| Program Name | : Computer Engineering Program Group / Diploma in Electronics and Computer Engineering / Diploma in Computer Hardware & Maintenance / Diploma in Artificial Intelligence and Machine Learning / Diploma in Cloud Computing and Big Data |
|---|---|
| Program Code | : CO/CM/CW/TE/HA/AN/BD |
| Semester | : Third |
| Course Title | : Database Management System |
| Course Code | : 22319 |

## 1. RATIONALE

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

## 2. COMPETENCY

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

- **Apply Database management concept using SQL.**

## 3. COURSE OUTCOMES (COs)

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

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 of 1 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.
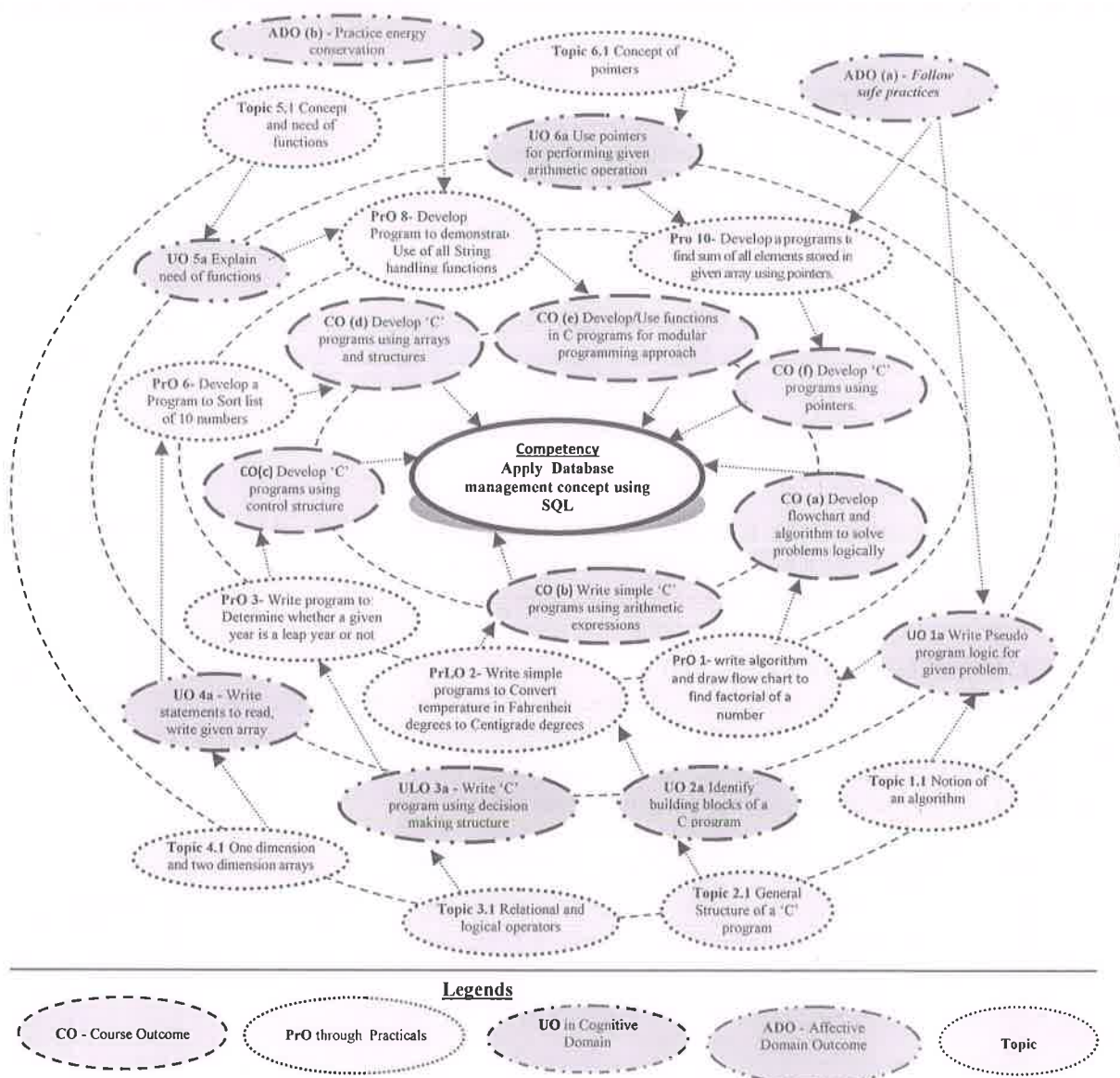


**Figure 1 - Course Map**

## 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 <br> i) Create Database <br> ii) Create tables and assign primary key . | II | 02* |

| S. No. | Practical Outcomes (PrOs) | Unit No. | Approx. Hrs. Required |
|---|---|---|---|
| | iii) Modify the table structure-add column ,change the data type of column, delete the column from table.<br>iv) Insert, update and delete the record from table.<br>v) Retrieve data from the table according to condition given. | | |
| 2 | Perform following in GUI based database using GUI only<br>i) Apply given validation on table and set error messages.<br>ii) Set default value for column.<br>iii) Set and remove database password. | II | 02 |
| 3 | Design E-R diagram and Create Normalized Database on given data. | II | 02 |
| 4 | i) Create and Execute DDL commands using SQL.<br>ii) Apply following Integrity constraints on table:<br>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:<br>Arithmetic Operators, Comparison Operators,Logical Operators, Set Operators, Range Searching operators-Between, Pattern matching operators-Like. | II | 02* |
| 7 | Write Queries using following Functions:<br>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<br>i) Create different views<br>ii) Insert, modify and delete records through views.<br>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<br>i) Create users<br>ii) Grant privileges to users<br>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 % |
|--------|------------------------|----------------|
| a. | SQL queries and PL/SQL programming | 60 |
| b. | Database Integrity | 10 |
| c. | Quality result displayed by SQL queries. | 10 |
| d. | Answer to sample questions | 10 |
| e. | Submit report in time | 10 |
| | **Total** | **100** |

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

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

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

- 'Valuing Level' in 1st year
- 'Organising Level' in 2nd year
- 'Characterising Level' in 3rd year.
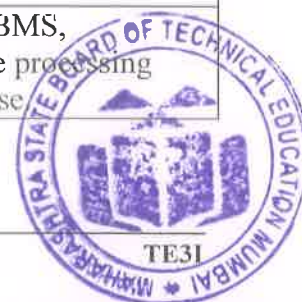
## 7. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED

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

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

## 8. UNDERPINNING THEORY COMPONENTS

The following topics are to be taught and assessed in order to develop the sample UOs given below for achieving the COs to attain the identified competency. More UOs could be added:
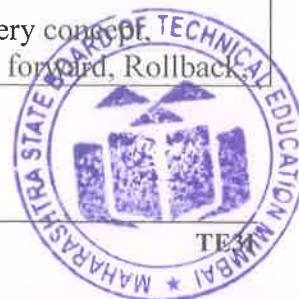
| Unit | Unit Outcomes (UOs) (in cognitive domain) | Topics and Sub-topics |
|------|-------------------------------------------|----------------------|
| Unit – I Database System | 1a State the importance of DBMS over file processing in the | 1.1 Concept of Data, database, DBMS, advantages of DBMS over file processing system, Application of database |

| Unit | Unit Outcomes (UOs) (in cognitive domain) | Topics and Sub-topics |
|------|-------------------------------------------|------------------------|
| Concept | given situation.<br>1b Describe the overall structure of the given DBMS<br>1c Identify the relevant database model in the given situation.<br>1d Draw the E-R diagram of the given database and identify relationship between the entities. | 1.2 Three level Architecture for Database System.<br>1.3 Data abstraction: Different levels of Data abstraction, Instance and schema, Data independence - Logical and Physical Independence.<br>1.4 Overall Structure of DBMS.<br>1.5 Data Modeling: Record based logical model- Relational,  Network, Hierarchical<br>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.<br>2b Design Normalized database structure in the given problem.<br>2c Design SQL queries to create Relational database and apply in the given data constraints.<br>2d Identify the operators for queries implementation of the given problem. | 2.1 Fundamentals of RDBMS – Record, fields, data types, tables and database<br>2.2  Concept of RDBMS, E.F.Codd's Rule for RDBMS, Key concepts- Candidate key, Primary key, Foreign key.<br>2.3 Normalization: Normalization Concepts, Need of Normalization, Types of Normalization- 1NF,2NF,3NF<br>2.4  Introduction to Structured Query Language, Data Types in SQL, components of  SQL-DDL,DML,DCL,DQL<br>2.5 DDL Commands: CREATE, ALTER, DROP, TRUNCATE, DESC, RENAME<br>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.<br>2.7 DML Commands: INSERT, UPDATE, DELETE<br>2.8 DCL Commands: COMMIT, SAVEPOINT, ROLLBACK, GRANT, and REVOKE.<br>2.9 DQL Commands: SELECT.<br>2.10 SQL Operators: Arithmetic Operators, Comparison Operators, Logical Operators, Set Operators, Range Searching operators-Between, Pattern matching operators-Like. |
| Unit III- Interactive SQL and Advance SQL: SQL Performanc | 3a. Write the given queries using relevant functions.<br>3b. Write query to combine the given multiple table using | 3.1 In-built Functions: String, Arithmetic,<br>3.2 Date and time, Aggregate functions.<br>3.3 Queries using Group by, having, and Order by clause, Joins-Inner and Outer Join, Sub queries.<br>3.4 Views: Concept of View, The Create View |

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

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

## 9.    SUGGESTED SPECIFICATION TABLE FOR QUESTION PAPER DESIGN

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

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

## 10.    SUGGESTED STUDENT ACTIVITIES

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

## 11.    SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

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

## 12.    SUGGESTED MICRO-PROJECTS

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

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

A suggestive list of micro-projects is given here. Similar micro-projects could be added by the concerned faculty:
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 / Diploma in Electronics & Computer Engineering / Diploma in Computer Hardware & Maintenance/ Diploma in Artificial Intelligence and Machine Learning |
|---|---|
| Program Code | : CO/CM/CW/DE/EJ/ET/EN/EX/EQ/IE/IS/IC/MU/TE/HA/AN |
| Semester | : Third |
| Course Title | : Digital Techniques |
| Course Code | : 22320 |

## 1.     RATIONALE

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

## 2.     COMPETENCY

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

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

## 3.     COURSE OUTCOMES (COs)

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

- a.     e 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.*

## 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.
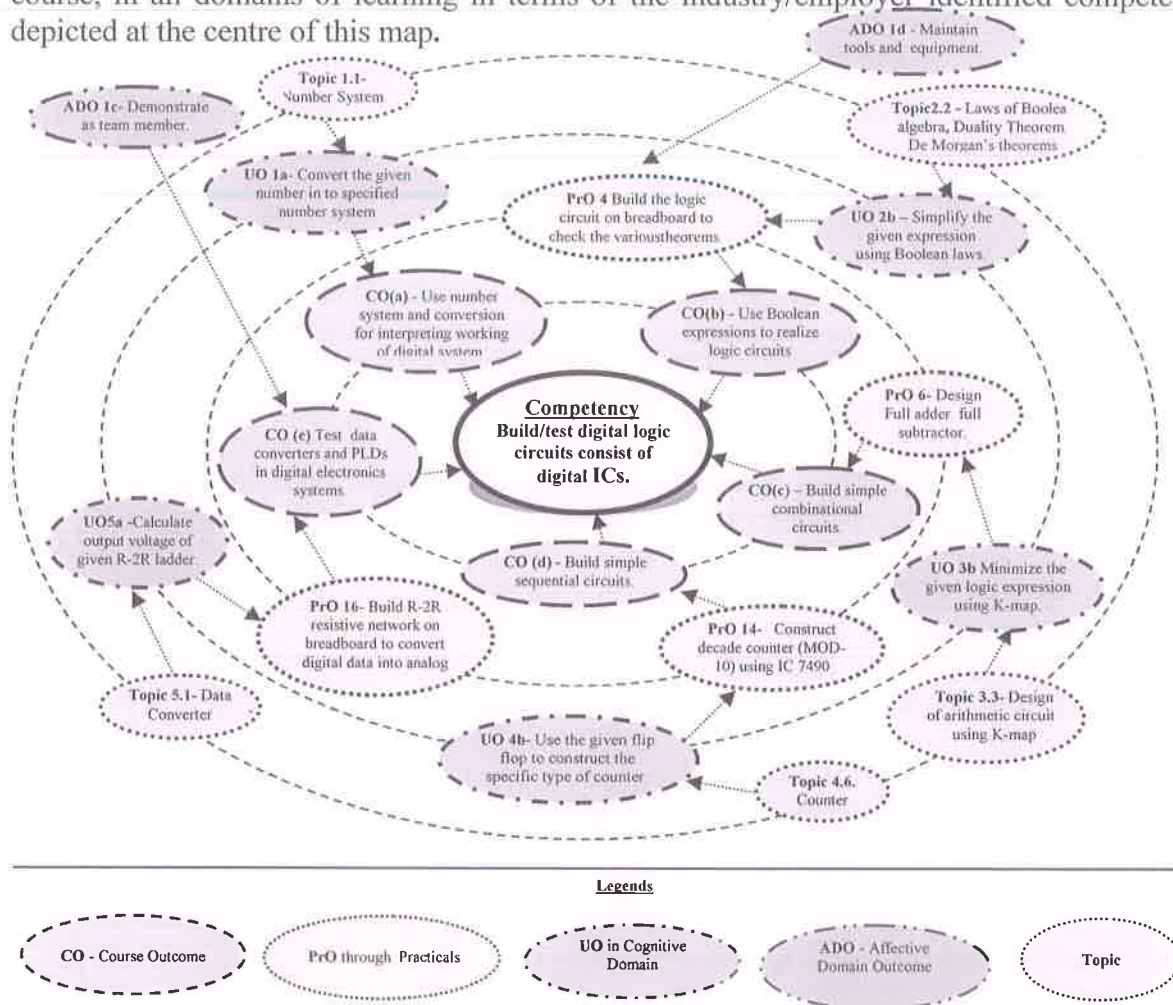


**Figure 1 - Course Map**

## 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) | | |
| 3 | Construct AND, OR, NOT gates using universal gates. | I | 02 |
| 4 | Build the logic circuit on breadboard to check the De Morgan's | II | 02 |

| S. No. | Practical Outcomes (PrOs) | Unit No. | Approx. Hrs. required |
|--------|---------------------------|----------|------------------------|
|        | theorems. |          |        |
| 5 | Design Half adder and Half subtractor using Boolean expressions. | III | 02* |
| 6 | Design Full adder and full subtractor. | III | 02 |
| 7 | Construct and test BCD to 7 segment decoder using IC 7447/ 7448. | III | 02 |
| 8 | Build / test function of MUX 74151/74150/any other equivalant. | III | 02 |
| 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.
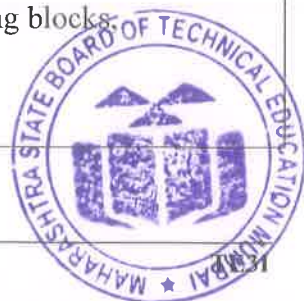
| Unit | Unit Outcomes (UOs) (in cognitive domain) | Topics and Sub-topics |
|---|---|---|
| Unit – I Number System and Codes | 1a.  Convert the given number into the specified number system. <br> 1b.  Perform the binary | 1.1 Number System: base or radix of number system, binary, octal, decimal and hexadecimal number system <br> 1.2 Binary Arithmetic: Addition, subtraction, |

| Unit | Unit Outcomes (UOs) (in cognitive domain) | Topics and Sub-topics |
|---|---|---|
| | arithmetic operation on the given binary numbers.<br>1c. Convert the given coded number into the other specified code.<br>1d. Add the given two decimal numbers using BCD code. | multiplication, division.<br>1.3 Subtraction using 1's complement and 2's complement.<br>1.4 Codes: BCD, Gray Code, Excess-3, and ASCII code.<br>1.5 BCD Arithmetic: BCD Addition |
| **Unit – II**<br>**Logic gates and logic families** | 2a. Develop the basic gates using the given NAND/NOR gate as universal gate.<br>2b. Simplify the given expression using Boolean laws.<br>2c. Develop logic circuits using the given Boolean expressions.<br>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<br>2.2 **Boolean algebra**: Laws of Boolean algebra, Duality Theorem, De-Morgan's theorems<br>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**<br>**Combinational Logic Circuits** | 3a. Develop logic circuits in standard SOP/ POS form for the given logical expression.<br>3b. Minimize the given logic expression using K-map.<br>3c. Use IC 7483 to design the given adder/ subtractor.<br>3d. Draw MUX/DEMUX tree for the given number of input and output lines.<br>3e. Write the specifications of the component for the given application.<br>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<br>3.2 **K-map reduction technique for the Boolean expression:** Minimization of Boolean functions up to 4 variables (SOP and POS form)<br>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)<br>3.4 **Arithmetic circuits:** (IC 7483 ) Adder and Subtractor, BCD adder<br>3.5 **Encoder/Decoder:** Basics of encoder, decoder, comparison, (IC 7447) BCD to 7 segment decoder/driver<br>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 |

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

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

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

## 9.     SUGGESTED SPECIFICATION TABLE FOR QUESTION PAPER DESIGN

| Unit No. | Unit Title | Teaching Hours | 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**.

    e. Guide student(s) in undertaking micro-projects.

    f. PPTs/Animations may be used to explain the construction and working of electronic circuits.

    g. Guide students for using data sheets / manuals.

## 12.    SUGGESTED MICRO-PROJECTS

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

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

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

    a. Build a Digital IC tester circuit.

    b. Build a 4bit parity generator and parity checker circuit.

    c. Build a circuit to implement 4 bit adder.

    d. Build a circuit to test 7 segment display.

    e. Build a circuit to implement debounce switch.

    f. Build a circuit for LED flasher.

    g. Build a circuit for LED BAR display

    h. Design and analyze digital arithmetic circuit

**Note:** Use general purpose PCB for making micro projects

## 13.    SUGGESTED LEARNING RESOURCES

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

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

## 14.    SUGGESTED SOFTWARE/LEARNING WEBSITES

a.  www.cse.yorku.ca/~mack/1011/01.NumberSystems.ppt
b.  www.people.sju.edu/~ggrevera/arch/slides/binary-arithmetic.ppt
c.  www.mathsisfun.com/binary-number-system.html
d.  www.codesandtutorials.com/hardware/electronics/digital_codes-types.php
e.  www.ee.surrey.ac.uk/Projects/Labview/gatesfunc/
f.  www.ee.surrey.ac.uk/Projects/Labview/boolalgebra/
g.  www.eng.auburn.edu/~strouce/class/elec2200/elec2200-8.pdf
h.  www.maxwell.ict.griffith.edu.au/yg/teaching/dns/dns_module3_p3.pdf
i.  www.scs.ryerson.ca/~aabhari/cps213Chapter5.ppt
j.  www.eng.wayne.edu/~singhweb/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

| Program Name | : **Diploma in Electronics and Computer Engineering** |
| Program Code | : **TE** |
| Semester | : **Third** |
| Course Title | : **Analog Electronics** |
| Course Code | : **22391** |

## 1.    RATIONALE

Analog electronic circuits are the building blocks for electronic systems used in industries and in daily life. It is therefore necessary for students to understand the principle and working of the basic analog circuits built by discreate components and integrated circuits. Most of the physical parameters can be converted into electrical signal with the use of transducers and sensor. The learning of the basic operating principles of electronic circuits will help the students to use and maintain the electronic and computer based instruments. This course is developed in such a way that, the students will be able to apply the knowledge of basic electronic circuit working to solve broad based electronic and computer engineering hardware application problems.

## 2.    COMPETENCY

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

- **Maintain analog electronics circuits.**

## 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 Transistor as an amplifier.
b. Use Op-Amp for basic analog circuits
c. Maintain different waveform generator circuits
d. Use various analog ICs to construct specified applications
e. Select suitable type of sensors and transducers for specified applications.

## 4.    TEACHING AND EXAMINATION SCHEME

| Teaching Scheme | | | | Examination Scheme | | | | | | | | | | | | |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| | | | | Theory Marks | | | | | | Practical Marks | | | | | | |
| L | T | P | Credits (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 attainment of COs and the remaining 20 marks is the average of 2 test to be taken during the semester for the assessment of the cognitive domain UOs required for the attainment of the COs , @: Internal Assessment*
**Legends: L**-Lecture; **T** – Tutorial/Teacher Guided Theory Practice; **P** -Practical; **C** CF 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.
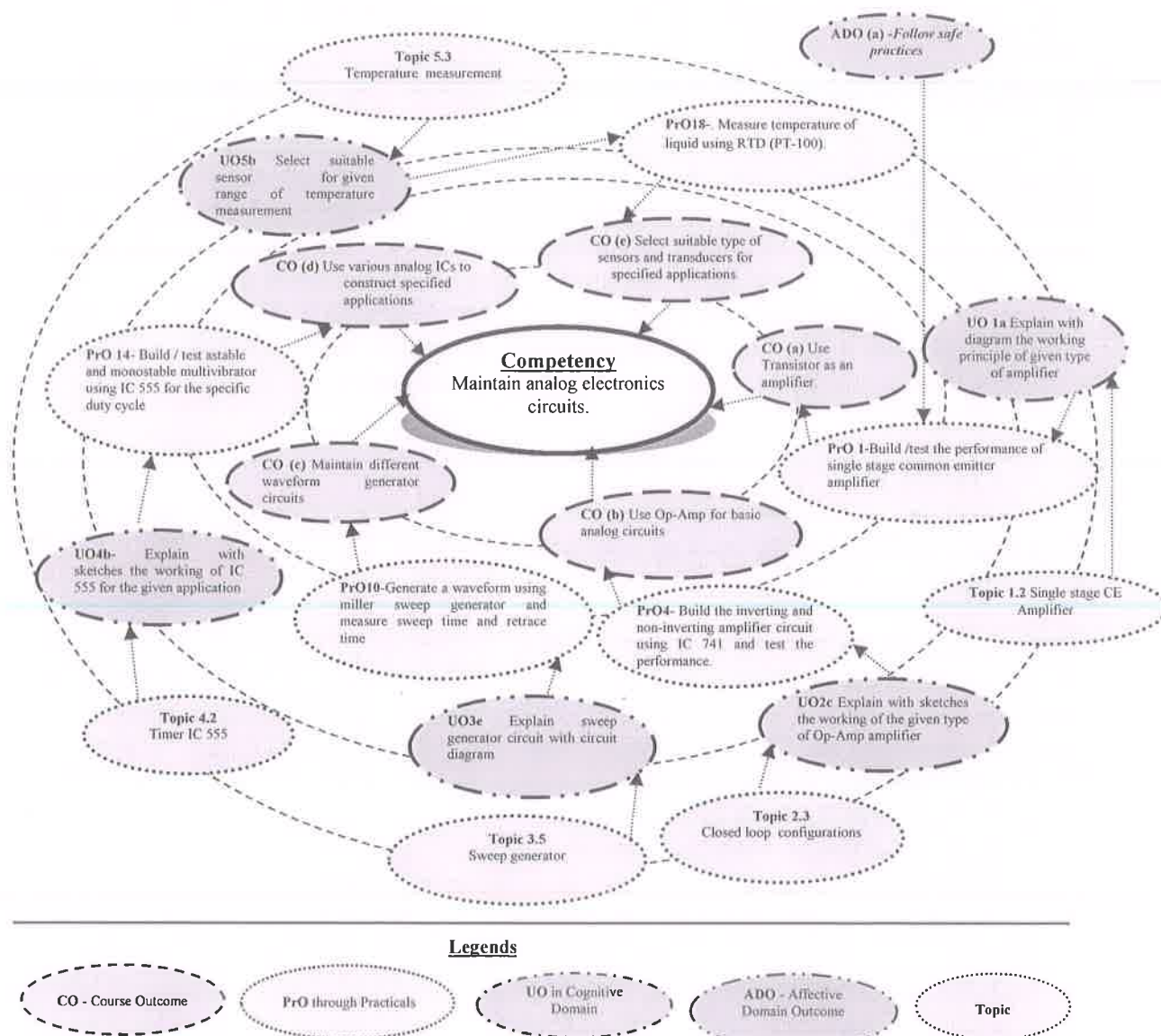


**Figure 1 - Course Map**

## 6.    SUGGESTED PRACTICALS/EXCERCISES

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

| Sr. No. | Practical Outcomes (PrOs) | Unit No. | Approx. Hrs. Required |
|---------|---------------------------|----------|------------------------|
| 1 | Build /test the performance of single stage common emitter amplifier. | I | |
| 2 | Simulate two stage RC coupled common emitter amplifier using suitable simulation software and test the frequency response of it. | | |

| Sr. No. | Practical Outcomes (PrOs) | Unit No. | Approx. Hrs. Required |
|---|---|---|---|
| 3 | Simulate single tuned amplifier using suitable simulation software and interpret the frequency response. | I | 02 |
| 4 | Build the inverting and non-inverting amplifier circuit using IC 741 and test the performance. | II | 02* |
| 5 | Build /Test adder and subtractor circuit consisting of IC 741. | II | 02 |
| 6 | Build /Test Integrator and Differentiator circuit consisting of IC 741. | II | 02* |
| 7 | Build/ Test I to V converter circuit using IC 741. | II | 02 |
| 8 | Measure the frequency of oscillation of the given RC phase shift oscillator using transistor and IC 741 | III | 02* |
| 9 | Build the Crystal Oscillator and measure the generated frequency using CRO. | III | 02 |
| 10 | Generate a waveform using miller sweep generator and measure sweep time and retrace time | III | 02 |
| 11 | Build dual regulated power supply using IC 78XX and 79XX for specified regulated output voltage | IV | 02* |
| 12 | Build voltage regulator using IC 723 for given regulated output voltage. (low voltage 2-7 V) | IV | 02 |
| 13 | Build voltage regulator using IC 723 for given regulated output voltage. (High voltage 7-37 V) | IV | 02 |
| 14 | Build / test astable and monostable multivibrator using IC 555 for the specific duty cycle. | IV | 02* |
| 15 | Build/ Test Voltage Controlled Oscillator using IC 555 . | IV | 02 |
| 16 | Test relation between Linear displacement and output voltage of LVDT. | V | 02* |
| 17 | Build/ Test pressure measurement system using strain gauge. | V | 02 |
| 18 | Measure temperature of liquid using RTD(PT-100). | V | 02* |
| | | Total | 36 |

## 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 practical set up | 20 |
| b. | Setting and operation | 20 |
| c. | Use of 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 |

| S. No. | Performance  Indicators | Weightage in % |
|--------|-------------------------|----------------|
|        | Total                   | 100            |

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

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

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

- 'Valuing Level' in 1st year
- '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. No. |
|--------|-------------------------------------------|----------|
| 1 | Variable DC power supply 0-30V,2A /3A with short circuit and over voltage protection with atleast 2 ½ digit display Properly earth chassis, Fine and Coarse control with .01Volt variation. | All |
| 2 | Dual Tracking Power Supply +/-(12 To 15V),2 A, short circuit and overvoltage protection with precision variation setting with 2 ½ digit display | 4,5,6,7,8 |
| 3 | Cathode Ray Oscilloscope Dual Trace 20Mhz/30Mhz,1MegaΩ Input Impedance with X10 magnification,CRT display 5inch diagonal size with magnifying probe. | 1,4,6,8,9, 10,14,15 |
| 4 | Digital Storage Oscilloscope 25MHz/60MHz/70MHz/100MHz Dual Channel, 4 Trace CRT / TFT based X10 magnification 20 nS max sweep rate, Alternate triggering Component tester and with optional features such as Digital Read out, USB interface. Any other Oscilloscope with additional features is also suitable with magnifying probe at least two probes, if possible isolated probe. | 1,4,6,8,9, 10,14,15 |
| 5 | Analog IC tester which tests Opamp,555,Transistor Arrays,Analog switches, Opto couplers and Others. IC testing 741, 555 ,556 ,565 with Auto search facility of IC's. Keys: 28 cherry keys Key pad with numerical and functional keys, Supply Input Voltage: 230V AC | 4,5,6,7,8, 14,15 |
| 6 | Function Generator: Frequency range 0.1Hz to 30 MHz sine, square, triangular, ramp and pulse generator, Output amplitude 20V open circuited, Output impedance 50 ohms. Facility to indicate output frequency and amplitude on display. | 1,4,6,10,14 |

| S. No. | Equipment Name with Broad Specifications | PrO. No. |
|---|---|---|
| 7 | Digital Multimeter: Minimum 3 ½ digit 4 ½ digit display, multimeter measures $V_{ac}$, $V_{dc}$ (1000V max), $A_{dc}$, $A_{ac}$ (10-amp max), Resistance (0-100 M$\Omega$), diode and transistor testing mode | All |
| 8 | Electronic Work Bench: Bread Board: 840 tie points, Withstanding Voltage: 1,000V AC, Positive and Negative power rails on opposite side of the board, connecting wires. | All |
| 9 | Displacement Transducer (LVDT type) with instrumentation and digital indicator. Trainer kit consists of industrial grade LVDT of +/- 20 mm with instrumentation, Micrometer with resolution of 0.1 mm, Digital indicator in terms of voltage. Built in Excitation signal, DC regulated power supply. Facility to vary excitation frequency and amplitude and observe its effect on LVDT performance. | 16 |
| 10 | Strain gauge trainer with instrumentation and indicator. Trainer kit consists of Whetstone bridge, Cantilever type loading arrangement, on which 2 strain gauges are mounted, Weights up to 2Kg, DC amplifier, Digital indicator in terms of gms. Facility to select Quarter and Half bridge mode. Should be housed in transparent acrylic cover so that strain gauges are visible to students. Inbuilt DC regulated Power supply etc. | 17 |
| 11 | Trainer kit suitable to measure the temperature using PT 100 type R.T.D. housed in S.S. type industrial housing. Set up should be provided with Heater which can go up to 200 deg C with facility to vary heater power, Required instrumentation constant current source with amplifier, 3 1/2-digit digital indicator of temperature, In built DC regulated power supply. | 18 |
| 12 | Simulation software like: TINA-TI/MultiSim etc or any other open-source simulation software can be used. | 2,3 |

## 8.    UNDERPINNING THEORY COMPONENTS

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

| Unit | Unit Outcomes (UOs) (in cognitive domain) | Topics and Sub-topics |
|---|---|---|
| Unit – I Transistorised Amplifiers | 1a. Explain with diagram the working principle of given type of amplifier. <br> 1b. Calculate the gain and bandwidth of the given type of amplifier <br> 1c. Compare the performance parameters of the given types of coupled amplifier <br> 1d. Explain with diagram the working principle of the given type of tuned amplifier. | 1.1 Transistor as an amplifier, Classification of amplifiers. <br> 1.2 Single stage CE Amplifier, frequency response, gain , bandwidth <br> 1.3 BJT based Multistage amplifier:need and types , circuit diagram, operation, impedance matching, frequency response and applications of RC coupled, transformer coupled and direct coupled amplifier <br> 1.4 Tuned Amplifier: Need of tuned amplifier, circuit diagram, operating principle, frequency |

| | | |
|---|---|---|
| | | response of single tuned, double tuned amplifier. |
| **Unit – II**<br>**Op-Amp**<br>**and its**<br>**applications** | 2a. Describe with sketches the function of the given block(s) of Op-Amp.<br>2b. Explain the given parameters of the Op-Amp.<br>2c. Explain with sketches the working of the given type of Op-Amp amplifier.<br>2d. Calculate the output voltage of given arithmetic circuit based on Op-Amp.<br>2e. Explain with sketches the working of Op-Amp for given application. | 2.1 Op-Amp: block diagram, symbol, characteristics of IC-741 and its pin configuration, open loop and closed loop amplifier, virtual ground concept<br>2.2 Op-Amp parameters: Input and output offset voltage, Input offset current, Input bias current, CMRR, slew rate, Input and Output Impedance, Bandwidth, Gain Bandwidth Product<br>2.3 Closed loop configurations: Inverting , non-inverting and differential amplifier<br>2.4 Basic mathematical applications such as adder, subtractor, integrator and differentiator (Derivation not expected)<br>2.5 Sample and Hold circuit, I-V converter, V-I converter,<br>2.6 Comparator: Zero Crossing Detector, Schmitt Trigger, Window Detector, peak detector |
| **Unit– III**<br>**Waveform**<br>**Generators**<br>**using**<br>**transistor and**<br>**OP-AMP** | 3a. Explain the principle of positive and negative feedback<br>3b. Explain the working principle of given type of oscillator.<br>3c. Calculate the frequency of oscillation for given oscillator<br>3d. Design an oscillator for given operating frequency.<br>3e. Explain sweep generator circuit with circuit diagram | 3.1 Principle of feedback Amplifier, Types of Feedback, applications.<br>3.2 Oscillator: need of oscillator, compare oscillator and amplifier.<br>3.3 Condition for oscillation: Barkhausen's criteria, classification of oscillator based on feedback components and based on application<br>3.4 Oscillators using transistor phase shift oscillator, crystal oscillator<br>3.5 Sweep generator: Miller's sweep circuit, bootstrap circuit.<br>3.6 Oscillators using IC 741: Phase shift oscillator, Wein bridge oscillator, Colpitts oscillator, Hartley oscillator. |

| Unit– IV<br>Special IC<br>Applications | 4a. Explain with sketches the working principle of given type of voltage regulator IC.<br>4b. Explain with sketches the working of IC 555 for the given application<br>4c. Calculate the duty cycle of the given type of multivibrator.<br>4d. Explain with sketches the working of IC565 for the given application. | 4.1 Voltage regulator IC: Fixed and variable, 78XX and 79XX series, LM723, line and load regulation.<br>4.2 Timer IC 555: block diagram, pin diagram and functions, Astable, Monostable and bistable Multivibrators, VCO, Schmitt Trigger.<br>4.3 Phase Lock Loop (PLL) IC 565: Pin diagram, Block diagram and its operation, Lock range and Capture range<br>4.4 Applications of PLL: PLL as a frequency multiplier |
|---|---|---|
| Unit– V<br>Transducers,<br>and Signal<br>conditioning | 5a. Explain the function of each block of Instrumentation system.<br>5b. Compare the different types of transducers.<br>5c. Select suitable sensor for given range of temperature measurement<br>5d. Select suitable transducer for the given range of displacement measurement.<br>5e. Explain the need of signal conditioning. | 5.1 Instrumentation system: Block diagram of instrumentation system, function of each block<br>5.2 Transducer: Need of transducer, types of transducer: primary, secondary, active, passive, analog, digital, resistive, capacitive, inductive, Piezoelectric transducer and selection criteria of transducer.<br>5.3 Temperature measurement: Thermistor, RTD(PT-100), Thermocouple:working principle, construction and application,selection criteria<br>5.4 LVDT, strain gauges: working principle, construction and application, specifications<br>5.5 Concept of signal conditioning: need of signal conditioning, instrumentation amplifier IC AD623, AC and DC signal conditioning circuits: working principle, block digram and applications |

## 9.    SUGGESTED SPECIFICATION TABLE FOR QUESTION PAPER DESIGN

| Unit<br>No. | Unit Title | Teaching<br>Hours | Distribution of Theory Marks | | | |
|---|---|---|---|---|---|---|
| | | | R<br>Level | U<br>Level | A<br>Level | Total<br>Marks |
| I | Trasistorised Amplifiers | 10 | 2 | 4 | 4 | 10 |
| II | Op-Amp and its applications | 16 | 4 | 8 | | |
| III | Waveform Generators using transistor and OP-AMP | 14 | 4 | 6 | 6 | 16 |

| Unit No. | Unit Title | Teaching Hours | Distribution of Theory Marks | | | |
|---|---|---|---|---|---|---|
| | | | R Level | U Level | A Level | Total Marks |
| IV | Special IC Applications | 14 | 4 | 4 | 8 | 16 |
| V | Transducers and Signal conditioning Systems | 10 | 2 | 4 | 4 | 10 |
| | **Total** | **64** | **16** | **26** | **28** | **70** |
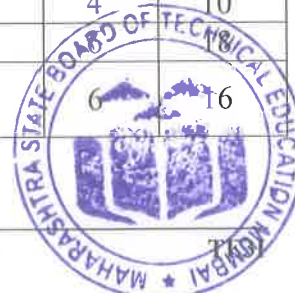
**Legends:** *R=Remember, U=Understand, A=Apply and above (Bloom's Revised taxonomy)*
<u>**Note**</u>: *This specification table provides general guidelines to assist student for their learning and to teachers to teach and assess students with respect to attainment of UOs. The actual distribution of 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) Test different components using CRO.
   b) Use various meter to test electronic component and equipment.
   c) Give seminar on any relevant topic.
   d) Use datasheets of various linear IC's and discrete components.
   e) Library survey regarding different data books of different instruments and electronics circuits.
   f) Comparative study of various parameters of different manufacturer's Op-Amp.
   g) Study of different parameters and specification of PT100,Thermocouple K, Ultrasonic range meter using datasheet and various links of transducer.
   h) Survey of various transducer's industrial applications through industrial website.

## 11.    SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES

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 develope 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) Guide students for using data manuals.
   g) Demonstrate students thoroughly before they start doing the practice.
   h) Encourage students to refer different websites to have deeper understanding of measurements.

i) Observe the performance of students continuously and give them feedback about the progress periodically.

## 12.    SUGGESTED MICRO-PROJECTS

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

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

a) Construct buzzer circuit using transistor.
b) Construct clap switch using transistor.
c) Build simple mobile phone detector circuit using Op-Amp.
d) Build Operational Amplifier 741 Tester circuit
e) Develop Square Wave Generator circuit with IC 741.
f) Develop Sound detector circuit using IC 741.
g) Develop Automatic Plant Watering system using IC555.
h) Develop Water level controller using IC555.
i) Develop Mobile Recharge station using IC555.
j) Develop prototype for distance measurement system using ultrasonic sensor.
k) Build prototype for automatic street light controller using PIR sensor.
l) Build prototype for automatic testing of tire using piezoelectric crystal with vibration principles.
m) Build prototype for automatic vibration testing of electrical vehicle using piezoelectric sensor or strain gauge.
n) Build prototype for temperature on-off control system using LM 35 temperature sensor.
o) Build and test voltage sensor circuit using Op-Amp

## 13.    SUGGESTED LEARNING RESOURCES

| Sr. No. | Title of Book | Author | Publication |
|---------|---------------|--------|-------------|
| 1 | Applied Electronics | Sedha R.S. | S.Chand,New Delhi,2015 ISBN:9788121927833 |
| 2 | Electronic Devices and Circuit Theory | Boylestad,Robert Nashelsky Louis | Pearson Education. New Delhi 2014, ISBN:9780132622264 |
| 3 | Electronics Devices and Circuits | Salivahanan S, Suresh KumarN. | McGraw Hill Education; 3rd edition ,2012, ISBN-978-1259006468 |
| 4 | Op-Amps and Linear Integrated Circuits | Gayakwad Ramakant A | PHI Learning, New Delhi 2011, ISBN:9788120340581 |

| 5 | Operational Amplifiers And Linear IC's | Bell David A. | Oxford University Press, New Delhi,India,2011, ISBN:9780195696134 |
|---|---|---|---|
| 6 | Operational Amplifiers with Linear Integrated Circuits | Stanley William D | Pearson Education India, New Delhi,2002, ISBN: 9788131708453 |
| 7 | Linear Integrated Circuits | Salivahanan S. | Tata McGraw-Hill Education,New Delhi, 2008, ISBN: 9780070648180 |
| 8 | Electronic Insrtumentation | Kalsi H.S. | McGraw Hill,New Delhi,2010 ISBN:13-9780070702066 |
| 9 | Electrical and Electronic Measurement and Instrumentation | SawhneyA.K. | DhanpatRai and Sons, New Delhi,2005, ISBN:13-9788177000160 |

## 14.    SUGGESTED SOFTWARE WEBSITES

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

| Sr. No | Keyword | QR Code | Weblink |
|---|---|---|---|
| 1. | How to Create the Project using Easy EDA(free software ) | | https://www.youtube.com/watch?v=gjPNYMRA0m8&list=PLbKMtvtYbdPMZfzGuVTdc0MWKrFvU4nsu&index=2 |
| 2. | Simulate various circuit | | https://www.ti.com/tool/TINA-TI |
| 3. | Simulate various circuit | | https://www.ni.com/multisim (paid) |

## 15.    SUGGESTED ONLINE TEACHING/ LEARNING RESOURCES

Following learning websites are suggested to students to enhance their skill or specific learning domain. It helps student to visualize and demonstrate the concept easily using given online resources.
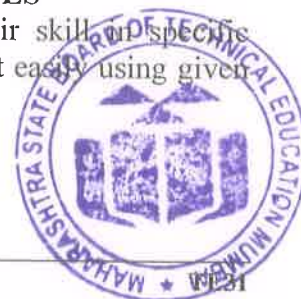
| Sr. No. | Keyword | QR Code | Weblink |
|---|---|---|---|
| 1 | CE amplifier | | http://vlabs.iitkgp.ac.in/be/exp13/ceamp.html |
| 2 | Op-amp basic | | https://nptel.ac.in/courses/117107094 (op-amp) |
| 3 | IC MOSFET and Their application | | https://nptel.ac.in/courses/108108111 |
| 4 | Comparators, Instrumentation Amplifiers, Filters | | https://onlinecourses.nptel.ac.in/noc20_ee13/preview |
| 5 | Characteristics of Ideal Op-Amp | | https://qr.page/g/4S2JOJXDq4v |
| 6 | Transistor as an amplifier | | https://qr.page/g/4PABoASTZYW |
| 7 | Single Tuned Amplifier | | https://youtu.be/iat53DqIOcU |

| 8 | Op-Amp as a Comparator | | https://youtu.be/i7U_I85wLEM |
|---|---|---|---|
| 9 | Introduction to 555 Timer | | https://www.youtube.com/watch?v=EGmreVQ-yNM |
| 10 | Phase Locked Loop (PLL) | | https://youtu.be/Q5dC9TbzR9k |
| 11 | Positive feedback and oscillation | | https://www.youtube.com/watch?v=xHNDrbB-iWY |
| 12 | Phase Locked Loop (PLL) | | https://www.youtube.com/watch?v=Q5dC9TbzR9k |
| 13 | Construction and Working LVDT. | | https://www.youtube.com/watch?v=anCnrtjNLQM |
| 14 | Comparator | | https://www.youtube.com/watch?v=XDZNiPySuW4&t=1928s |

| Program Name | : Diploma in Electronics and Computer Engineering |
|---|---|
| Program Code | : TE |
| Semester | : Third |
| Course Title | : Communication Techniques |
| Course Code | : 22392 |
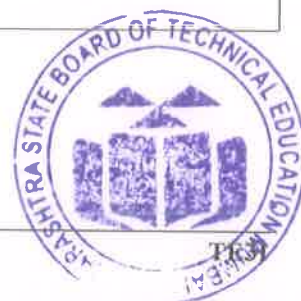
## 1.    RATIONALE

In recent era communication system have undergone radical changes and plays a vital role in industrial and domestic applications. The study of analog, digital and data communication systems will enable the technologists to apply facts, concepts and working principles in day to day communication applications. This course is developed to lay foundation for understanding and maintaining various communication systems.

## 2.    COMPETENCY

The aim of this course is to help the student to attain the following industry identified competency through various teaching learning processes:
- **Maintain various Electronic Communication 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.   Use relevant Frequency range for different communication system.
b.   Maintain Amplitude Modulation based communication system.
c.   Maintain Frequency Modulation based communication system.
d.   Use various Pulse Modulation techniques for the specified application.
e.   Use suitable media for data communication.

## 4.    TEACHING AND EXAMINATION SCHEME

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

*(\*): Under the theory PA, Out of 30 marks 10 marks are for micro-project assessment to facilitate attainment of COs and the remaining 20 marks is the average of 2 test to be taken during the semester for the assessment of the cognitive domain UOs required for the attainment of the COs. @: Internal Assessment*
**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 at 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.
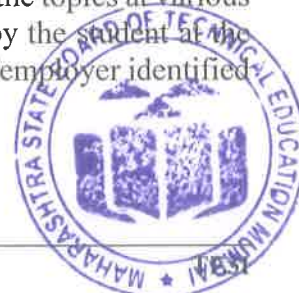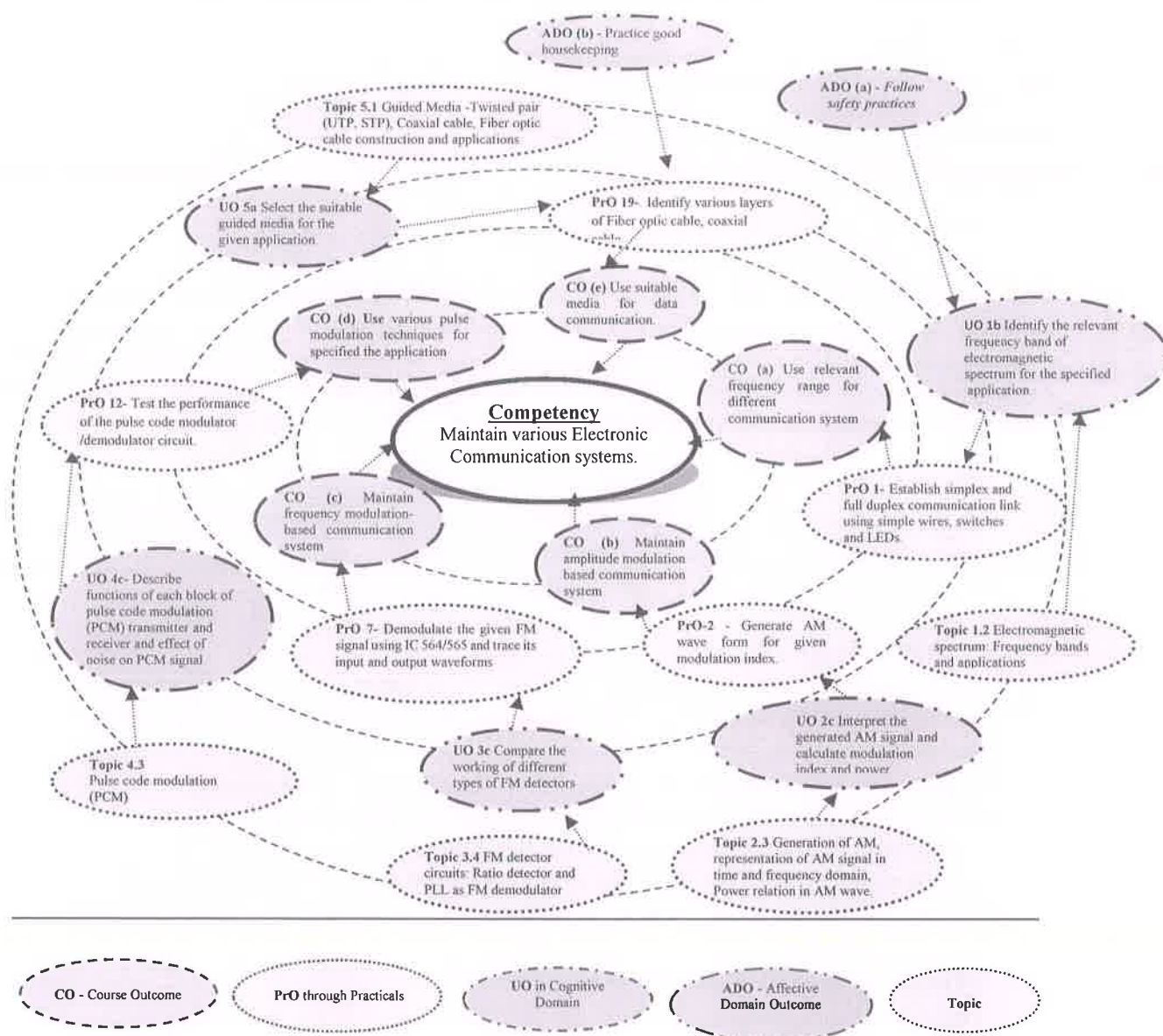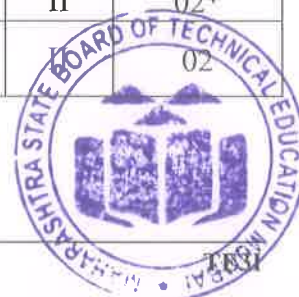
**Figure 1- Course Map**

## 6.    SUGGESTED PRACTICALS/EXCERCISES

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

| Sr. No. | Practical Outcomes (PrOs) | Unit No. | Approx. Hrs. Required |
|---------|---------------------------|----------|----------------------|
| 1 | Establish simplex and full duplex communication link using simple wires, switches and LEDs. | I | 02 |
| 2 | Generate AM wave form for given modulation index. | II | 02* |
| 3 | Use AM demodulator circuit to recover the information from the received AM signal. | | 02 |

| 4 | Use suitable simulation software to generate AM wave for various carrier frequencies. | II | 02 |
|---|---|---|---|
| 5 | Locate and rectify the fault in the given AM system. | II | 02 |
| 6 | Generate FM wave using voltage controlled oscillator and measure the frequency deviation and modulation index. | III | 02 |
| 7 | Demodulate the given FM signal using IC 564/565 and trace its input and output waveforms | III | 02* |
| 8 | Use suitable simulation software to generate FM wave. | III | 02 |
| 9 | Locate and rectify the fault in the given FM system. | III | 02 |
| 10 | Use suitable simulation software to generate Pulse Width Modulated [PWM] wave. | IV | 02 |
| 11 | Test the performance of sampling circuit for variation in sampling frequency. | IV | 02* |
| 12 | Test the performance of the pulse code modulator /demodulator circuit. | IV | 02* |
| 13 | Develop a program using a relevant simulation tool to observe effect of sampling rate on the sampling process. | IV | 02 |
| 14 | Test the performance of the Delta modulator -demodulator circuit. | IV | 02* |
| 15 | Test the performance of the Adaptive Delta modulator - demodulator circuit. | IV | 02 |
| 16 | Test the performance of the Differential Pulse Code Modulator (DPCM) modulator-demodulator circuit. | IV | 02 |
| 17 | Use suitable simulation software to measure: Radio horizon for given height of transmitting and receiving antenna | V | 02* |
| 18 | Use suitable simulation software to plot radiation pattern of the given type of antenna | V | 02 |
| 19 | Identify various layers of Fiber optic cable, coaxial cable. | 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:

| Sr. No. | Performance Indicators | Weightage in % |
|---|---|---|
| a. | Preparation of practical set up | 20 |
| b. | Setting and operation | 20 |
| c. | Use of 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 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.
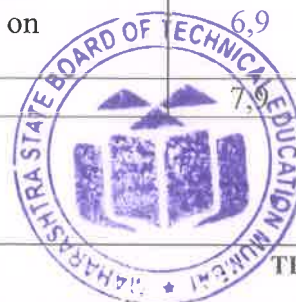e. Follow ethical Practices.

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

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

## 7.    MAJOR EQUIPMENT/INSTRUMENTS REQUIRED

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

| Sr. No. | Equipment Name with Broad Specifications | PrO No. |
|---|---|---|
| 1 | Cathode Ray Oscilloscope Dual Trace 20Mhz/30Mhz,1MegaΩ Input Impedance with X10 magnification, CRT display 5inch diagonal size with magnifying probe. | 2-16 |
| 2 | Digital Storage Oscilloscope 25MHz/60MHz/70MHz/100MHz Dual Channel, 4 Trace CRT / TFT based X10 magnification 20 nS max sweep rate, Alternate triggering Component tester and with optional features such as Digital Read out, USB interface. Any other Oscilloscope with additional features is also suitable with magnifying probe at least two probes, if possible isolated probe. | 2-16 |
| 3 | Variable DC power supply 0-30V,2A /3A with short circuit and over voltage protection with at least 2 ½ digit display, properly earth chassis, Fine and Coarse control with .01Volt variation. | 2-16 |
| 4 | Function Generator: Frequency range 0.1Hz to 30 MHz sine, square, triangular, ramp and pulse generator, Output amplitude 20V open circuited, Output impedance 50 ohms. Facility to indicate output frequency and amplitude on display. | 2-16 |
| 5 | Digital Multimeter: Minimum 3 ½ digit 4 ½ digit display, multimeter measures Vac, Vdc (1000V max), Adc, Aac (10-amp max), Resistance (0-100 MΩ), diode and transistor testing mode | 2-16 |
| 6 | Trainer kit for AM Modulation and Demodulation AM Frequency Band 530 KHz – 1650 KHz , Intermediate Frequency (IF) 455 KHz , Local Oscillator Freq. Range 980 KHz to 2.060 MHz AM Detectors1. Diode detector (for DSB)<br>          2. Product detector (for SSB) | 2,3,5 |
| 7 | Trainer kit for FM Modulation AC Source: 600Hz to 2.5 KHz. FM Modulator: VCO, Test Points, circuit diagram engraved on front panel with transparent rear panel | 6,9 |
| 8 | Trainer kit for FM demodulation using IC 565 | 7,9 |

| Sr. No. | Equipment Name with Broad Specifications | PrO No. |
|---------|------------------------------------------|---------|
|         | AC Source: 600Hz to 2.5 KHz. |  |
| 9 | Digital communication trainer for Sampling and reconstruction<br>Crystal Frequency: 8 MHz; Sampling Frequency: 20, 50, 80, 100, 200 and 400 KHZ (switch selectable) ;<br>On-board Generator: Synchronized 1 KHz sine wave (5 V ) pp ;<br>Low Pass Filters | 11 |
| 10 | Digital communication trainer for Pulse Code Modulation<br>Crystal Frequency: 16 MHz;<br>On Board Analog Signal: 2 KHz, 4 KHz (Sine wave synchronized to sampling pulse Adjustable amplitude and separate variable DC level);<br>Input Channels: 2 nos.;<br>Multiplexing: Time Division Multiplexing;<br>Modulation: Pulse Code Modulation; Sync Signal: Pseudo Random Sync Code Generator;<br>Error Check Code: Off - Odd - Even - Hamming;<br>Operating Mode: Fast: 320 KHz / channel approximately, Slow: 1.9 Hz / channel approximately | 12 |
| 11 | Digital communication trainer for Delta and Adaptive Delta Modulation<br>Input Channel: Time Division Multiplexed Serial;<br>Crystal Frequency: 6.400 MHz;<br>Sampling Clock Frequency: 50, 100, 200 and 400 KHz (Switch selectable) On board Generator: Synchronized and Adjustable Amplitude;<br>Sine Wave Generator of 1 KHz,2 KHz,3 KHz,4 KHz;<br>Separate Variable DC level Integrator: Four integrator gain settings Normal, X 2, X 4, X 8;<br>Low Pass Filter | 14,15 |
| 12 | Digital communication trainer for Differential Pulse Code Modulation<br>Functions: Sine and Square;<br>O/P frequency range: 300Hz to 3.4 KHz ; Audio blocks: Audio I/P and O/P processing circuits ;<br>Control signals: Read/Write (R/W) for ADC, reset. Latch enables, Output Enable (OE);<br>Sampling frequency: 8 KHz Total; Bits per sample :5 bits including sign bit Compared to 8-bit PCM :3 bits per sample | 16 |
| 13 | Simulation Software: Scilab / Matlab | 4,8,10,13 |
| 14 | Simulation Software: Scilab / Matlab / Antenna radiation pattern simulation tool | 17,18 |

## 8.  UNDERPINNING THEORY COMPONENTS

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

| Unit | Unit Outcomes (UOs)<br>(in cognitive domain) | Topics and Sub-topics |
|------|----------------------------------------------|------------------------|
| Unit I<br>Fundamentals<br>of Electronic | 1a. Interpret the working of basic block diagram of electronic communication system. | 1.1 Basic components of generalized electronic Communication system. |

| Unit | Unit Outcomes (UOs) (in cognitive domain) | Topics and Sub-topics |
|---|---|---|
| Communication System | 1b. Identify the relevant frequency band of electromagnetic spectrum for the specified application.<br>1c. Compare features of the given type of transmission modes.<br>1d. Differentiate properties of the given types of noise. | 1.2 Electromagnetic spectrum: Frequency bands and applications<br>1.3 Types of Data Transmission modes: Serial and Parallel, Synchronous, Asynchronous and Isochronous, Simplex, Half duplex and full duplex.<br>1.4 Noise, Sources of Noise (internal and external), SNR. |
| Unit II Amplitude Modulation and Demodulation | 2a. Interpret necessity of the given type of modulation technique.<br>2b. Describe with sketches the given parameters of AM signal.<br>2c. Interpret the generated AM signal and calculate modulation index and power distributions of the AM signal.<br>2d. Explain the functions of blocks of AM super heterodyne receiver.<br>2e. Explain the working principle of different AM demodulation techniques.<br>2f. Describe the procedure to troubleshoot the given AM system. | 2.1 Need for modulation.<br>2.2 Amplitude Modulation: basic concept, Mathematical representation of amplitude modulated wave, modulation index, bandwidth requirement.<br>2.3 Generation of AM, representation of AM signal in time and frequency domain, Power relation in AM wave. (Only equations and numerical, derivation not expected).<br>2.4 Block diagram of AM super heterodyne receiver and its working with waveforms.<br>2.5 Demodulation of AM signal: Diode detector and Practical Diode detector.<br>2.6 Automatic gain control, Need and its types. |
| Unit III Frequency Modulation and Demodulation | 3a. Explain the generation of FM wave.<br>3b. Interpret the generated FM signal and calculate modulation index and power distributions of the FM signal.<br>3c. Compare the working of different types of FM detectors.<br>3d. Describe the procedure to troubleshoot the given FM system. | 3.1 Frequency Modulation, Basic concept, Mathematical representation of frequency modulated wave, modulation index, bandwidth requirement, representation of FM signal in time and frequency domain, concept of pre-emphasis and De-emphasis.<br>3.2 Generation of FM using direct (Varactor diode and reactance modulator) and indirect method (Armstrong method).<br>3.3 Block diagram of FM receiver: working and its waveforms.<br>3.4 FM detector circuits: Ratio detector and PLL as FM demodulator. |
| Unit IV | 4a. Explain the process of sampling and quantization. | 4.1 Sampling and quantization process: types of sampling, Nyquist sampling theorem only |

| Unit | Unit Outcomes (UOs) (in cognitive domain) | Topics and Sub-topics |
|---|---|---|
| **Pulse Modulation Techniques** | 4b. Explain the process of Pulse width Modulation <br> 4c. Describe functions of each block of pulse code modulation (PCM) transmitter and receiver and effect of noise on PCM signal. <br> 4d. Differentiate Delta and adaptive delta modulation technique. <br> 4e. Compare the features of PCM, DM, ADM and DPCM. | statement). Aliasing effect, Quantization process, Quantization error, Companding. <br> 4.2 Pulse Modulation and its types (PAM, PPM, PWM and PCM), PWM: Basic concept, waveform and application <br> 4.3 Pulse code modulation (PCM): Transmitter, Receiver: Block diagram, working, Advantages and disadvantages. Differential Pulse Code Modulation (DPCM): Transmitter, Receiver: Block diagram, working, Advantages and disadvantages. <br> 4.4 Delta Modulation: Transmitter, Receiver: Block diagram, working, Advantages and disadvantages, Concept of slope overload and Granular Noise. <br> 4.5 Adaptive Delta Modulation: Transmitter, Receiver: Block diagram, working, Advantages and disadvantages. |
| **Unit V Signal Propagation** | 5a. Select the suitable guided media for the given application. <br> 5b. Identify the type of wave propagation for a given frequency. <br> 5c. Explain the need of antenna. <br> 5d. Select the type of antenna for given application. | 5.1 Guided Media -Twisted pair (UTP, STP), Coaxial cable, Fiber Optic Cable: Construction and Application. <br> 5.2 Unguided Media - concept of Propagation of Radio waves, Ground waves, Space wave and Sky wave. <br> 5.3 Necessity of antenna, Antenna parameters: Radiation pattern, Polarization, Beamwidth, Bandwidth, directivity, power gain, antenna resistance, antenna gain. <br> 5.4 Types of antennas and applications: Reflector Antennas, Micro strip Antennas, Array Antennas, and Wire Antenna. |

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 | Fundamentals of Electronic Communication System | 06 | 4 | 4 | 2 | 10 |
| II | Amplitude Modulation and Demodulation. | 12 | 4 | 6 | 8 | 18 |
| III | Frequency Modulation and Demodulation | 12 | 2 | 6 | 6 | 14 |
| IV | Pulse Modulation Techniques | 12 | 4 | 6 | 8 | 18 |
| V | Signal Propagation | 06 | 2 | 4 | 4 | 10 |
| | Total | 48 | 16 | 26 | 28 | 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 LOs. 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 report 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 chart for Electromagnetic Spectrum.
b)   Give seminar on various types of sampling techniques.
c)   Prepare power point presentation on guided and unguided media.
d)   Prepare a brief report on recent trends in communication system.
e)   Prepare chart showing PAM, PWM, PPM and PCM waveform.
f)   Visit a radio/TV transmitter station.
g)   Visit auditorium near or within your campus and make layout of PA system.
h)   Plot the radiation pattern for the given antenna on Smith Chart using Turn T table.
i)   Participate/assist in events like paper presentation, Quiz competition, Project competition, Circuit design, Circuit troubleshooting, Hackathon.

11.     **SUGGESTED SPECIAL INSTRUCTIONAL STRATERGIES**
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 *(MOOC's)* may be used to teach various topics/sub topics.
b)   *'L' in item No. 4* does not mean only the traditional lecture method, but different types of teaching methods and media that are to be employed to develop the outcomes.
c)   About *15-20% of the topics/sub-topics* which is relatively simpler or descriptive in nature is to be given to the students for self-directed learning and assess the development of the COs through classroom presentations (see implementation guidelines 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)   Video programs/YouTube/Animations may be used to teach various topics and sub topics.

g)   Demonstrate working of the communication instruments to students before they start doing the practical.

h)   Encourage students to refer different websites specified under learning resources to have deeper understanding of the various communication techniques.

i)   Observe performance of the student continuously and give them feedback about the progress periodically.

j)   Motivate students to participate in course related co-curricular activities

## 12.   SUGGESTED MICROPROJECTS

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

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

a)   Demonstrate working for Simplex and Duplex system.
b)   Demonstrate AM and FM wave using MATLAB/Scilab simulation software.
c)   Demonstrate AM and FM detector using MATLAB/Scilab simulation software.
d)   Demonstrate sampling process with various sampling rate and its effect using simulation software.
e)   Build a PCM generator circuit using suitable IC
f)   Build a DM/ADM circuit using suitable IC.
g)   Demonstrate TDM and FDM signal using simulation software.
h)   Demonstrate radiation pattern of at least 2 (yagi uda antenna and dish antenna) antennas using Simulation software.

## 13.   SUGGESTED LEARNING RESOURCES

| Sr. No. | Title of Book | Author | Publication |
|---|---|---|---|
| 1 | Data Communication and Networking | Forouzan, Behrouz A | McGraw Hill, Education New Delhi,2015; ISBN 9780072967753 |
| 2 | Electronic Communication Systems | Kennedy George; Davis Bernard; Prasanna SRM | Mc-Graw Hill 5th Edition, New Delhi,2011, ISBN: 9780071077828 |
| 3 | Principles of Electronics Communication system. | Frenzel Louis E | Mc-Graw Hill 5th Edition, New Delhi,2007, ISBN: 9780073222783 |
| 4 | Electronic communication system | Tomasi Wayne. | Pearson Education, Delhi,2009, ISBN: 9788131719534 |

| Sr. No. | Title of Book | Author | Publication |
|---|---|---|---|
| 5 | Antenna Theory: Analysis and Design | Constantine A. Balanis | Wiley-Student edition India, New Delhi, 2015-16, ISBN: 9788126524228 |
| 6 | Digital Communication | Sklar, Bernald | Pearson Education India, Delhi, Second Edition 2014, ISBN:9781292026060 |
| 7 | Digital Communications | J S Chitode | Technical Publication, ISBN 8184311559, 9788184311556 |
| 8 | Digital Communication | Rao, Ramakrishna P. | McGraw Hill, Delhi, 2011, ISBN:9780070707764 |

## 14.    SUGGESTED SOFTWARE WEBSITES

Following websites are suggested for different programming languages and/or simulation software's to enhance psychomotor domain skills. Any other equivalent open source software can be used if required.

| Sr. No | Keyword | QR Code | Website |
|---|---|---|---|
| 1 | Scilab | | https://www.scilab.org/download/6.1.1/scilab-6.1.1.exe |
| 2 | TINA PRO | | https://tina.software.informer.com/download/ |
| 3 | Multisim | | https://www.ni.com/multisim  (paid) |
| 4 | Matlab | | https://www.mathworks.com/help/rptgen/ug/create-links.html |

## 15.    SUGGESTED ONLINE TEACHING /LEARNING RESOURCES

Following learning websites are suggested to students to enhance their skill in specific learning domain. It helps student to visualize and demonstrate the concept easily using given online resources.
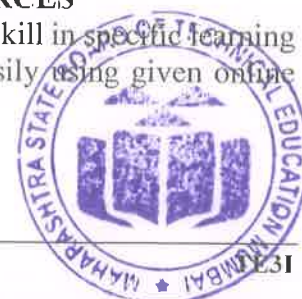
| Sr No | Keyword | QR code | Weblink |
|-------|---------|---------|---------|
| 1 | Need for Modulation | | https://youtu.be/dvGcCk1vbjk |
| 2 | Amplitude Modulation | | https://youtu.be/I46eP8uZh_Y |
| 3 | Amplitude Demodulation | | https://youtu.be/4JrryefRNFk |
| 4 | Frequency Modulation | | https://youtu.be/gFu7-7lUGDg |
| 5 | Frequency Demodulation | | https://youtu.be/Q5CaNODrXrQ |
| 6 | NPTEL video on Digital Modulation Techniques | | https://youtu.be/ZW1glqkIgcw |

| 7 | Pulse Modulation: | | https://youtu.be/wn71QBApCR |
|---|---|---|---|
| 8 | Guided and Unguided Media | | https://youtu.be/doAVuehH-L4 |
| 9 | Quantization | | https://youtu.be/1KBLguIXL30 |
| 10 | NPTEL Video Amplitude Modulation and Demodulation | | https://youtu.be/S8Jod9AtpN4 |
| 11 | Pulse Code Modulation | | https://youtu.be/l_SqkcP6hZ4 |
| 12 | Virtual Lab | | https://kcgcollege.ac.in/Virtual-Lab/Electronics-and-Communication Engineering/simulation.html |
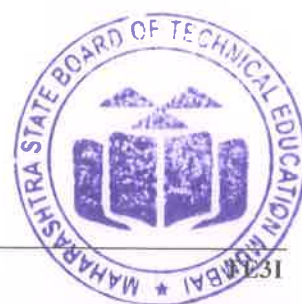
**Program Name**    : **Diploma in Electronics and Computer Engineering**

**Program Code**    : **TE**

**Semester**        : **Third**

**Course Title**    : **C++ with Data Structure**

**Course Code**     : **22393**

## 1.    RATIONALE

In the modern technology, Object Oriented Programming (OOP) and Data Structures are integrated for software development. It offers efficient way to solve real world problems. The concept of Object Oriented Programming (OOP ) and Data Structures are widely used in software industries. This course will enable students to identify problems and analyze different algorithms to implement feasible solutions for industry.

## 2.    COMPETENCY

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

- **Implement relevant algorithms of Data structures 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 builds the logical reasoning skill and apply it for real-world challenging issues in software industry through demonstrating the following CO's associated with the above-mentioned  industry identified competency:

- a.  Develop basic C++ Programs to solve problems using Procedure Oriented Approach.
- b.  Develop programs in C++ based on fundamental OOP concepts.
- c.  Implement features of OOP like Inheritance, Polymorphism using C++.
- d.  Apply basic operations on arrays for searching and sorting techniques.
- e.  Implement Linear Data Structures like stack, queue, linked list using C++.

## 4.    TEACHING AND EXAMINATION SCHEME

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

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

**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.
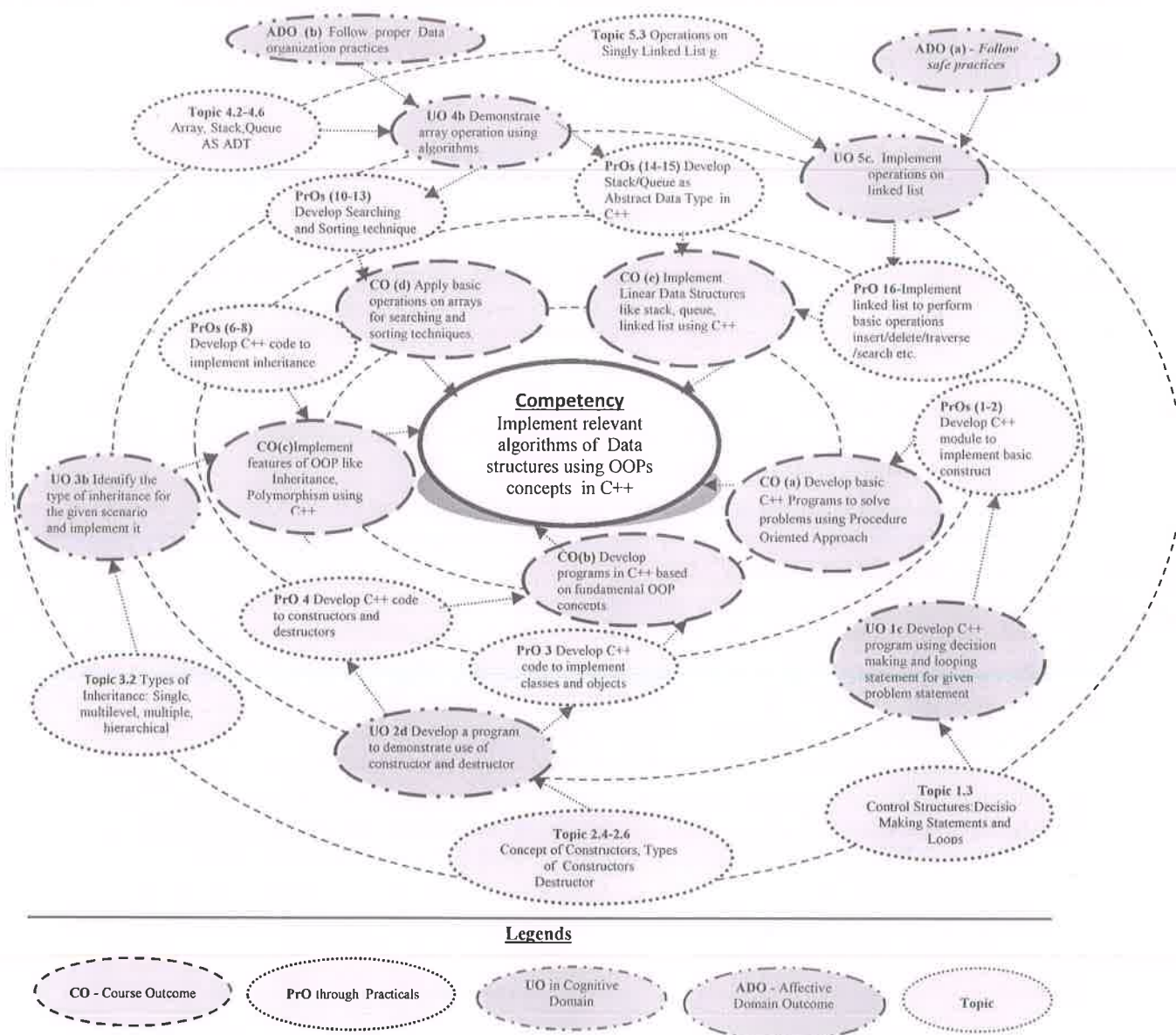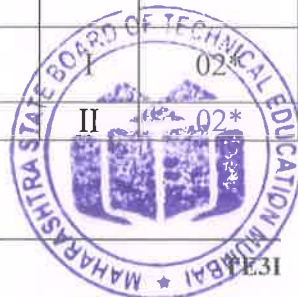


**Figure 1 - Course Map**

### 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 attainment of the competency:

| S. No. | Practical Outcomes (PrOs) | Unit No. | Approx. Hrs. Required |
|---|---|---|---|
| 1 | Develop program to perform arithmetic operations using cin and cout (demonstrate using minimum 2 IDE like turboC IDE/netbeans/devC++/GCC for linux/VSCode) | I | 02 |
| 2 | Develop C++ code to implement different looping and control structures. | I | 02 |
| 3 | Develop C++ code to implement classes and objects | II | 02 |

| S. No. | Practical Outcomes (PrOs) | Unit No. | Approx. Hrs. Required |
|---|---|---|---|
| 4 | Develop C++ code to constructors and destructors | II | 02 |
| 5 | Develop C++ code to implement function overloading | III | 02 |
| 6 | Develop C++ code to implement inheritance single, multilevel | III | 02* |
| 7 | Develop C++ code to implement multiple inheritance | III | 02 |
| 8 | Develop C++ code to implement hierarchical inheritance, hybrid inheritance | III | 02 |
| 9 | Implement an array to perform basic operations as insertion, deletion of element. | IV | 02 |
| 10 | Develop Linear Search and Binary Search technique | IV | 02* |
| 11 | Develop C++ code to implement Bubble Sort | IV | 02 |
| 12 | Develop C++ code to implement Selection Sort | IV | 02 |
| 13 | Develop C++ code to implement insertion sort | IV | 02* |
| 14 | Develop Stack as Abstract Data Type in C++ | V | 02 |
| 15 | Develop Queue as Abstract Data Type in C++ | V | 02* |
| 16 | Implement Singly Linked List in C++ to perform basic operations as Insertion, Deletion, Traversal and Search. | 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. | Building programming blocks | 20 |
| b. | Logic building ability | 20 |
| c. | Debugging ability | 20 |
| d. | Correctness of desired output | 10 |
| e. | Answer to sample questions | 15 |
| f. | 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 laboratory/field based experiences:

     a. Follow safety practices.
     b. Follow proper Data organization practices
     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 ADOs takes place gradually in the student as s/he undertakes a series of practical

experiences over a period of time. Moreover, the level of achievemnet 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.

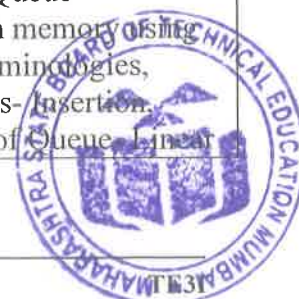| S. No | Equipment Name with Broad Specifications | PrO. No. |
|---|---|---|
| 1 | Computer system Windows/Android/IOs mobile device Windows-7 / Linux OS with hardware above Pentium Series, minium 2GB RAM, Injet/Laser/Dot matrix Printer (minimum requirement for batch size of 20 students) | ALL |
| 2 | C++ Compiler (Turbo C++/Dev C++/Visual Studio/GNU compiler/Borland C++) Any free IDE : netbeans/ Code Block | |
| 3 | Online Compilers<br>• https://www.onlinegdb.com/online_c++_compiler<br>• https://www.programiz.com/cpp-programming/online-compiler/ | |
| 4 | Android App like :<br>• Turbo Cdroid<br>https://play.google.com/store/apps/details?id=www.turboc8.com.turbocdroider<br>• Any other suitable Editor App. | |

## 8. UNDERPINNING THEORY COMPONENTS

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

| Unit | Unit Outcomes (UOs) (in cognitive domain) | Topics and Sub-topics |
|---|---|---|
| Unit – I Constructs of C++ | 1a. Differentiate between POP and OOP<br>1b. Write simple C++ program to demonstrate use of basic operators<br>1c. Develop C++ program using decision making and looping statement for given problem statement<br>1d. Write C++ program to demonstrate use of pointers and String functions. | 1.1 Procedure Oriented Programming Vs Object Oriented Programming, OOP languages and applications of OOP.<br>1.2 Tokens, Keywords, Identifiers, Variables, Constants, Datatypes, Type Casting, Operators, Memory management operators, Expressions and create simple C++ program<br>1.3 Control Structures: Decision Making Statements and Loops<br>1.4 Pointers, Arrays and String functions. |

| Unit | Unit Outcomes (UOs) (in cognitive domain) | Topics and Sub-topics |
|------|-------------------------------------------|------------------------|
| **Unit– II Overview of C++** | 2a. Develop C++ program to create class and object for given problem statement<br>2b. Develop a program to demonstrate the use of static members and functions<br>2c. Develop a program to create an array of object.<br>2d. Develop a program to demonstrate use of constructor and destructor. | 2.1 Class and Object :Declaration and Specifying a class, Access Specifiers, Defining member functions, Creating Objects, Scope Resolution Operator, Memory allocation for objects.<br>2.2 Static data members and static member functions.<br>2.3 Object as function Arguments, Arrays of objects.<br>2.4 Concept of Constructors,Types of Constructors<br>2.5 Constructor overloading, Constructor with default arguments<br>2.6 Destructors |
| **Unit– III Inheritance and Polymorphism** | 3a. Classify different types of classes<br>3b. Identify the type of inheritance for the given scenario and implement it<br>3c. Demonstrate the use of constructors in class<br>3d. Illustrate the use of function overloading and opertator overloding | 3.1 Fundamentals of inheritance: Concrete class, base class, derived class and abstract class, defining a derived class, access specifiers<br>3.2 Types of Inheritance: Single, multilevel,multiple,hierarchical<br>3.3 Constructors in derived class<br>3.4 Polymorphism:Function Overloading,Operator overloading using member function |
| **Unit-IV Linear Data Structures** | 4a. Compare Time and Space complexity for different algorithms.<br>4b. Demonstrate array operation using algorithms.<br>4c. Demonstrate the operations on Stack<br>4d. Demonstrate the operations on Queue | 4.1 Data Structure(DS): Concept, Need of DS, Abstract Data Type (ADT), Classification of Data Structures, Operations to be performed on Data Structures. Big'O'notation, Time complexity: best case, average case, and worst case analysis , Space Complexity<br>4.2 Array as ADT: Insertion, Deletion<br>4.3 Searching Techniques: Linear Search, Binary Search<br>4.4 Sorting Techniques: Bubble Sort, Selection Sort, Insertion Sort<br>4.5 Stack as ADT: Stack Representation in memory using array, Stack Terminologies, Stack Operations- PUSH, POP, Stack Application<br>4.6 Queue as ADT: Queue Representation in memory using array, Queue Terminologies, Queue Operations- Insertion, Deletion, Types of Queue- Linear |

| Unit | Unit Outcomes (UOs) (in cognitive domain) | Topics and Sub-topics |
|------|-------------------------------------------|------------------------|
| | | Queue, Circular Queue, Queue Application |
| **Unit –V Linked list as ADT** | 5a. Explain linked list terminologies 5b. Demonstrate the SLL 5c. Implement operations on linked list 5d. Demonstrate stack and queue using SLL | 5.1 Linked List terminologies 5.2 Linear linked list: Node structure, Memory representation 5.3 Operations on Singly Linked List(SLL): Create list, list traversal, Searching, Insertion and deletion 5.4 Representation of stack and queue using linked list |

## 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 | Constructs of C++ | 6 | 4 | 2 | 4 | 10 |
| II | Overview of C++ | 12 | 4 | 8 | 6 | 18 |
| III | Inheritance and Polymorphism | 10 | 4 | 6 | 6 | 16 |
| IV | Linear Data Structures | 14 | 4 | 6 | 8 | 18 |
| V | Linked List as ADT | 6 | 2 | 2 | 4 | 08 |
| | **Total** | **48** | **18** | **24** | **28** | **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 LOs. 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 of activities in the group and prepare the 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) Self prepared Quiz based on course unit contents
   b) Undertake the micro project.
   c) Participate/assist in organizing activities like Blind code Competition/ Code Debugging competition
   d) Prepare chart/Poster to represent OOP and data structure concepts.
   e) Implement Problem Based Learning (PBL).

## 11.    SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES
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 *(MOOC's)* may be used to teach various topics/sub topics.
   b) *'L' in item No. 4* does not mean only the traditional lecture method, but different types of teaching methods and media that are to be employed to develop the outcomes.

c)  About *15-20% of the topics/sub-topics* which is relatively simpler or descriptive in nature is to be given to the students for self-directed learning and assess the development of the COs through classroom presentations (see implementation guideline for details).
d)  With respect to item No.10, teachers need to ensure to create opportunities and provisions for *co-curricular activities*.
e)  Guide student(s) in undertaking micro-projects.
f)  Demonstrate students thoroughly before they start doing the practice.
g)  Encourage students to refer different websites to have deeper understanding of the course.
h)  Observe continuously and monitor the performance of students in Lab.
i)  Motivate students to participate in course related co-curriculur activities.

## 12.    SUGGESTED MICRO-PROJECTS

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

a)  Develop an arithmetic expression evaluator using Stack as a Data Structure.
b)  Develop student record management system.
c)  Develop bank management application which includes operations like Deposit, Withdraw and Balance enquiry. Select appropriate data structure for the same
d)  Develop applications as Dictionory/phone directory etc
e)  Develop basic library management application which provides facility to issue book , return book, search book from existing record.
f)  Implement different sorting techniques and present comparative study in terms of efficiency for input of size N.
g)  Implement and Compare two searching algorithms with Respect to different input case (input case – Best Case/ Worst Case/ Average Case)
h)  Develop a C++ code to find value of a resistor based on provided colour code or vice versa.
i)  Implement micro-project given in point 'h' using user defined header file.
     (reference link of video- https://www.youtube.com/watch?v=Uw1HiIyZZxE )

Any other micro-projects suggested by course 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

| Sr. No. | Title of Book | Author | Publication |
|---|---|---|---|
| 1 | C++ Complete reference | Herbert Schildt | Tata McGraw Hill, 4th Edition, 2017 ISBN: 007053246X |
| 2 | Data Structure Using C and C++ | Yedidyah Langsam, Moshe J. Augenstein, | Pearson Education India, 2nd Edition ,2015 |

| Sr. No. | Title of Book | Author | Publication |
|---|---|---|---|
| | | Aaron M. Tenenbaum | ISBN:9332549311 |
| 3 | Data Structures through C++ - A quick reference | Dr .Ch V Raghavendran, Ganti Naga Satish | Paperback, 2019 ISBN:6138801024 |
| 4 | Object Orinted Programming with C++ | E Balagurusamy | Tata McGraw Hill Publications, 8th Edition Paperback, 2020 ISBN:9389949181 |
| 5 | Object-Oriented Programming in C++ | Robert Lafore | Sams publication 4th edition (19 December 2001) ISBN-13 :   978-0672323089 |

## 14.    SUGGESTED  SOFTWARE  WEBSITES

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

| Sr. No. | Keyword | QR Code | Web Links |
|---|---|---|---|
| 1 | Turbo C++ for Windows | | https://developerinsider.co/download-turbo-c-for-windows-7-8-8-1-and-windows-10-32-64-bit-full-screen/ |
| 2 | Visual Studio Code | | https://code.visualstudio.com/download |
| 3 | Install Borland C++ | | https://developerinsider.co/download-and-install-borland-c-compiler-on-windows-10/ |
| 4 | Online compiler | | https://www.onlinegdb.com/online_c++_compiler |

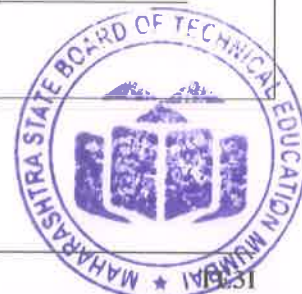| Sr. No. | Keyword | QR Code | Web Links |
|---|---|---|---|
| 5 | Online compiler | | https://www.programiz.com/cpp-programming/online-compiler/ |
| 6 | GNU Compiler Collection | | https://gcc.gnu.org/ |

## 15. SUGGESTED ONLINE TEACHING/LEARNING RESOURCES:

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

| Sr. No. | Keyword | QR Code | Web Links |
|---|---|---|---|
| 1 | C++ basic constructs | | https://www.tutorialspoint.com/cplusplus/index.htm |
| 2 | Array, Stack, Queue, Linked List | | https://www.geeksforgeeks.org/data-structures/ |
| 3 | Array, Stack, Queue, Linked List(basic overview) | | https://www.educative.io/blog/cpp-data-structures-interview-prep |
| 4 | Linear Vs Non-Linear Data Structure | | https://www.programiz.com/dsa/data-structure-types |
| 5 | Coding skills | | https://www.hackerrank.com |

| 6 | Data Structure | | https://www.youtube.com/watch?v=B31Lgl4Y4DQ |
|---|---|---|---|
| 7 | Linked List | | https://www.youtube.com/watch?v=K7VIKlUdo20 |
| 8 | Stack | | https://www.youtube.com/watch?v=r7P9sv5Rar8&list=PLIY8eNdw5tW_zX3OCzX7NJ8bL1p6pWfgG&index=5 |
| 9 | Insertion Sort | | https://www.youtube.com/watch?v=3GC83dh4cf0&list=PLfqMhTWNBTe0b2nM6JHVCnAkhQRGiZMSJ&index=22 |
| 10 | OOP, Class, Object, Function, Constructor, Inheritance | | http://vlabs.iitb.ac.in/vlabs-dev/labs/oops/labs/index.php |
| 11 | C++ MCQs | | https://www.sanfoundry.com/cplusplus-interview-questions-answers/ |
| 12 | Data Structure lab | | https://www.vlab.co.in/broad-area-computer-science-and-engineering |
| 13 | Bubble Sort, Linked List, Arrays, Seacrching | | https://ds1-iiith.vlabs.ac.in/List%20of%20experiments.html |

| 14 | Selection Sort |  | https://ds2-iiith.vlabs.ac.in/List%20of%20experiments.html |
|----|----------------|------|------|
| 15 | Data Structure MCQs |  | https://www.sanfoundry.com/1000-data-structure-questions-answers/ |

| Program Name | : **Computer Engineering Program Group / Diploma in Electronics and Computer Engineering** |
|---|---|
| Program Code | : **CO/CM/IF/CW/TE** |
| Semester | : **Third** |
| Course Title | : **Computer Peripheral and Hardware Maintenance** |
| Course Code | : **22013** |

## 1.    RATIONALE

Maintenance and troubleshooting of computer system and its peripherals is an important skill to upkeep the computer systems and peripherals. Diploma pass out must be able to use and maintain these system peripherals authentically. They must also possess basic skills of assembling desktop computers, interfacing with peripheral devices, installing new devices and carry out preventive and breakdown maintenance and troubleshooting. This course is designed to develop these vital skills in them through lab based activities to solve problems associated with computer hardware.

## 2.    COMPETENCY

The aim of this course is to help the student to attain the following industry identified competency through various teaching learning experiences:
*   **Maintain computer hardware and peripherals.**

## 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 different types of computer systems.
    b.  Troubleshoot common motherboard problems.
    c.  Select processors required for relevant systems.
    d.  Partition/format hard disk drives.
    e.  Troubleshoot peripherals and networks.
    f.  Test power supplies.

## 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 | - | 2 | 4 | -- | --- | --- | --- | --- | --- | --- | 50# | 20 | 50~ | 20 | 100 | 40 |

*(~): For the **practical only courses,** the PA has two components under practical marks i.e. the assessment of practicals (seen in section 6) has a weightage of 60% (i.e. 30 marks) and micro-project assessment (seen in section 12) has a weightage of 40% (i.e. 20 marks. This is designed to facilitate attainment of COs holistically, as there is no theory ESE.*

**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.
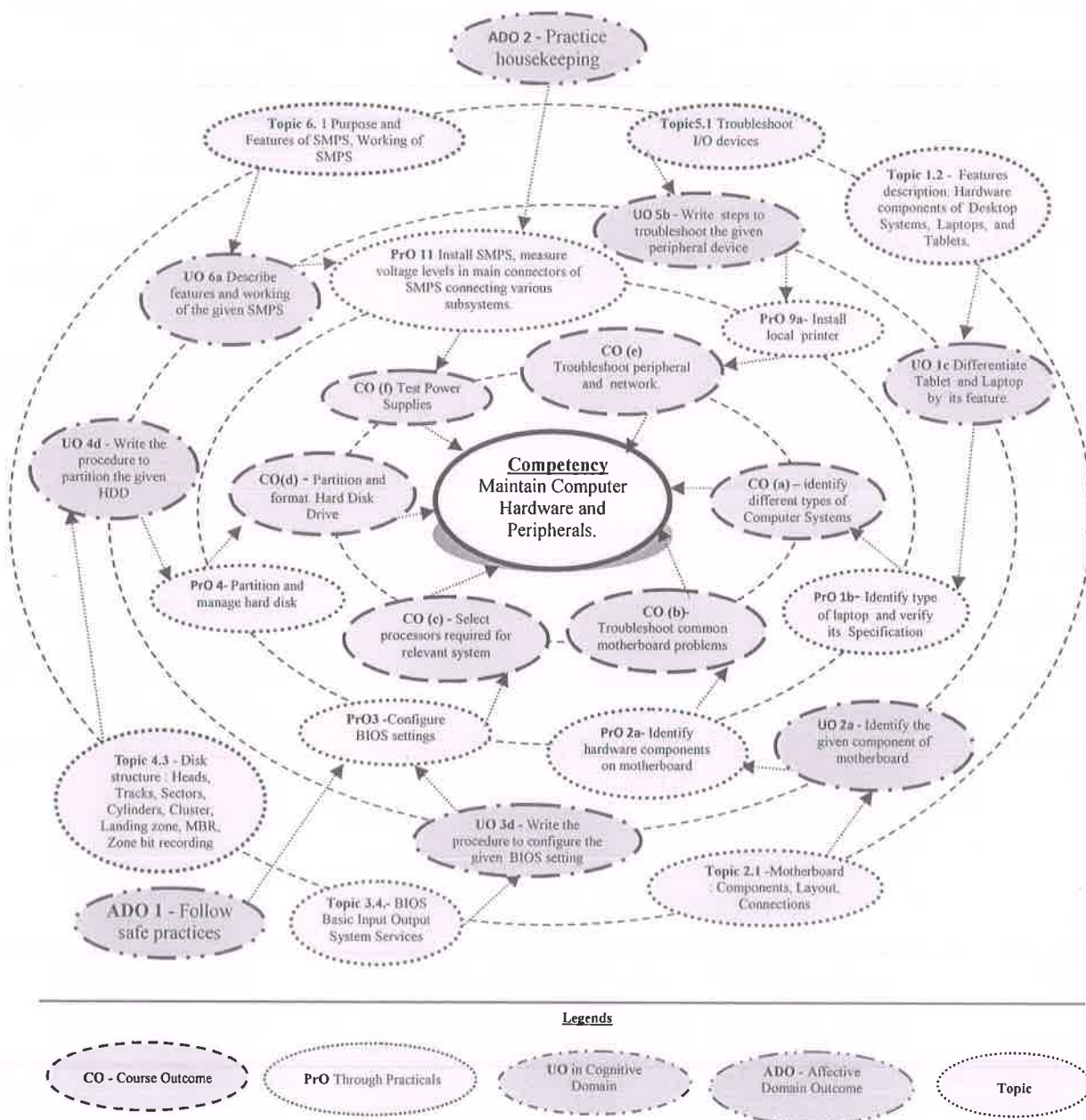


**Figure 1 - Course Map**

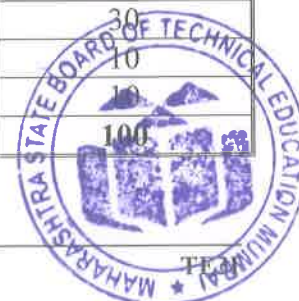### 6.    SUGGESTED PRACTICALS/ EXERCISES

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. Identify desktop and server by its type and verify its specifications | I | 2* |
|   | b. Identify type of laptop and verify its Specification | | |
| 2 | a. Identify hardware components on motherboard | II | 2* |
|   | b. Troubleshoot common problems of motherboard. | | |
| 3 | Configure BIOS settings | III | 2* |
| 4 | Partition and manage hard disk: format hard drives with different file systems. (Part-I) | IV | 2* |
| 5 | Partition and manage hard disk, format hard drives with different file systems. (Part-II) | IV | 2 |
| 6 | Install Operating System – Windows family (such as Windows 7/ Windows 10,Windows server 12) | IV | 2 |
| 7 | Install Operating System –Unix family (such as Linux/Ubuntu/Centos) | IV | 2 |
| 8 | Troubleshoot Hard disk problems. | IV | 2 |
| 9 | a. Install local printer (Software configuration settings on printer and troubleshooting ) | V | 2* |
|   | b. Share Printer in Network(Software configuration settings on printer and troubleshooting ) | | |
| 10 | Set keyboard, mouse, monitor, Speaker, Microphone and LCD Projector | V | 2 |
| 11 | Install SMPS, measure voltage levels in main connectors of SMPS connecting various subsystems. | VI | 2* |
| 12 | Assemble and Disassemble Desktop System (Part-I) | VI | 2 |
| 13 | Assemble and Disassemble Desktop System (Part-I) | VI | 2 |
| 14 | Troubleshoot computer system by diagnosing the problem | VI | 2 |
| 15 | Use diagnostic software for fault finding and viruses | VI | 2 |
| 16 | Undertake Preventive Maintenance of PC using vacuum cleaner and simple tools. | VI | 2 |
| | **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. All the above listed practical need to be performed compulsorily, so that the student reaches the 'Applying Level' of Blooms's 'Cognitive Domain Taxonomy' as generally required by the industry.*

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

| S. No. | Performance  Indicators | Weightage in % |
|---|---|---|
| a. | Use of Appropriate tool to solve the problem | 10 |
| b. | Operate equipment skillfully | 30 |
| c. | Follow Safety measures | 10 |
| d. | Completed the exercise in stipulated time | 30 |
| e. | Answer to sample questions | 10 |
| 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.
  - '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 | Exp. S.No. |
|---|---|---|
| 1 | Computer system with all necessary components like; motherboard, random access memory (RAM), read-only memory (ROM), Graphics cards, sound cards, internal hard disk drives, DVD drive, network interface card | All |
| 2 | LCD/DLP Projector | Student Activity |
| 3 | Mouse :Mechanical, Optical, Opto-Mechanical | 8 |
| 4 | Laptop | All |
| 5 | Bluetooth based wireless mouse and keyboard or any other device | 8 |
| 6 | Dot Matrix Printer, Laser Printer, Inkjet Printer | 7 |
| 7 | Computer Maintenance kit | All |
| 8 | Logic probe, logic pulser, current tracer | 11 |
| 9 | Digital voltmeter | 9 |
| 10 | Operating systems | 5,6,7,8,,11,12 |
| 11 | Power Supply | All |
| 12 | Diagnostics Software | 12 |
| 13 | Vacuum Cleaner/Blower | 13 |

*Note: There are no specifications fixed for the above listed equipments, devices and instruments. Depending on the availability in the institute they can be utilized for the purpose.*

## 8. UNDERPINNING THEORY COMPONENTS

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

| Unit | Unit Outcomes (UOs) (in cognitive domain) | Topics and Sub-topics |
|---|---|---|
| **Unit – I Features of Computer Hardware** | 1a. Explain characteristics of the given type of computer systems. <br> 1b. Describe features of the given desktop systems. <br> 1c. Describe features of the given Tablet systems. <br> 1d. Describe features of the given server systems. | 1.1 Computers: Desktop Computers, Tablet, Laptop, Mainframe, Supercomputer. <br> 1.2 Features description: Hardware components of Desktop Systems, Laptops, and Tablets. <br> 1.3 Types of Servers, Server Feature descriptions and its applications. |
| **Unit– II Motherboard** | 2a. Identify the given component of motherboard. <br> 2b. Describe features of the given motherboard. <br> 2c. Differentiate hardware based and software based problems of motherboard. <br> 2d. Describe the procedure to identify the given type of motherboard problems. | 2.1 Motherboard : Components, Layout, Connections <br> 2.2 Motherboards : Types and Features <br> 2.3 Enhancing features of motherboard: Adding and or replacing components. <br> 2.4 Troubleshooting problems of a motherboard. |
| **Unit– III Processor and BIOS** | 3a. Describe architecture of given type of Multi-core processors. <br> 3b. Explain the purpose of the given type of co-processors. <br> 3c. Explain the level and purpose of cache memory. <br> 3d. Write the procedure to configure the given BIOS setting. | 3.1 Processor : Common Features, Types of Processors, Basic Structure of CPU, Different levels of cache, system bus, clock speed, packaging <br> 3.2 Multiple Core Processors: Description, Two core processor architecture and multi-core processor architecture <br> 3.3 Co-processors: Graphics, Math. <br> 3.4 BIOS: Basic Input Output System Services, Bios Interaction, date and time, Boot device priority, boot setting configuration, password security. |
| **Unit– IV Hard Disk** | 4a. Describe features of the given type of hard disk interface. <br> 4b. Describe features of the given type of disk structure. <br> 4c. Explain characteristics of the given disk performance parameter. <br> 4d. Write the procedure to partition the given HDD. <br> 4e. Describe the given type of file system. | 4.1 Hard Disk Drive <br> 4.2 Hard Disk Interfaces: EIDE, Serial ATA, SCSI, USB and IEEE 1394 (Firewire), RAID, Solid State Drive (laptop) <br> 4.3 Disk structure : Heads, Tracks, Sectors, Cylinders, Cluster, Landing zone, MBR, Zone bit recording <br> 4.4 Disk performance parameters Characteristics: Seeks and Latency, Data Transfer Rate <br> 4.5 File system: FAT16, FAT32, NTFS, Unix file system, EXT2/EXT3, RAID |

| Unit | Unit Outcomes (UOs)<br>(in cognitive domain) | Topics and Sub-topics |
|------|---------------------------------------------|------------------------|
| Unit– V<br>I/O and<br>Modem | 5a. Describe features of the given I/O device.<br>5b. Write steps to troubleshoot the given peripheral device<br>5c. Explain use of the given I/O cable.<br>5d. Explain features of given type of Interface.<br>5e. Describe the procedure to troubleshoot the given network problem. | 5.1 Troubleshoot I/O devices: Keyboard, Switches, Mouse, Scanners, Webcam, Monitors, Printers, Speaker and Mike, LCD Projector<br>5.2 I/O Cables: Specification of I/O Cables, Types of I/O cables, Types of I/O Ports, Internal and External modem, Block diagram and specifications.<br>5.3 Network Interface: Definition of network interface, Types of network interface, troubleshooting of network connectivity, Antivirus |
| Unit–VI<br>Power<br>Supply | 6a. Describe features and working of the given SMPS<br>6b. Describe features and working of the given UPS.<br>6c. Differentiate the salient features of the specified type of UPS.<br>6d. Describe the steps to troubleshoot the given tpe of SMPS. | 6.1 Purpose and Features of SMPS, Working of SMPS<br>6.2 Fault finding in power supply<br>6.3 Uninterrupted Power Supply: Characteristics of UPS, Types of UPS, online and offline<br>6.4 Preventive Maintenance of Power Supply |

*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
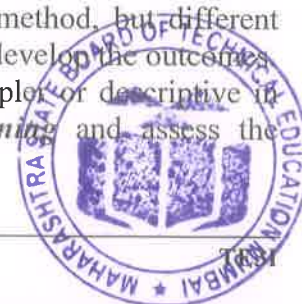-Not Applicable --

## 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:
 a.    Prepare specification chart of different types/family of processors (Ex. Intel/AMD )
 b.    Prepare journal of practical.
 c.    Prepare a presentation to display Layout of different motherboards and different System components and present it in groups.

## 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. Show video/animation films to explain handling/functioning of different instruments.
h. Continuously observe and monitor the performance of students in Lab/Workshop

## 12. SUGGESTED MICRO-PROJECTS

*Only one micro-project* is planned to be undertaken by a student assigned to him/her in the beginning of the semester. S/he ought to submit it by the end of the semester to develop the industry oriented COs. Each micro-project should encompass two or more COs which are in fact, an integration of PrOs, UOs and ADOs. The micro-project could be industry application based, internet-based, workshop-based, laboratory-based or field-based. 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.*

In the first four semesters, the micro-project could be group-based. However, in higher semesters, it should 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. A suggestive list is given here. Similar micro-projects could be added by the concerned faculty:

a. **SMPS**: List down the components available in SMPS. Measure different output voltages from SMPS.
b. **Computer motherboard**: Prepare brief report by identifying different electronics components in a given motherboard. Classify them in passive and active components.
c. **Microprocessor**: Prepare a small report of different microprocessors being used in industry (Any four) by doing market survey.
d. **Computer Specifications**: Prepare a small report on major specification of different types of computer systems available in your lab.
e. **Peripheral Specifications**: Prepare a small report based on technological differences and installation procedure of printers and scanners.
f. **Network Layout**: Prepare a small report by doing survey of computer labs. List various networking devices/components with its application.

## 13. SUGGESTED LEARNING RESOURCES

| S. No. | Title of Book | Author | Publication |
|--------|---------------|--------|-------------|
| 1. | The computer hardware installation, interfacing, troubleshooting and maintenance | James, K.L. | PHI Learning, New Delhi, 2014 ISBN: 978-81-203-4798-4 |
| 2. | Comdex: Hardware and Networking Course Kit | Gupta, Vikas | Dreamtech Press, New Delhi ISBN: 978-93-5119-265-7 |
| 3. | The Complete PC Upgrade And maintenance Guide | Minasi, Mark | BPB Publication, New Delhi ISBN:978-81-265-0XX71 |
| 4. | Computer Architecture and Maintenance Vol.1 | Kadam, Sachin | Shroff Publication, Mumbai ISBN: 978-93-80230244 |

## 14.    SOFTWARE/LEARNING WEBSITES
   a.    http://www.howstuffworks.com/
   b.    http://www.gcflearnfree.org/computerbasics/keeping-your-computer-clean/1/
   c.    https://www.youtube.com/watch?v=4iaxOUYalJU
   d.    http://www.instructables.com/id/Computer-Assembly/