the given key using binary Search method.	2.1 Searching: searching an item in a data set using following methods: (i) Linear Search (ii) Binary Search 2.2 Sorting: sorting of data set in an order using following methods:

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
	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.	(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 • 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 –V Trees and Graphs	5a. Draw Binary Search Tree for the given data set. 5b. Write algorithms to traverse the tree using the	**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,

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Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
	given method. 5c. Construct Expression tree for the given data. 5d. Represent the given Graph using adjacency matrix and adjacency list.	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:

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

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:

a. Develop a program in 'C' to evaluate an arithmetic expression using Stack with linked list representation.
b. 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.
c. 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.
d. 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

S. No.	Title of Book	Author	Publication
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 : **Diploma in Information Technology**

Program Code : **IF**

Semester : **Third**

Course Title : **Principles of Database**

Course Code : **22321**

1. RATIONALE

Database management system stores, organizes and manages a large amount of data which can be used by different software application. Developing and managing efficient and effective database applications requires understanding the fundamentals of database management systems and techniques for the design of databases by following principles of database design. This course enables students comprehending concept of database, they can design relational database and perform basic operations on stored 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:

- **Develop Relational Database by applying principles of database design.**

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:

a. Use fundamental concepts of database in a Database System.
b. Choose relevant data model to solve a problems.
c. Develop relational databases using Entity Relationship modelling approach.
d. Apply constraints for data integrity in Relational database.
e. Apply data normalization and denormalization techniques on database.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme			Credit (L+T+P)	Examination Scheme													
				Theory							Practical						
L	T	P		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;* ***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.

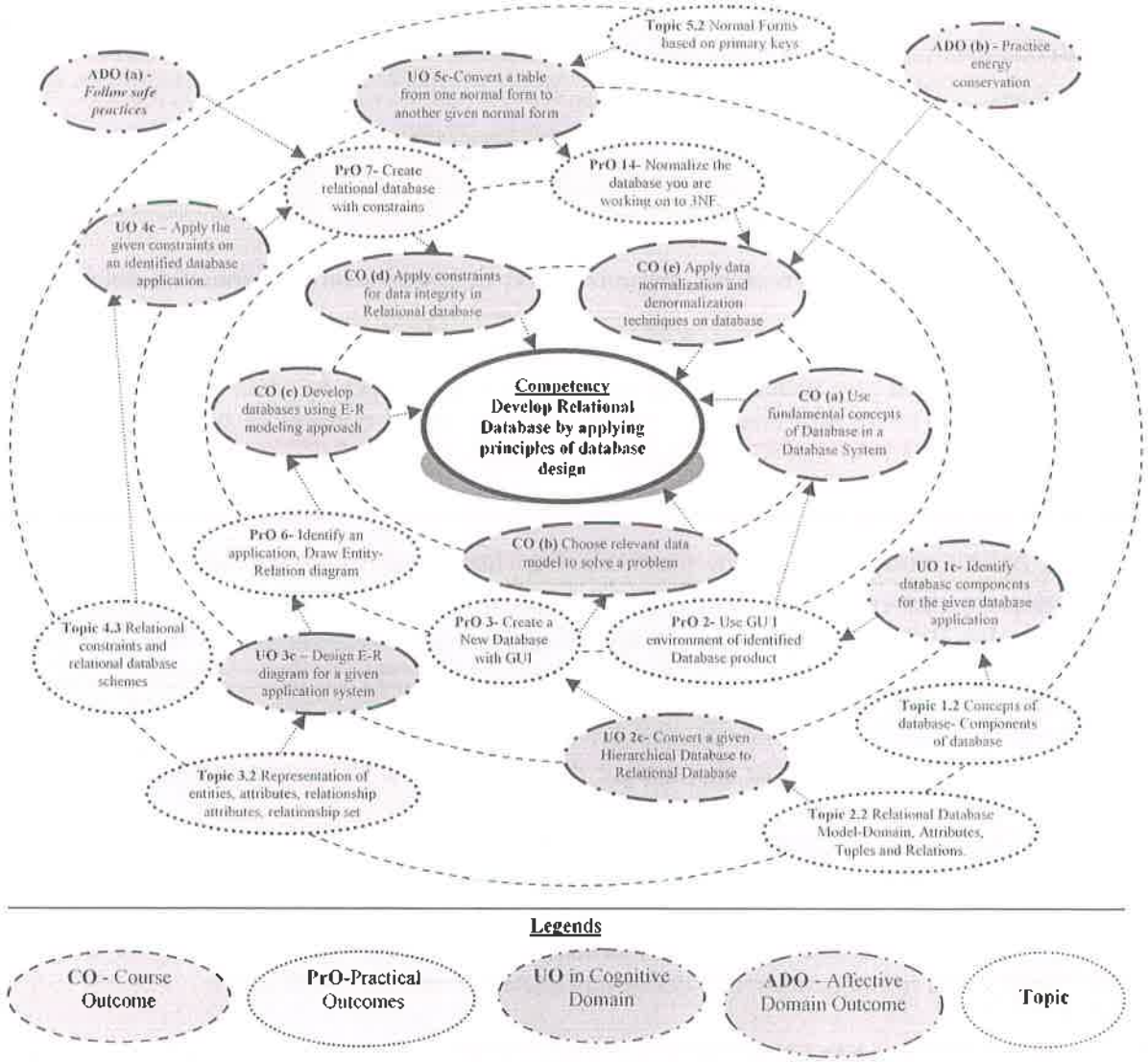

Figure 1 - Course Map

6. SUGGESTED PRACTICALS/ 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	Install database Product.	I	02*
2	Use GUI (Graphical User Interface) environment of identified Database product.	I	02
3	Create a New Database with GUI (Graphical User Interface).	II	02*
4	Create a Table structure with database GUI.	II	02
5	Insert Records in table(s).	II	02
6	Identify an application, Draw Entity-Relation diagram and Design database. Create table(s) and insert some records in it. Part I	III	02*

Sr. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
7	Identify an application, Draw Entity-Relation diagram and Design database. Create table(s) and insert some records in it. Part II	III	02
8	Create a relational database with constraints: Domain constraints, Key constraints, Not Null.	IV	02*
9	Create relations between the tables in database.	IV	02
10	Create Queries to perform different operations using GUI. Part I	IV	02
11	Create Queries to perform different operations using GUI. Part II	IV	02
12	Update and Replace Data in Database.	IV	02
13	Sort Records in the table Using given criteria.	IV	02
14	Filter the Data in the table based on criteria.	IV	02
15	Import and Export database to desired format.	IV	02
16	Normalize the database you are working on to 3NF.	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 judicial 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 database design	40
b.	Accuracy of Operations using GUI	30
c.	Answer to sample questions	15
d.	Submit report in time	15
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. 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.

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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- • **Operating System:** Windows 7 or higher • **Memory:** 2 GB RAM or higher • **Processor Speed:** Intel Core i3 or higher • **Hard Drive:** 500 GB or larger • **DVD Drive:** DVD +/- RW	All
2	Database Management System product with Graphical User Interface such as MS-ACCESS, MySQL, MariaDB	

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 Basics of Database and Architecture	1a. Distinguish the data and information based on their characteristics in the given context. 1b. Identify database components for the given database application. 1c. Differentiate the features of the given databases with examples. 1d. Explain the three level of architecture of database for the given application system.	1.1 Introduction: Data, Database and its purpose, Characteristics of the database, file system vs. database approach, Different types of Database, Advantages and disadvantages of database systems. 1.2 Concepts of database: Components of database- Hardware, Software, People, Procedure.Database Product, Data abstraction, Database languages –Data Definition Language(DDL), Data Manipulation Language(DML), Data Control Language(DCL).Data independence - Logical and Physical Independence, Data integrity. 1.3 Architecture of data base: Three Level Architecture for a Database System- Database (Data) Tier, Application (Middle) Tier and User (Presentation) Tier.
Unit– II Data Models and database types	2a. Explain the efficiency and storage complexity of the given data models. 2b. Explain the merits and draw backs of the given data model. 2c. Convert a given Hierarchical Database to Relational database. 2d. Represent a dataset in the	2.1 Database Models- Hierarchical Database Model, Network Database Model, Object-Oriented Database Model. 2.2 Relational Database Model- Domain, Attributes, Tuples and Relations. 2.3 Types of Database System-Centralized Database System, Parallel Database System, Client / Server Database System, Distributed Database System

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
	given data model graphically.	
Unit– III Database Design using ER model	3a. Represent identified entities set and their relationship in terms of tables for the given application system. 3b. Use relevant types of Key to establish the given type of relation between tables. 3c. Design E-R diagram for the given application system. 3d. Identify the shortcomings of ER modeling approach for the given system to resolve it through EER approach.	3.1 Entities, Entity set, Relationships 3.2 Representation of entities, attributes, relationship attributes, relationship set 3.3 Generalization, aggregation 3.4 Structure of relational Database and different types of keys. Expressing M: N relation 3.5 Shortcomings of ER Model, Enhanced ER (EER) model; sub class, super class, Specialization and Generalization.
Unit-IV Relational Data Base Model	4a. Apply relevant key in database to comply the given constraints. 4b. Describe with sketches the schema diagram of the given database. 4c. Apply the given constraints on the specified identified database application. 4d. Write procedure to manipulate the given table by adding/ modifying/ deleting records.	4.1 Database schema and subschema 4.2 Relational databases and relational database schemes, Entity integrity, referential integrity and foreign key. 4.3 Relational constraints and relational database schemes-Domain constraints, Key constraints, Not Null. 4.4 Codd's rules of RDBMS. 4.5 Working with RDBMS: Create table, insert values in the table, edit table, delete table using appropriate GUI based database.
Unit –V Normalization	5a. Derive Functional Dependency of the given attribute in a table. 5b. Identify the Normal Form of the given table. 5c. Convert the given table from one normal form to another given normal form. 5d. Denormalize the given database by introducing data redundancy or data grouping.	5.1 Concept of Normalization, Functional Dependency, Closures of a Set of Functional Dependencies. 5.2 Normal Forms based on primary keys (1 NF, 2 NF, 3 NF, BCNF). 5.3 Denormalization: Process, benefits and draw back.

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
1	Basics of Database and Architectu	08	04	04	04	12

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Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
II	Data models and database types	06	02	04	06	12
III	Database Design using ER model	12	02	04	08	14
IV	Relational Database Model	12	02	06	10	18
V	Normalization	10	02	04	08	14
Total		**48**	**12**	**22**	**36**	**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 Practicals.
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:

a. Represent an identified data base in hierarchical model, network model and relational model.
b. Create a Database for Students' formative assessment system, add sample data and perform queries on it using GUI tool.
c. Create database to keep employees' record of an organization. Normalize it up to third normal form.
d. Develop database for employee's payroll system of an organization. Add sample data and perform queries on it using GUI tool.
e. Create database to keep records of product orders, purchase & sales details in Sales Department, add sample data and perform queries on it using GUI tool.
(Use Database concepts and E-R diagram approach to design above listed systems)

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication
1	Database Management Systems	Gupta, G. K.	McGraw Hill Education, New Delhi 2013, ISBN: 978-07-107273-1
2	An Introduction to Database Systems	Date, C. J.	Addison Wesley, New Delhi 2003 ISBN 13: 9780321189561
3	Database System Concepts-6e	Silberschatz Abraham, Korth Henry, Sudarshan S.	McGraw Hill Education, New Delhi 2013, ISBN: 978-93-329-0138-4
4	Database Management System- A practical approach	Chopra, Rajiv	S. Chand and Company, New Delhi 2016, ISBN:978-93-856-7634-5

14. SUGGESTED SOFTWARE/LEARNING WEBSITES

a. www.webopedia.com
b. https://www.tutorialspoint.com/database_tutorials.htm
c. www.studytonight.com/dbms/overview-of-dbms.php
d. www.beginnersbook.com/2015/04/dbms-tutorial/
e. www.w3schools.in/dbms/
f. www.tutorialspoint.com/listtutorials/ms-access/1
g. http://www.quackit.com/microsoft_access/tutorial/
h. https://www.techonthenet.com/access/tutorials/

Program Name : **Diploma in Information Technology**

Program Code : **IF**

Semester : **Third**

Course Title : **Data Communication**

Course Code : **22322**

1. RATIONALE

Data communication, which is the transmission of digital data through a network or to a device external to the sending device, is the basis of computer networks. Most of the instruments used in IT can now be connected with network. The Information technology diploma passouts are required to handle the data commumnication related problems. This course examines the important concepts and techniques related to data communication and enable students to have an insight in to technology involved to make the network communication possible.

2. COMPETENCY

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

- **Manage information flow across different communication networks.**

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:

a. Identify process of data communication.
b. Select relevant types of transmission media depending upon requirements.
c. Identify various Multiplexing and Switching techniques used in digital communication.
d. Identify types of transmission error and error correction techniques.
e. Select components of relevant IEEE standards for wireless communication.

4. TEACHING AND EXAMINATION SCHEME

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

(*): 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, LOs and topics)

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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.

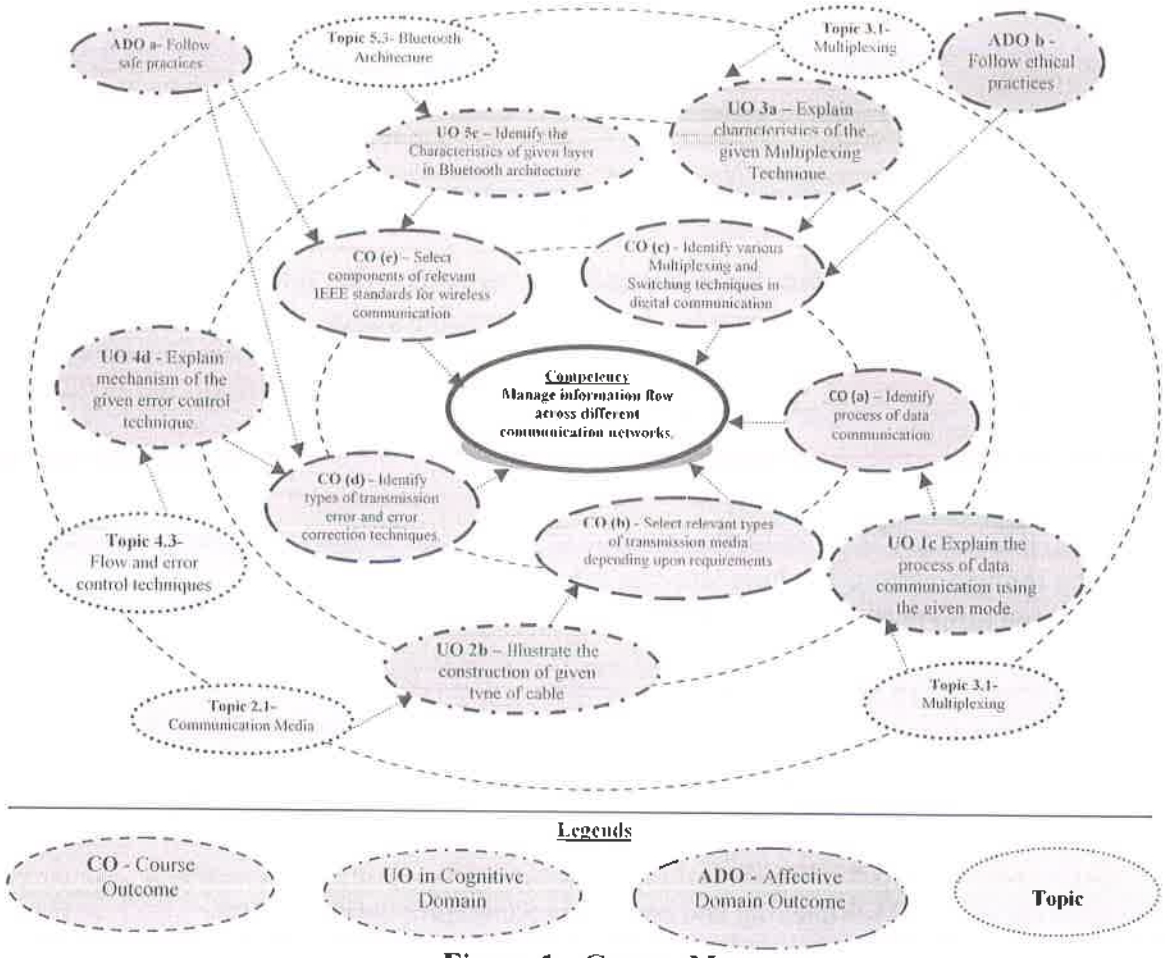

Figure 1 - Course Map

6. SUGGESTED PRACTICALS/ EXERCISES

Note : No practical Content

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.

Note : Not Applicable as there is no practical Content.

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 Communic	1a. Explain the role of the given component with the process of data communication. 1b. Compare analog and digital	1.1 Process of data communication and its components: Transmitter, Receiver, Medium, Message, Protocol.

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
ation	signals on the given parameters. 1c. Explain the process of data. communication using the given mode. 1d. Explain the principle of the given Shift Keying technique. 1e. Describe process of analog to analog conversion using the given modulation technique.	1.2 Protocols, Standards, Standard organizations. 1.3 Bandwidth, Data Transmission Rate, Baud Rate and Bits per second. 1.4 Modes of Communication (Simplex, Half duplex, Full Duplex). 1.5 Analog Signal and Digital Signal, Analog and Digital transmission 1.6 Digital-to-Analog Conversion: Amplitude Shift Keying, Frequency Shift Keying, Phase Shift Keying 1.7 Analog-to-analog conversion: Amplitude Modulation, Frequency Modulation, Phase Modulation.
Unit-II Transmissi on Media	2a. Describe characteristics of the given type of guided transmission media. 2b. Describe with sketches the construction of given type of cable. 2c. Identify strength/ limitations of the given cable type on the given parameters. 2d. Describe characteristics of the given type of transmission media.	2.1 Communication Media: Guided Transmission Media Twisted-Pair Cable, Coaxial Cable Fiber-Optic Cable 2.2 Unguided Transmssion Media Radio Waves, Microwaves, Infrared, Satellite 2.3 Line-of-Sight Transmission Point to Point, Broadcast
Unit– III Multiplexi ng and Switching	3a. Explain characteristics of the given type of multiplexing Technique. 3b. Explain working of the given Multiplexing technique. 3c. Explain with sketches the working of the given spread Spectrum technique. 3d. Describe with sketches the working principle of the given switching technique. 3e. Compare different Switching techniques on the basis of the given parameters.	3.1 Multiplexing: Frequency-Division Multiplexing, Wavelength-Division Multiplexing, Synchronous Time-Division Multiplexing, Statistical Time-Division Multiplexing 3.2 Spread spectrum: Frequency Hopping Spread Spectrum (FHSS), Direct Sequence Spread Spectrum (DSSS) 3.3 Switching: Circuit-switched networks, Datagram networks, Virtual-circuit networks
Unit– IV Error Detection and Correction	4a. Explain major functions of the given layer of OSI Reference Model. 4b. Explain with sketches the working of the given error	4.1 The OSI model Layered Architecture Types of Errors, Forward Error Correction Versus Retransmission Error Detection: Repetition codes, Parity bits, Checksums, CRC

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
	detection and correction method. 4c. Describe the process of the given type of Framing. 4d. Explain the mechanism of the given error control technique.	Error Correction: Automatic repeat request (ARQ), Error-correcting code 4.2 Framing Fixed-Size Framing Variable-Size Framing 4.3 Flow and error control techniques: stop and wait, sliding window, Go-back-n ARQ, Selective Reject ARQ
Unit –V Wireless Communication	5a. Explain features of the given IEEE standard of communication. 5b. Illustrate characteristics of the given layer in IEEE 802.11 architecture. 5c. Explain with sketches the characteristics of the given layer in bluetooth architecture 5d. Compare given generations of mobile telephone system on the given functional/operating parameters. 5e. Explain with sketches the workingof VoLTE	5.1 IEEE wireless Standards:802.11,802.11a, 802.11b, 802.11g, 802.11n, 802.11ac. 5.2 Wireless LANs: 802.11: Architecture MAC Sublayer, Addressing Mechanism 5.3Bluetooth Architecture: Bluetooth Layers, Radio Layer, Baseband Layer The Logical Link Control and Adaptation Layer Protocol (L2CAP),Smart bluettoth,Near field communication(NFC) 5.4 The Mobile Telephone System First-Generation: Analog Voice Second-Generation: Digital Voice Third-Generation: Digital Voice and Data 5.5 4G and VoLTE, Introduction to 4G and VoLTE, Features of 4G and VoLTE. Next generation mobile communication.

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 Communication	10	04	04	06	14
II	Transmission Media	10	02	06	06	14
III	Multiplexing and Switching	10	02	04	10	16
IV	Error Detection and Correction	10	02	04	10	16
V	Wireless Communication	08	02	04	04	10
Total		**48**	**12**	**22**	**36**	**70**

Legends: *R=Remember, U=Understand, A=Apply and above (Bloom's Revised taxonomy)*
Note*: This specification table provides general guidelines to assist students 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 Comparison table of Multiplexing techniques.
b. Prepare charts for Guided and Unguided Transmission media.
c. Draw OSI Reference model on chart.
d. Library / Internet survey on Wired and Wireless devices.

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 (***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. Use animations to explain various theorems in circuit analysis.
f. Guide student(s) in undertaking micro-projects

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:

a. **Survey on Guided Transmission media**: Prepare a report on recent and widely used Guided media in industries depending on Cost, speed, efficiency, reliability.

b. **Survey on Unguided Transmission Media:** Prepare a report on recent and widely used Unguided media in industries depending on Cost, speed, efficiency, reliability.

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication
1	Data communications and networking.	Forouzan Behrouz A.	Tata McGraw Hill, New Delhi, 2006. ISBN : 9780-07-296775-3
2	Computer Networks	Andrew s. Tanenbaum	PHI Learning, New Delhi, 2015 ISBN-13: 978-0-13-212695-3
3	Fundamentals of Buisness Data Communication	FitzGerald Jerry, Dennis Alan	Wiley India Pvt. Ltd. New Delhi, 2011, ISBN : 9788126521500
4	Data and Computer Communications	Stallings William	Pearson Education, I nc.,NJ 07458 ISBN: 0-13-243310-9
5	Data Communication and Networks	Godbole Achyut	McGraw Hill, New Delhi, 2006 ISBN : 0070472971
6	Data Communication and Computer Networks	Gupta Prakash C.	Pearson Education. New Delhi, 2006, ISBN: 81-203-2846-9

14. SUGGESTED SOFTWARE/LEARNING WEBSITES

a. www.nptelvideos.in/2012/11/data-communication.html
b. http://www.myreadingroom.co.in/notes-and-studymaterial/68-dcn/750-analog-to-analog-conversion-techniques.html
c. http://www.tutorial-reports.com/wireless/wlanwifi/wifi_architecture.php
d. http://standards.ieee.org/about/get/802/802.11.html
e. www.tutorialspoint.com/data_communication_computer_network/
f. http://iit.qau.edu.pk/books/Data%20Communications%20and%20Networking%20By%20Behrouz%20A.Forouzan.pdf
g. http://www.studytonight.com/computer-networks/overview-of-computer-networks
h. https://abmpk.files.wordpress.com/2013/04/data-and-computer-comm-8e-william-stallings.pdf
i. https://gradeup.co/flow-and-error-control-techniques-i-28750a29-ba8d-11e5-b537-dcac2f2dd7d1

Program Name : **Diploma in Information Technology**

Program Code : **IF**

Semester : **Third**

Course Title : **Digital Techniques and Microprocessor**

Course Code : **22323**

1. RATIONALE

It is essential to know fundamentals of digital electronics to understand the concept of microprocessor and its application. Microprocessor benefits to meet challenges of growing applications of advanced microprocessor based technologies hence students are expected to be conversant with components of microprocessors and microprocessor based programming. This course is designed to help the students to design logic circuits and to understand the architecture of 8086 microprocessor. The course also enables students to develop assembly language programs using instruction set of 8086 Microprocessor.

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 digital systems including microprocessor based systems.**

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:

a. Test the Digital Systems, Logic Families and logic gates
b. Construct combinational logical circuit
c. Construct sequential logical circuit
d. Use registers and instructions of 8086.
e. Develop assembly language programs using 8086.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme			Credit (L+T+P)	Examination Scheme													
				Theory							Practical						
L	T	P		Paper Hrs.	ESE		PA		Total		ESE		PA		Total		
					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 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.

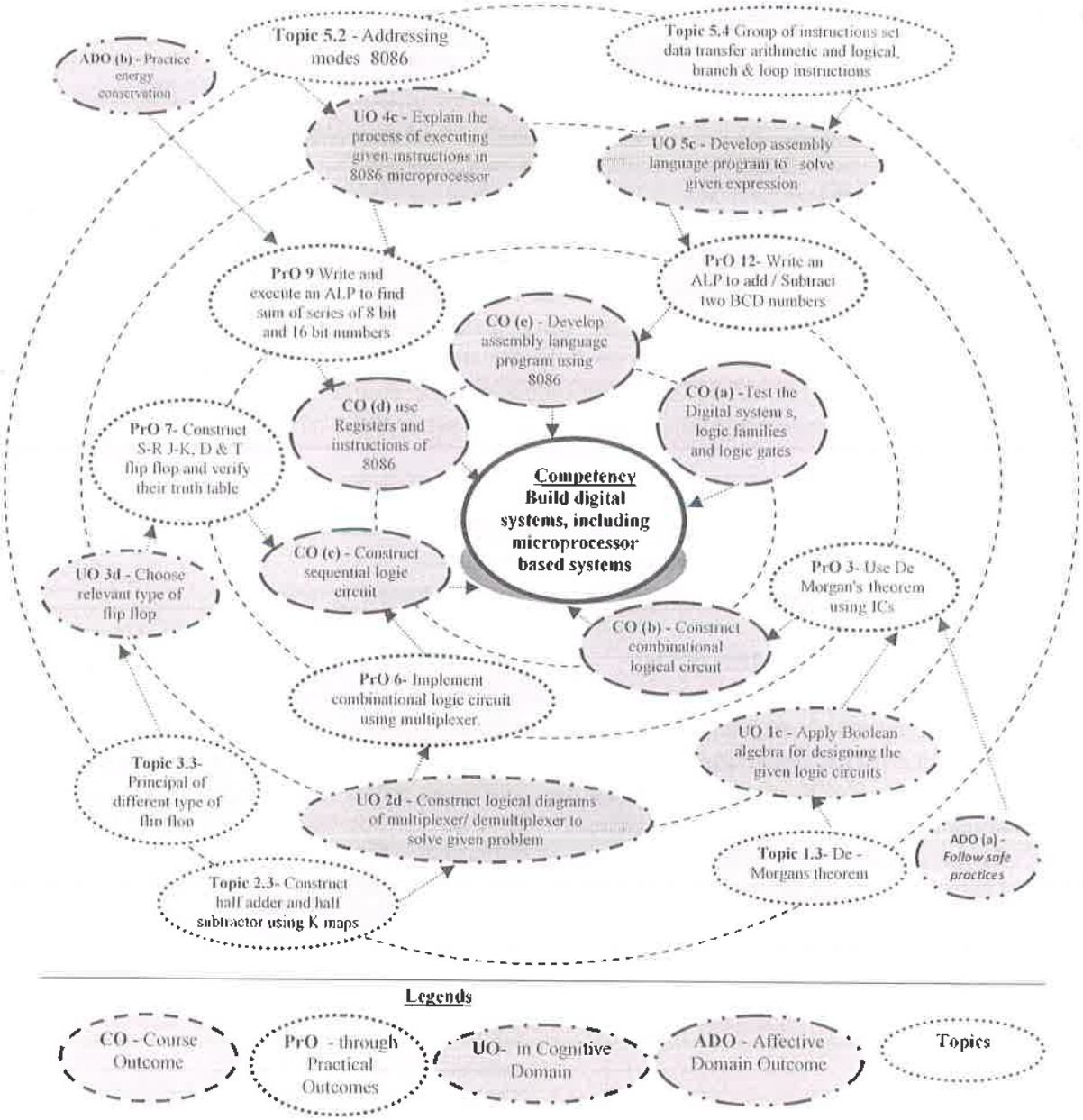

Figure 1 - Course Map

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	Test truth tables of basic logic gates using Transistor-Transistor Logic (TTL) Integrated Circuits (ICs) .	I	02
2	Check truth tables of universal logic gates (NAND and NOR) using Transistor-Transistor Logic (TTL) Integrated Circuits	I	02*

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
	(ICs).		
3	Check De Morgan's theorem using ICs	I	02
4	Convert given expression to Sum of Product (SOP) form using basic logic gates.	II	02*
5	Convert given expression to Product of Sum (POS) form using basic logic gates.	II	02
6	Implement Combinational Circuit using Multiplexer	II	02
7	Construct S-R, J-K, D and T flip-flop and verify their truth tables.	III	02*
8	Write and execute an Assembly Language Program(ALP) to add / subtract two 8 bit and 16 bit numbers with the help of programming tools and any simulator	V	02*
9	Write and execute an ALP to find sum of series of 8 bit and 16 bit numbers.	V	02
10	Develop an ALP to multiply two 8 bit and 16 bit numbers. Unsigned/ signed numbers.	V	02*
11	Develop an ALP to divide two 8 bit and 16 bit numbers. Unsigned/ signed numbers.	V	02
12	Write an ALP to add / Subtract two BCD numbers.	V	02
13	Write an ALP to multiply / Divide two BCD numbers.	V	02
14	Develop an ALP to find smallest and largest number from array of n numbers.	V	02*
15	Develop an ALP to find largest number from array of n numbers.	V	02
16	Write an ALP to perform block transfer from one memory location to another.	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 judicial 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 %
1	Design digital circuit.	20
2	Implement and test digital circuits	30
3	Final design/program output	20
4	Answer to sample questions	20
5	Submission of design in time with accuracy and neatness	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. 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	Digital Multimeter, pulse generator/function generator, DC regulated power supply, Bread boards, connecting wires, Stripper, Soldering Gun , Soldering Metal, Flux, IC Tester, LEDs, Digital ICs, Data sheets of ICs used in Lab.	1 to 8
2	Personal Computer Intel Pentium Onwards Minimum 2GB RAM, 500Gbyte HDD) installed with Windows 7 onwards , Any Editor to write/edit programs ,Turbo/Macro Assembler (TASM/MASM) Turbo Linker (TLINK/LINK, Turbo Debugger(TD/Debug), (DOSBOX utility for higher end operating systems) (Minimum 20 computers for batch of 20 students) with shared printer.	9 to 16
3	8086 freeware/open source based simulator to demonstrate internal functioning of microprocessor (Desirable)	Suggested for 9 to 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 Number systems, Digital Logic families and Logic Gates	1a. Convert the number from the given number system to the specified number system. 1b. Perform the given binary arithmetic operation on the given data. 1c. Describe the characteristics of the given Digital Logic family. 1d. Derive the truth table of the given basic logic gate/ derived logic gate. 1e. Apply Boolean algebra for designing the given logic circuit. 1f. Design the logical circuit for the given application.	1.1 Terms - Bit, Byte, Nibble 1.2 Number systems – Decimal, Binary, Octal and Hexadecimal and their conversions from one number system to another (Integer and fractional). 1.3 Codes – BCD, Gray, ASCII, EBCDIC 1.4 Binary arithmetic – Compliments – 1's and 2's, Addition, subtraction, multiplication and division.(up to 8 bit) 1.1 Applications of digital circuits, Comparison of TTL,CMOS,ECL, Characteristics of digital ICs.(Propagation Delay, Noise Margin, Power dissipation, Fan-in Fan-out. Threshold logic levels). 1.2 Basic gates(AND,OR,NOT), Derived gates (NAND,NOR,EX-OR,EX-NOR),Universal gates 1.3 Basic logic operations using laws of Boolean algebra. DE Morgan's Theorems.
Unit– II Combinational Logic Circuits	2a. Simplify the given logical expression using Sum-of-Product (SOP) and Product-of-Sum (POS) approaches. 2b. Minimize the given logical function using Karnaugh's map (K-MAP). 2c. Explain the approach of designing the given data for half-adder/half-subtractor using K-MAP. 2d. Construct the logical diagrams of multiplexer/demultiplexer to solve the given problem.	2.1 Standard/canonical forms for Boolean functions, Min terms and Max terms. 2.2 Simplification of logical circuit by way of Sum-of-Product (SOP) and Product-of-Sum (POS) approaches. 2.3 Expressions simplification using Boolean algebra techniques (i.e. K-MAP of 2,3,4 variable K-MAPs) 2.4 Construction of Half Adder and Half subtractor using K-MAP. 2.5 Necessity, principle and types of multiplexer and demultiplexer.
Unit– III Sequential Logic Circuits	3a. Differentiate characteristics of the given logic Circuits. 3b. Identify the given situations where edge triggering is preferred over level triggering with justification. 3c. Explain with sketches the working principle of given type	3.1 Combinational and sequential logic Circuits. Block diagram of sequential circuit 3.2 Flip-flops: One-Bit memory Cell symbol applications of flip-flops, Types of triggering flip-flops, Edge triggered and level triggered. 3.3 Principle of working of different

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
	of flip flop. 3d. Choose relevant type of flip-flop (SR/ JK/ D/T) based on given number of inputs and the manner in which they affect the binary state of the flip-flop.	flip-flop types- SR, JK, D and T Flip-flop.
Unit-IV Microprocessor: 8086 and Modern Microprocessors	4a. Explain the process of executing the given instructions in 8086 microprocessor. 4b. Derive physical address to locate the given data from memory Segmentation. 4c. Compare architecture of Microprocessor 8086 with the specified processor on the given parameters. 4d. Select the CISC/RISC architecture based processor for the given situation with justification.	4.1 Evolution of Microprocessor and type. 16-bit Microprocessor-8086. 4.2 Features of 8086, pin diagram and architecture of 8086, Flag register and segment registers of 8086, Minimum mode and maximum mode of operation. Timing diagram. Concept of Memory segmentation and pipelining, physical address generation. 4.3 Overview of Pentium Family and processors. 4.4 Characteristics of RISC processor. 4.5 CISC with RISC in terms of Instruction set, Length, addressing modes.
Unit-V Assembly Language Programming using 8086.	5a. Select relevant addressing mode of 8086 to identify instruction for solving the given problem with justification 5b. Choose relevant instruction to perform the given operation from the instruction set of 8086 with justification. 5c. Develop assembly language program to solve the given expression. 5d. Develop the assembly language program to solve the given problem using decision making and looping structure.	5.1 Programming Model of 8086 assembly language program. 5.2 Addressing Modes of 8086 with examples. 5.3 Group of instruction set-Data transfer, Arithmetic and Logical, Branch and loop, Flag manipulation, shift and rotate and string instructions, (Only format and examples) 5.4 Assembly Language programs for (8-bit and 16 bit) Addition subtraction, Multiplication Division, Decision making and looping.

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 systems, Digital Logic families and Logic Gates	12	2	4	10	16
II	Combinational Logic Circuits	14	2	4	8	14
III	Sequential Logic Circuits	12	2	4	6	12
IV	Microprocessor: 8086 and Modern Microprocessors	12	2	4	6	12
V	Assembly Language Programming using 8086.	14	0	4	12	16
	Total	**64**	**8**	**20**	**42**	**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. Undertake micro-project.
b. Prepare journals based on practical performed in laboratory.
c. Find and Utilize web based / simulator, android applications related to Digital electronics. And microprocessor 8086.
   i. Undertake a market survey of different digital electronics based application and Microprocessors.
   ii. Prepare a block diagram of application (eg. Gesture recognition or motion detection (RASPBERRY PI/ARM PROCESSOR) using RISC architecture and co relate RISC characteristics.

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 (***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. It is recommended to perform digital techniques practical on bread board.
h. Guide and motivate student(s) in performing testing and troubleshooting and implementing programs.

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:

For Digital Techniques: Student shall design, Assemble, Test and troubleshoot following micro projects

a. Burglar alarm
b. Freezer warning buzzer
c. A push-button lock
d. A light-activated burglar alarm
e. A safety thermostat
f. An automatic watering system

For Microprocessor: Students shall simulate program using assembler.

a. Checker's Board using 8X 8 Matrix.
b. Chess Board using 8X 8 Matrix

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication
1	Modern Digital Electronics	Jain R.P.	McGraw Hill Education, New Delhi, 2016 ISBN(13): 978-0-07-066911-6
2	Digital Principles and Applications	Leach Donald P, Malvino Albert Paul, Saha Gautam.	McGraw Hill Education New Delhi, 2016, ISBN: 978-93-392-0341-2
3	Advanced Microprocessor And Peripherals 3/E	Bhurchandi K.M., Roy A.K.	McGraw Hill Education New Delhi, 2016, ISBN: 9781259006135

S. No.	Title of Book	Author	Publication
4	8086 Programming and advance processor architecture	Savaliya M.T.	Wiley India, New Delhi, 2013, ISBN: 978-81-265-3091-5

14. SUGGESTED SOFTWARE/ LEARNING WEBSITES

a. http://www.electrical4u.com/some-common-applications-of-logic-gates/
b. http://www.zeepedia.com/toc.php?digital_logic_design&b=9
c. http://www.cburch.com/logisim
d. http://www.logiccircuit.org/download.html
e. http://www.learnabout-electronics.org/Digital/dig42.php
f. http://www.electrical4u.com/jk-flip-flop/
g. http://ce.kashanu.ac.ir/sabaghian/assembly/8086%20tutorial/8086%20Assembler%20Tutorial%20for%20Beginners%20(Part%201).htm
h. http://www.firmcodes.com/difference-risc-sics-architecture/
i. http://www.arm.com/products/processors/instruction-set-architectures/index.php
j. https://en.wikipedia.org/wiki/ARM_architecture
k. http://www.botskool.com/user-pages/tutorials/electronics/arm-7-tutorial-part-1
l. http://meseec.ce.rit.edu/551-projects/fall2012/1-1.pdf
m. www.intel.com

Program Name : **Diploma in Information Technology**

Program Code : **IF**

Semester : **Third**

Course Title : **Applied Multimedia Techniques**

Course Code : **22024**

1. RATIONALE

Multimedia application is the combined use of text, graphics, animation, audio, and video which can be used for entertainment, Business, and in Education to enhances communication and learning. The multimedia components like video, animation, still images, audio components and text can be developed using various tools. This practical oriented course enables the students to use audio and video files available in different formats and implement their creative imagination to produce graphics and animated multimedia objects that can be used in an application.

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 core Graphical Concepts.**

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:

a. Prepare images using different color models.
b. Edit images using Graphical processing tools.
c. Build website with multimedia contents.
d. Develop 2D animation objects.
e. Develop 3D animation objects.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme			Credit (L+T+P)	Examination Scheme												
				Theory							Practical					
L	T	P		Paper Hrs.	ESE		PA		Total		ESE		PA		Total	
					Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min
2	-	4	6	--	--	--	--	--	--	--	50#	20	50~	20	100	40

'#': No Theory Examination,(~[2]): For the courses having only practical, the PA has two parts (i) Practical part-30 marks (60%) (ii) Micro project part- 20 marks (40%).
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.

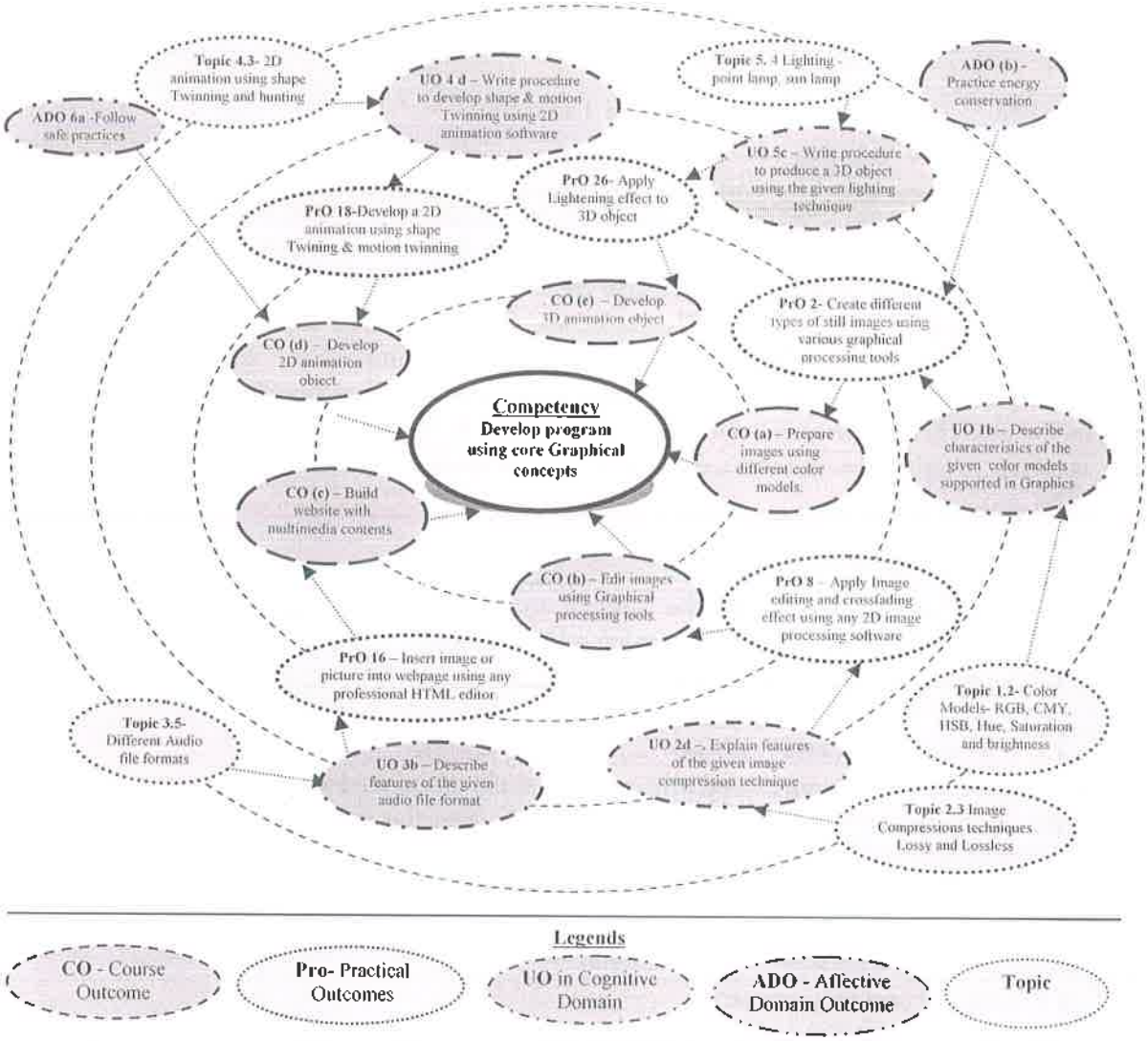

Figure 1 - Course Map

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	(a) Use various graphics processing tools. (b) Convert given image into different image formats and observe the changes in image quality and file size.	I	02*
2	Create different types of still images using various graphical processing tools.	I	02
3	Develop images using RGB/ CMY/ HSB color models.	I	02
4	Develop simple movie clip using movie maker.	I	02
5	Develop GIF image using graphics processing tool.	II	02*
6	Design Banner using graphics processing tool.	II	02

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
7	Apply different word art on text using any 2D image processing software.	II	02
8	Create Wallpaper using various tools of 2D image processing software.	II	02
9	Apply various effects (Drop Shadow, vignette, mirror, reflection) on text using any 2D image processing software.	II	02
10	Apply Image editing and crossfading effect using any 2D image processing software.	II	02
11	Create images based on layers.	II	02
12	Merge multiple photographs using any 2D image processing software.	II	02
13	Apply Rotate and change rotation center operation to an image using any 2D image processing software.	II	02
14	Modify existing image by adding Rainy Season effect using 2D image processing software.	II	02
15	Design a stylish image using 2D image processing software.	II	02
16	Design wallpaper showing water drop effect in image.	II	02
17	Design poster by using different Text effect (Ketchup, rope, Fire, fruit).	II	02
18	Apply special effects like broken mirror effect, Flaming ball effects to an image.	II	02
19	Convert image in different format using relevant software.	II	02
20	Insert image or picture into webpage using any professional HTML editor.	III	02*
21	Develop a webpage which show animation with sound effect using any professional HTML editor.	III	02
22	Develop a webpage by Embedding video.	III	02
23	Develop a 2D animation using Shape Twinning and Motion Twinning.	IV	02*
24	Develop different types of symbols (button symbol, graphic, movie clip symbol and similar types of icons).	IV	02
25	Create 2D Animation using Motion guide layer and Masking.	IV	02
26	Create 2D Animation for Bouncing and Rolling ball down.	IV	02
27	Design simple 3D animation using basic shapes.	V	02*
28	Object creation, types and development methods, sample model development.	V	02
29	Object creation of different types- primitives, compound objects, lofting, lathe, Boolean creation methods.	V	02
30	Design Metallic text in 3D animation tool.	V	02
31	Apply Lighting effect to 3D object.	V	02
32	Render the animation by review key framing, animating props and cameras, render settings to prepare a scene.	V	02
	Total		**64**

Note

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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 judicial mix of minimum 24 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 %
1	Use of relevant graphical tools to create, edit given Multimedia object.	20
2	Aesthetics of developed product.	20
3	Precision of output for given task.	30
4	Able to answer oral questions.	15
5	Submission of report in time.	15
	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. 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.	Hardware: Personal computer Pentium IV, 2 GHz minimum (i3-i5 preferable), RAM minimum 2 GB.	For all Experiments
2.	Graphics and animation development tools preferably Open source based Software: Gif animation tool, Pencil, Synfig Studios, Stykz, Blender, Sci lab or any other Multimedia graphics processing tool.	

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 Introduction to Multimedia	1a. Describe characteristics of the given color model supported in Graphics. 1b. Differentiate Representation of the given media. 1c. Describe the phases of the given Multimedia application development Life cycle with an example 1d. Explain the concept of the given Virtual Reality with example.	1.1. Vector and Raster Graphics in multimedia, Regular text vs. anti-aliased text , Standard selection vs. floating, selection, Tolerance and Opacity 1.2. Color Models – RGB, CMY, HSB, Hue, saturation, and brightness, 1.3. Concepts of Multimedia: Types, Use of Multimedia. 1.4. Basics of Graphics – Basic Shapes: Line, Circle, Rectangle; Hardware Requirements and Software Requirements (Color Model in different Software), Characteristics of Multimedia. 1.5. Analog and Digital Representation of media. 1.6. Creating Multimedia based application, Multimedia Authoring. 1.7. Fundamentals of Virtual Reality, its applications
Unit– II Image Editing and Compression.	2a. Describe use of the given image/graphic manipulation tool. 2b. Identify changes occurred in the given file size, and image quality after format conversion. 2c. Describe the given image editing operation on an image. 2d. Explain features of the given image compression technique. 2e. Write major steps to develop the given GIF image/ banner using Gif animator software.	2.1 Image Types: Raster Format, Bitmap (BMP) Format, Graphics Interchange Format (GIF), Joint Photographic Experts Group (JPEG), Tagged Image File Format (TIFF), Portable Network Graphics (PNG) and their differences. 2.2 Basic operations on image: Crop, Resize, Complement 2.3 Image Compressions techniques Lossy and Lossless. 2.4 Effects and its types: Fonts and its types, Text effect (Ketchup, rope, Fire, fruit), Image Effect broken mirror effect, Flaming ball effects, water drop effect in image.
Unit – III Webpage Development Using Multimedia	3a. Write steps to develop a webpage comprising of graphical media using a HTML composer for the given situation.. 3b. Describe features of the given audio file format. 3c. Differentiate between the two	3.1 Create Simple Two-Column Web Page with Header and Footer. 3.2 Design Home Page. 3.3 Hypertext and Hypermedia. 3.4 Upload or Publish Web Page. 3.5 Different Audio file formats: Uncompressed audio format, Lossless compressed audio format,

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
	types of audio. 3d. Describe features of the given video file format.	Lossy compressed audio format. mp3, wav, mpeg-4, wma, pcm. MIDI Versus Digital Audio. 3.6 Video file Formats: MPEG: MPEG1, MPEG2, MPEG4, AVI
Unit – IV Create 2D animation	4a. Write steps to modify the given type of 2D still elements. 4b. Describe use of the given graphical manipulation tool to create a 2D object. 4c. Write steps to create the given 2D animation effect on a text. 4d. Write procedure to develop the given Shape and Motion Twining using 2D animation software.	4.1 Create and modify 2D elements. 2D versus 3D 4.2 Line tool, Fill/Attributes, Different shapes, text tools and pen tool 4.3 2D animation: Animation basics, Timeline, Frames and Key Frames, Creating a basic text animation, Creating and manipulating animations, Creating a basic frame-by-frame animation, Using Onion Skin to modify an animation, Using shape twining and hinting, Using motion twining with a guide, Mask Animations
Unit– V Create 3D animation	5a. Describe use of the given graphical manipulation tool to create a 3D object. 5b. Write procedure to apply the given modeling operation on a 3D object. 5c. Write procedure to produce the given 3D object using the given lighting technique. 5d. Write procedure to develop the given Shape and Motion Twining using 3D animation software.	5.1 3D Animation: Manipulate Objects in 3D 5.2 Edit mode/Mesh Modeling. 5.3 Object / Edit Mode Modeling: Empty Object, Background Image, Parenting Objects, Joining Objects, Separating Objects. 5.4 Lighting: Point Lamp, Sun Lamp 5.5 Animation in 3D: Basic Key frame Animation, Graph Editor, Cyclic Animation, Path Animation

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

--Not applicable –

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 journals based on practicals performed in laboratory.
b. Give seminar on relevant topic.

c. Library/E-Book survey regarding multimedia techniques used in industries.
d. Prepare web site including different types of multimedia application.

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 (***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 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. Discuss with student(s) thoroughly so as to visualize the required output.
g. Guide students in creating multimedia object(s) and applying it in relevant application.
h. Involve each student to ensure their participation in the entire practical performed.

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:

a. Create collage of main annual events of the institute.
b. Build Interactive animated web page.
c. Design Personnel Portfolio using 2D Animation.
d. Create animation to show action of internal parts inside the hand pump/two stroke engine.
e. Modeling a cartoon character in 3D graphic processing tool.

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

(Use structure and other features of graphics processing tools suggested in Section 7.)

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13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication
1	Principles of Multimedia 2e	Parekh, Ranjan	McGraw Hill Education, New Delhi. 2015, ISBN-13:978-1-25-900650-0
2	Multimedia Systems and Design	Andleigh, Prabhat K.Thakrar , Kiran	PHI Learning, New Delhi 2013 ISBN: 81-203-2177-4
3	Fundamentals of Multimedia	Li , Ze - Nian	PHI Learning, New Delhi 2013 ISBN-13: 978-8120328174
4	Multimedia: Making It Work,9e	Vaughan Tay	McGraw Hill Education, New Delhi. 2015, **ISBN:** 9780071832885

14. SUGGESTED SOFTWARE/LEARNING WEBSITES

a. https://www.youtube.com/watch?v=7FSxJJ5-SZ8
b. https://www.youtube.com/watch?v=faWNkTPKKjg
c. http://gryllus.net/Blender/Lessons/Lesson02.html
d. https://www.thesitewizard.com/gettingstarted/dreamweaver1.shtml
e. https://www.youtube.com/watch?v=OGa61mDT4a4
f. https://www.youtube.com/watch?v=zYA4gYho5vo
g. https://www.youtube.com/watch?v=9KOVgLsvHYM