# GUJARAT TECHNOLOGICAL UNIVERSITY

ADVANCE ENGINEERING MATHS
**SUBJECT CODE**: 2130002
B.E. 3RD SEMESTER

**Type of course:** Engineering Mathematics

**Prerequisite:** The course follows from Calculus, Linear algebra

**Rationale:** Mathematics is a language of Science and Engineering

**Teaching and Examination Scheme:**

| Teaching Scheme | | | Credits | Examination Marks | | | | | | Total Marks |
|---|---|---|---|---|---|---|---|---|---|---|
| L | T | P | C | Theory Marks | | | Practical Marks | | | |
| | | | | ESE (E) | PA (M) | | PA (V) | | PA (I) | |
| | | | | | PA | ALA | ESE | OEP | | |
| 3 | 2 | 0 | 5 | 70 | 20 | 10 | 30 | 0 | 20 | 150 |

**Content:**

| Sr. No. | Topics | Teaching Hrs. | Module Weightage |
|---|---|---|---|
| **1** | **Introduction to Some Special Functions:** Gamma function, Beta function, Bessel function, Error function and complementary Error function, Heaviside's function, pulse unit height and duration function, Sinusoidal Pulse function, Rectangle function, Gate function, Dirac's Delta function, Signum function, Saw tooth wave function, Triangular wave function, Halfwave rectified sinusoidal function, Full rectified sine wave, Square wave function. | 02 | 4 |
| **2** | **Fourier Series and Fourier integral:** Periodic function, Trigonometric series, Fourier series, Functions of any period, Even and odd functions, Half-range Expansion, Forced oscillations, Fourier integral | 05 | 10 |
| **3** | **Ordinary Differential Equations and Applications:** First order differential equations: basic concepts, Geometric meaning of $y' = f(x,y)$ Direction fields, Exact differential equations, Integrating factor, Linear differential equations, Bernoulli equations, Modeling , Orthogonal trajectories of curves.Linear differential equations of second and higher order: Homogeneous linear differential equations of second order, Modeling: Free Oscillations, Euler- Cauchy Equations, Wronskian, Non homogeneous equations, Solution by undetermined coefficients, Solution by variation of parameters, Modeling: free Oscillations resonance and Electric circuits, Higher order linear differential equations, Higher order homogeneous with constant coefficient, Higher order non homogeneous equations. Solution by [1/f(D)] r(x) method for finding particular integral. | 11 | 20 |
| **4** | **Series Solution of Differential Equations:** Power series method, Theory of power series methods, Frobenius method. | 03 | 6 |
| **5** | **Laplace Transforms and Applications:** Definition of the Laplace transform, Inverse Laplace transform, Linearity, Shifting theorem, Transforms of derivatives and integrals Differential equations, Unit step function Second shifting theorem, | 09 | 15 |

| | | | |
|---|---|---|---|
| | Dirac's delta function, Differentiation and integration of transforms, Convolution and integral equations, Partial fraction differential equations, Systems of differential equations | | |
| **6** | **Partial Differential Equations and Applications:** Formation PDEs, Solution of Partial Differential equations f(x,y,z,p,q) = 0, Nonlinear PDEs first order, Some standard forms of nonlinear PDE, Linear PDEs with constant coefficients,Equations reducible to Homogeneous linear form, Classification of second order linear PDEs.Separation of variables use of Fourier series, D'Alembert's solution of the wave equation,Heat equation: Solution by Fourier series and Fourier integral | 12 | 15 |

**Reference Books:**


1. Advanced Engineering Mathematics (8th Edition), by E. Kreyszig, Wiley-India (2007).
2. Engineering Mathematics Vol 2, by Baburam, Pearson
3. W. E. Boyce and R. DiPrima, Elementary Differential Equations (8th Edition), John Wiley (2005)
4. R. V. Churchill and J. W. Brown, Fourier series and boundary value problems (7th Edition), McGraw-Hill (2006).
5. T.M.Apostol, Calculus , Volume-2 ( 2nd Edition ), Wiley Eastern , 1980


**Course Outcome:**

After learning the course the students should be able to

1. Fourier Series and Fourier Integral
   - Identify functions that are periodic. Determine their periods.
   - Find the Fourier series for a function defined on a closed interval.
   - Find the Fourier series for a periodic function.
   - Recall and apply the convergence theorem for Fourier series.
   - Determine whether a given function is even, odd or neither.
   - Sketch the even and odd extensions of a function defined on the interval [0,L].
   - Find the Fourier sine and cosine series for the function defined on [0,L]
2. Ordinary Differential Equations and Their Applications
   - Model physical processes using differential equations.
   - Solve basic initial value problems, obtain explicit solutions if possible.
   - Characterize the solutions of a differential equation with respect to initial values.
   - Use the solution of an initial value problem to answer questions about a physical system.
   - Determine the order of an ordinary differential equation. Classify an ordinary differential equation as linear or nonlinear.
   - Verify solutions to ordinary differential equations.
   - Identify and solve first order linear equations.
   - Analyze the behavior of solutions.
   - Analyze the models to answer questions about the physical system modeled.
   - Recall and apply the existence and uniqueness theorem for first order linear differential equations.
   - Identify whether or not a differential equation is exact.
   - Use integrating factors to convert a differential equation to an exact equation and then solve.
   - Solve second order linear differential equations with constant coefficients that have a characteristic equation with real and distinct roots.
   - Describe the behavior of solutions.
   - Recall and verify the principal of superposition for solutions of second order linear differential equations.
   - Evaluate the Wronskian of two functions.

- Determine whether or not a pair of solutions of a second order linear differential equations constitute a fundamental set of solutions.
- Recall and apply Abel's theorem.
- Apply the method of reduction of order to find a second solution to a given differential equation.
- Apply the method of undetermined coefficients to solve non-homogeneous second order linear differential equations.
- Model undammed mechanical vibrations with second order linear differential equations, and then solve. Analyze the solution. In particular, evaluate the frequency, period, amplitude, phase shift, and the position at a given time.
- Define critically damped and over damped. Identify when these conditions exist in a system.
- Describe the phenomena of beats and resonance. Determine the frequency at which resonance occurs.
- Recall the definition of linear independence for a finite set of functions. Determine whether a set of functions is linearly independent or linearly dependent.
- Use the method of variation of parameters to solve non-homogeneous higher order linear differential equations.

3. Series Solution of Differential Equations

- Manipulate expressions involving summation notation. Change the index of summation.
- Find the general solution of a differential equation using power series.
- Given an initial value problem, use the differential equation to inductively determine the terms in the power series of the solution, expanded about the initial value.

4. Laplace Transforms and Applications

- Sketch a piecewise defined function. Determine if it is continuous, piecewise continuous or neither.
- Evaluate Laplace transforms from the definition.
- Determine whether an infinite integral converges or diverges.
- Evaluate inverse Laplace transforms.
- Use Laplace transforms to solve initial value problems.
- Convert piecewise defined functions to functions defined in terms of step functions and vice versa.
- Find the Laplace transform of a piecewise defined function.
- Apply the shifting theorems to evaluate Laplace transforms and inverse Laplace transforms.
- Use Laplace transforms to solve differential equations with discontinuous forcing functions.
- Define an idealized unit impulse function.
- Use Laplace transforms to solve differential equations that involve impulse functions.
- Evaluate the Laplace transform of a convolution of functions.
- Use the convolution theorem to evaluate inverse Laplace transforms.

5. Partial Differential Equations and Applications

- Determine the order of a partial differential equation.
- Classify a partial differential equation as linear or nonlinear.
- Verify solutions to partial differential equations.
- Apply the method of separation of variables to solve partial differential equations, if possible.
- Find the solutions of heat conduction problems in a rod using separation of variables.
- Solve steady state heat conduction problems in a rod with various boundary conditions.
- Solve the wave equation that models the vibration of a string with fixed ends.
- Describe the motion of a vibrating string.

- Solve Laplace's equation over a rectangular region for various boundary conditions.
- Solve Laplace's equation over a circular region for various boundary conditions.

**List of Open Source Software/learning website:**

1. NPTEL
   http://www.cdeep.iitb.ac.in/nptel/Electrical%20&%20Comm%20Engg/Signals%20and%20System/Course_home4.30
   https://www.youtube.com/watch?v=DPg5T-YBQjU
   https://www.youtube.com/watch?v=7fJeo1fylKI
   https://www.youtube.com/watch?v=1FnBPmEWpus
   https://www.youtube.com/watch?v=dgDIQ0VA0pA
   https://www.youtube.com/watch?v=SoBs-YGQUdc
   https://www.youtube.com/watch?v=Fh8m6ZdFaqU

2. **Instructor(s):** Prof. Haynes Miller, Prof. Arthur Mattuck

   http://ocw.mit.edu/courses/mathematics/18-03-differential-equations-spring-2010/video-lectures/

3. **Instructor:** Prof. Haynes Miller, Prof. Arthur Mattuck, Dr. John Lewis

   http://ocw.mit.edu/courses/mathematics/18-03sc-differential-equations-fall-2011/

**ACTIVE LEARNING ASSIGNMENTS**: Preparation of power-point slides, which include videos, animations, pictures, graphics for better understanding theory and practical work – The faculty will allocate chapters/ parts of chapters to groups of students so that the entire syllabus to be covered. The power-point slides should be put up on the web-site of the College/ Institute, along with the names of the students of the group, the name of the faculty, Department and College on the first slide. The best three works should submit to GTU.

**GUJARAT TECHNOLOGICAL UNIVERSITY**

ENGINEERING ECONOMICS AND MANAGEMENT
**SUBJECT CODE:** 2130004
B.E. 3rd/4th SEMESTER

**Teaching and Examination Scheme:**

| Teaching Scheme | | | Credits | Examination Marks | | | | | | Total Marks |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Theory Marks | | | Practical Marks | | | |
| L | T | P | C | ESE (E) | PA (M) | | PA (V) | | PA (I) | |
| | | | | | PA | ALA | ESE | OEP | | |
| 3 | 0 | 0 | 3 | 70 | 20 | 10 | 0 | 0 | 0 | 100 |

**Content:**

| Sr. No | Topics | Hrs. | Module Weightage |
|---|---|---|---|
| 1. | Introduction to Economics; Definitions, Nature, Scope, Difference between Microeconomics & Macroeconomics<br>Theory of Demand & Supply; meaning, determinants, law of demand, law of supply, equilibrium between demand & supply<br>Elasticity; elasticity of demand, price elasticity, income elasticity, cross elasticity | 04 | 10% |
| 2. | Theory of production; production function, meaning, factors of production (meaning & characteristics of Land, Labour, capital & entrepreneur),<br>Law of variable proportions & law of returns to scale<br>Cost; meaning, short run & long run cost, fixed cost, variable cost, total cost, average cost, marginal cost, opportunity cost.<br>Break even analysis; meaning, explanation, numerical | 04 | 10% |
| 3. | Markets; meaning, types of markets & their characteristics ( Perfect Competition, Monopoly, Monopolistic Completion, Oligopoly)<br>National Income; meaning, stock and flow concept, NI at current price, NI at constant price, GNP, GDP, NNP,NDP, Personal income, disposal income. | 05 | 10% |
| 4. | Basic economic problems; Poverty-meaning, absolute & relative poverty, causes, measures to reduce<br>Unemployment: meaning, types, causes, remedies<br>Inflation; meaning, types, causes, measures to control | 04 | 10% |
| 5. | Money; meaning, functions, types, Monetary policy- meaning, objectives, tools, fiscal policy-meaning, objectives, tools<br>Banking; meaning, types, functions, Central Bank- RBI; its functions, concepts; CRR, bank rate, repo rate, reverse repo rate, SLR. | 04 | 10% |
| 6. | Introduction to Management; Definitions, Nature, scope<br>Management & administration, skill, types and roles of managers<br>Management Principles; Scientific principles, Administrative principles, Maslow's Hierarchy of needs theory | 04 | 11% |
| 7. | Functions of Management; Planning, Organizing, Staffing, Directing, Controlling ( meaning, nature and importance)<br>Organizational Structures; meaning, principles of organization, types-formal and informal, line, line & staff, matrix, hybrid (explanation with merits and demerits), span of control, departmentalization. | 05 | 11% |
| 8. | Introduction to Marketing management; Marketing Mix, concepts of marketing, demand forecasting and methods, market segmentation<br>Introduction to Finance Management; meaning, scope, sources, functions | 05 | 11% |
| 9. | Introduction to Production Management; definitions, objectives, functions, plant layout-types & factors affecting it, plant location- factors affecting it.<br>Introduction to Human Resource Management; definitions, objectives of manpower planning, process, sources of recruitment, process of selection | 05 | 11% |
| 10. | Corporate Social Responsibility; meaning, importance<br>Business Ethics; meaning, importance. | 02 | 6% |

**Reference Books:**


1. Engineering Economics, R.Paneerselvam, PHI publication
2. Fundamentals of Management: Essential Concepts and Applications, Pearson Education, Robbins S.P. and Decenzo David A.
3. Economics: Principles of Economics, N Gregory Mankiw, Cengage Learning
4. Principles and Practices of Management by L.M.Prasad
5. Principles of Management by Tripathy and Reddy
6. Modern Economic Theory, By Dr. K. K. Dewett & M. H. Navalur, S. Chand Publications


**Course Outcomes:** The course is intended to provide basic understanding of Economics and Management to engineering students with following aspects:

- To impart knowledge, with respect to concepts, principles and practical applications of Economics, which govern the functioning of a firm/organization under different market conditions.
- To help the students to understand the fundamental concepts and principles of management; the basic roles, skills, functions of management, various organizational structures and basic knowledge of marketing.

**ACTIVE LEARNING ASSIGNMENTS**: Preparation of power-point slides, which include videos, animations, pictures, graphics for better understanding theory. The faculty will allocate chapters/ parts of chapters to groups of students so that the entire syllabus to be covered. The power-point slides should be put up on the web-site of the College/ Institute, along with the names of the students of the group, the name of the faculty, Department and College on the first slide. The best three works should submit to GTU.

# GUJARAT TECHNOLOGICAL UNIVERSITY

DESIGN ENGINEERING
**SUBJECT CODE:** 2130005

**Teaching and Examination Scheme:**

| Teaching Scheme | | | Credits | Examination Marks | | | | | Total Marks |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Theory Marks | | | Practical Marks | | |
| L | T | P | C | ESE (E) | PA (M) | | PA (V) | PA (I) | |
| | | | | | PA | ALA | ESE | | |
| 0 | 0 | 3 | 3 | 0 | 0 | 0 | 80 | 20 | 100 |

## Design Engineering 1, 2 and 3

What is design? Design is a plan of a system, its implementation and utilization for attaining a goal. It is to change undesired situation into desired situation means to find solution for undesired/uncomfortable situation.
Designs can be for
(1) Technical systems (power plant)
(2) Educational systems (Montessori Method)
(3) Aesthetic systems (logo designs, advertisements)
(4) Legal systems
(5) Social, religious or cultural systems
(6) Theories, Models, etc.

Design thinking gives students a taste of the rich internal-remunerations associated with knowledge-creation and in curiosity and problem-driven contexts. Design need to satisfy technical functions, ergonomics functions, aesthetic functions, cost function and environment functions.

Essential features of Design:
Design solution of a problem starts with planned constructions for achieving goal/s. Designing means evolving goal oriented processes. At the beginning of the design process only goals are known while at the end, both the goals and plans are known and that to with more clarity. Goal and plans evolve together and they influencing each other. In designing process some goals are more important than others and similarly some plans are better than others. Designing does not guarantee that the design will work.

Design thinking process:
(1) Find goals or need
(2) Evaluate goals or need
(3) Generate proposals to satisfy goals
(4) Evaluate proposals
(5) Improve goals and proposals

**Teaching methodology:**
The design engineering should be with fun and should create excitement. It should be integrated theme across the various courses. It should promote the team work. Design is thinking and doing. The complete design process should be included in design engineering 1, 2 and 3. The prototype design must consider technical, aesthetic, ergonomics, cost and environmental requirements.

**Content:**

Design Engineering 1: (3 credits in Semester 3, 3 credits in Semester 4)
Introduction to product innovation process (Need-requirement-concept-detail-prototype-services-business)
Modules on: Task clarification and conceptualization: Problem-idea-solution-evaluation

- Problem identification
- Ideation
- Consolidation
- Evaluation

Project: identifying need to developing proof of concept to demonstrate solution selected

Students can tackle simple design problems with engineering content – posed by the teacher or based on a survey of real life concerns of the public. The second is more effective – the students "own the problem" - but has to be accepted by the teacher.

Examples: (a) A device to help carry heavy luggage to the upper floors of a building – a building that has no lifts. (b) Systems to ensure that water does not come out as a jet from the taps in the lower floors of a tall building. One can insist on multiple realistic solutions and all should be part of the submission along with statements of their shortcomings or advantages. Teacher should not entertain fancy solutions – based on fancy ideas - with no engineering or scientific basis.

Short lectures on the topics in the syllabus should parallel the activity.

Design Engineering 2: (3 credits in Semester 5, 3 credits in Semester 6)
Introduction to detail design
Modules on

- Design for performance, safety, reliability
- Design for ergonomics and aesthetics
- Design for manufacturability
- Design for cost, environment

Project: developing the concept into a detailed design with a functional prototype

Here one could ask students to develop products based on themes - "Garbage compactors, Energy from kitchen waste, etc" making sure that the problems identified by the students within the themes possess an engineering content and insisting on some facets of design for assembly, for manufacturability, .....and so on while preparing the design and the prototypes. One could encourage students to innovate, arrive at multiple solutions and conduct a detailed design of one of the solutions.

Prototyping requires funds and effort, so it pays to identify one subsystem of the design of the whole machine. One can insist on prototyping demonstrating at least that sub-system, if not the whole system.

Design Engineering 3: (3 credits in Semester 7, 3 credits in Semester 8)
Introduction to services and business planning
Modules on

- Design of services
- Intellectual property
- Materials and recourse planning
- Business planning

Project: developing a business model

OR

Research or Technology Development project
Modules on

- Detailed literature survey and to find out technology gap
- Intellectual property
- Re-evaluate prototype of DE-2 and proposal of novel idea

Project: developing a novel functional prototype

# GUJARAT TECHNOLOGICAL UNIVERSITY

## COMPUTER ENGINEERING (07) / INFORMATION TECHNOLOGY (16) / INFORMATION & COMMUNICATION TECHNOLOGY (32)

DATA STRUCTURES

**SUBJECT CODE:** 2130702

B.E. 3rd Semester

**Type of course:** Compulsory

**Prerequisite:** Computer Programming & utilization

**Rationale:** Data structure is a subject of primary importance in Information and Communication Technology. Organizing or structuring data is important for implementation of efficient algorithms and program development. Efficient problem solving needs the application of appropriate data structure during program development.

Understanding of data structures is essential and this facilitates the understanding of the language. The practice and assimilation of data structure techniques is essential for programming. The knowledge of „C" language and data structures will be reinforced by practical exercises during the course of study. The course will help students to develop the capability of selecting a particular data structure.

**Teaching and Examination Scheme:**

| Teaching Scheme | | | Credits | Examination Marks | | | | | | Total Marks |
|---|---|---|---|---|---|---|---|---|---|---|
| L | T | P | C | Theory Marks | | | Practical Marks | | | |
| | | | | ESE (E) | PA (M) | | PA (V) | | PA (I) | |
| | | | | | PA | ALA | ESE | OEP | | |
| 4 | 0 | 4 | 8 | 70 | 20 | 10 | 20 | 10 | 20 | 150 |

**Contents:**

| Sr. No. | Topics | Teaching Hrs. | Module Weightage |
|---|---|---|---|
| 1 | INTRODUCTION TO DATA STRUCTURE:<br>Data Management concepts, Data types – primitive and non-primitive, Performance Analysis and Measurement (Time and space analysis of algorithms-Average, best and worst case analysis), Types of Data Structures- Linear & Non Linear Data Structures. | 04 | 10 |
| 2 | LINEAR DATA STRUCTURE<br>Array: Representation of arrays, Applications of arrays, sparse matrix and its representation<br>Stack: Stack-Definitions & Concepts, Operations On Stacks, Applications of Stacks, Polish Expression, Reverse Polish Expression And Their Compilation, Recursion, Tower of Hanoi<br>Queue: Representation Of Queue, Operations On Queue, Circular Queue, Priority Queue, Array representation of Priority Queue, Double Ended Queue, Applications of Queue<br>Linked List: Singly Linked List, Doubly Linked list, | 13 | 30 |

| | | | |
|---|---|---|---|
| | Circular linked list ,Linked implementation of Stack, Linked implementation of Queue, Applications of linked list. | | |
| 3 | NONLINEAR DATA STRUCTURE :<br>Tree-Definitions and Concepts, Representation of binary tree, Binary tree traversal (Inorder, postorder, preorder), Threaded binary tree, Binary search trees, Conversion of General Trees To Binary Trees, Applications Of Trees-Some balanced tree mechanism, eg. AVL trees, 2-3 trees, Height Balanced, Weight Balance, Graph-Matrix Representation Of Graphs, Elementary Graph operations,(Breadth First Search, Depth First Search, Spanning Trees, Shortest path, Minimal spanning tree ) | 13 | 30 |
| 4 | HASHING AND FILE STRUCTURES :<br>Hashing: The symbol table, Hashing Functions, Collision-Resolution Techniques,<br>File Structure: Concepts of fields, records and files, Sequential, Indexed and Relative/Random File Organization, Indexing structure for index files, hashing for direct files, Multi-Key file organization and access methods. | 06 | 15 |
| 5 | Sorting & Searching:<br>Sorting – Bubble Sort, Selection Sort, Quick Sort, Merge Sort Searching – Sequential Search and Binary Search | 06 | 15 |

**Reference Books:**


1. An Introduction to Data Structures with Applications. by Jean-Paul Tremblay & Paul G. Sorenson Publisher-Tata McGraw Hill.
2. Data Structures using C & C++ -By Ten Baum Publisher – Prenctice-Hall International.
3. Fundamentals of Computer Algorithms by Horowitz, Sahni,Galgotia Pub. 2001 ed.
4. Fundamentals of Data Structures in C++-By Sartaj Sahani.
5. Data Structures: A Pseudo-code approach with C -By Gilberg & Forouzan Publisher-Thomson Learning.


**Course Outcome:**

After learning the course the students should be able:

1. Differentiate primitive and non primitive structures
2. Design and apply appropriate data structures for solving computing problems.
3. Apply sorting and searching algorithms to the small and large data sets.

**List of Practical:**

At least 10 practical should be performed by students using programming language.

1. Introduction to pointers. Call by Value and Call by reference.
2. Introduction to Dynamic Memory Allocation. DMA functions malloc(), calloc(), free() etc.
3. Implement a program for stack that performs following operations using array.
   (a) PUSH (b) POP (c) PEEP (d) CHANGE (e) DISPLAY
4. Implement a program to convert infix notation to postfix notation using stack.
5. Write a program to implement QUEUE using arrays that performs following operations (a) INSERT (b) DELETE (c) DISPLAY

5. Write a program to implement Circular Queue using arrays that performs following operations. (a) INSERT (b) DELETE (c) DISPLAY
6. Write a menu driven program to implement following operations on the singly linked list.
    (a) Insert a node at the front of the linked list.
    (b) Insert a node at the end of the linked list.
    (c) Insert a node such that linked list is in ascending order.(according to info. Field)
    (d) Delete a first node of the linked list.
    (e) Delete a node before specified position.
    (f) Delete a node after specified position.
7. Write a program to implement stack using linked list.
8. Write a program to implement queue using linked list.
9. Write a program to implement following operations on the doubly linked list.
    (a) Insert a node at the front of the linked list.
    (b) Insert a node at the end of the linked list.
    (c) Delete a last node of the linked list.
    (d) Delete a node before specified position.
10. Write a program to implement following operations on the circular linked list.
    (a) Insert a node at the end of the linked list.
    (b) Insert a node before specified position.
    (c) Delete a first node of the linked list.
    (d) Delete a node after specified position.
10. Write a program which create binary search tree.
11. Implement recursive and non-recursive tree traversing methods inorder, preorder and post-order traversal.
12. Write a program to implement Queue Sort
13. Write a program to implement Merge Sort
14. Write a program to implement Bubble Sort
15. Write a program to implement Binary Search.

**Open Ended Problem:**

1) Simulate a simple dictionary. Assume each character contains at least 10 vocabularies. Create an index page for all characters. Retrieve the word using index value. Assume that the index characters from a to z.
2) Design a simple search engine to display the possible websites upon entering a search query. Use suitable data structure for storage and retrieval.
3) Design and Develop the index for a text book of at least 100 pages using alphabets.
4) Design a Student Prerequisite Subjects Management System requires the use of linked list or tree to store different courses and their prerequisites and based on this list it will allow any student to take any course or not.
5) Write a program that uses the radix sort to sort 1000 random digits. Print the data before and after the sort. Each sort bucket should be a linked list. At the end of the sort, the data should be in the original array.

**ACTIVE LEARNING ASSIGNMENTS**: Preparation of power-point slides, which include videos, animations, pictures, graphics for better understanding theory and practical work – The faculty will allocate chapters/ parts of chapters to groups of students so that the entire syllabus to be covered. The power-point slides should be put up on the web-site of the College/ Institute, along with the names of the students of the group, the name of the faculty, Department and College on the first slide. The best three works should submit to GTU.

# GUJARAT TECHNOLOGICAL UNIVERSITY

**COMPUTER ENGINEERING (07) / INFORMATION TECHNOLOGY (16) / INFORMATION & COMMUNICATION TECHNOLOGY (32)**
DATABASE MANAGEMENT SYSTEMS
**SUBJECT CODE:** 2130703
B.E. 3rd Semester

**Type of course:** Compulsory

**Prerequisite:**
(1) Elementary knowledge about computers including some experience using UNIX or Windows.
(2) Computer Programming & Utilization
(3) Knowledge about data structures and algorithms, corresponding to the basic course on Data Structures and Algorithms.

**Rationale:** A database management system (DBMS) is designed to manage a large body of information. Data management involves both defining structures for storing information and providing mechanisms for manipulating the information. In addition, the database system must provide for the safety of the stored information, despite system crashes or attempts at unauthorized access. If data are to be shared among several users, the system must avoid possible anomalous results due to multiple users concurrently accessing the same data.

Examples of the use of database systems include airline reservation systems, company payroll and employee information systems, banking systems, credit card processing systems, and sales and order tracking systems.

A major purpose of a database system is to provide users with an abstract view of the data. That is, the system hides certain details of how the data are stored and maintained. Thereby, data can be stored in complex data structures that permit efficient retrieval, yet users see a simplified and easy-to-use view of the data. The lowest level of abstraction, the physical level, describes how the data are actually stored and details the data structures. The next-higher level of abstraction, the logical level, describes what data are stored, and what relationships exist among those data. The highest level of abstraction, the view level, describes parts of the database that are relevant to each user; application programs used to access a database form part of the view level.

**Teaching and Examination Scheme:**

| Teaching Scheme | | | Credits | Examination Marks | | | | | | Total Marks |
|---|---|---|---|---|---|---|---|---|---|---|
| L | T | P | C | Theory Marks | | | Practical Marks | | | |
| | | | | ESE (E) | PA (M) | | PA (V) | | PA (I) | |
| | | | | | PA | ALA | ESE | OEP | | |
| 4 | 0 | 4 | 8 | 70 | 20 | 10 | 20 | 10 | 20 | 150 |

**Contents:**

| Sr. No. | Topics | Teaching Hrs. | Module Weightage |
|---|---|---|---|
| 1 | Introductory concepts of DBMS :<br>Introduction and applications of DBMS, Purpose of data base, Data, Independence, Database System architecture- levels, Mappings, Database, users and DBA | 02 | 05 |

| | | | |
|---|---|---|---|
| 2 | Relational Model :<br>Structure of relational databases, Domains, Relations, Relational algebra – fundamental operators and syntax, relational algebra queries, tuple relational calculus | 03 | 10 |
| 3 | Entity-Relationship model :<br>Basic concepts, Design process, constraints, Keys, Design issues, E-R diagrams, weak entity sets, extended E-R features – generalization, specialization, aggregation, reduction to E-R database schema | 04 | 10 |
| 4 | Relational Database design :<br>Functional Dependency – definition, trivial and non-trivial FD, closure of FD set, closure of attributes, irreducible set of FD, Normalization – 1Nf, 2NF, 3NF, Decomposition using FD- dependency preservation, BCNF, Multi-valued dependency, 4NF, Join dependency and 5NF | 05 | 15 |
| 5 | Query Processing & Query Optimization :<br>Overview, measures of query cost, selection operation, sorting, join, evaluation of expressions, transformation of relational expressions, estimating statistics of expression results, evaluation plans, materialized views | 04 | 10 |
| 6 | Transaction Management :<br>Transaction concepts, properties of transactions, serializability of transactions, testing for serializability, System recovery, Two- Phase Commit protocol, Recovery and Atomicity, Log-based recovery, concurrent executions of transactions and related problems, Locking mechanism, solution to concurrency related problems, deadlock, , two-phase locking protocol, Isolation, Intent locking | 09 | 20 |
| 7 | Security:<br>Introduction, Discretionary access control, Mandatory Access Control, Data Encryption | 02 | 05 |
| 8 | SQL Concepts :<br>Basics of SQL, DDL,DML,DCL, structure – creation, alteration, defining constraints – Primary key, foreign key, unique, not null, check, IN operator,<br>Functions - aggregate functions, Built-in functions – numeric, date, string functions, set operations, sub-queries, correlated sub-queries, Use of group by, having, order by, join and its types, Exist, Any, All , view and its types. transaction control commands – Commit, Rollback, Savepoint | 10 | 20 |
| 9 | PL/SQL Concepts :<br>Cursors, Stored Procedures, Stored Function, Database Triggers | 03 | 05 |

**Reference Books:**


1. An introduction to Database Systems, C J Date, Addition-Wesley.
2. Database System Concepts, Abraham Silberschatz, Henry F. Korth & S. Sudarshan, McGraw Hill.
3. Understanding SQL by Martin Gruber, BPB
4. SQL- PL/SQL by Ivan bayross

5. Oracle – The complete reference – TMH /oracle press

**Course Outcome:**

After learning the course the students should be able:

1. Evaluate business information problem and find the requirements of a problem in terms of data.
2. Understand the uses the database schema and need for normalization.
3. Design the database schema with the use of appropriate data types for storage of data in database.
4. Use different types of physical implementation of database
5. Use database for concurrent use.
6. Backup data from database.

**List of Practical:**

1. **To study DDL-create and DML-insert commands**.

**(i)** Create tables according to the following definition.

CREATE TABLE DEPOSIT (ACTNO VARCHAR2(5) ,CNAME VARCHAR2(18) , BNAME VARCHAR2(18) , AMOUNT NUMBER(8,2) ,ADATE DATE);

CREATE TABLE BRANCH(BNAME VARCHAR2(18),CITY VARCHAR2(18));

CREATE TABLE CUSTOMERS(CNAME VARCHAR2(19) ,CITY VARCHAR2(18));

CREATE TABLE BORROW(LOANNO VARCHAR2(5), CNAME VARCHAR2(18), BNAME VARCHAR2(18), AMOUNT NUMBER (8,2));

**(ii)** Insert the data as shown below.

**DEPOSIT**

| ACTNO | CNAME | BNAME | AMOUNT | ADATE |
|---|---|---|---|---|
| 100 | ANIL | VRCE | 1000.00 | 1-MAR-95 |
| 101 | SUNIL | AJNI | 5000.00 | 4-JAN-96 |
| 102 | MEHUL | KAROLBAGH | 3500.00 | 17-NOV-95 |
| 104 | MADHURI | CHANDI | 1200.00 | 17-DEC-95 |
| 105 | PRMOD | M.G.ROAD | 3000.00 | 27-MAR-96 |
| 106 | SANDIP | ANDHERI | 2000.00 | 31-MAR-96 |
| 107 | SHIVANI | VIRAR | 1000.00 | 5-SEP-95 |
| 108 | KRANTI | NEHRU PLACE | 5000.00 | 2-JUL-95 |
| 109 | MINU | POWAI | 7000.00 | 10-AUG-95 |

**BRANCH**

| | |
|---|---|
| VRCE | NAGPUR |
| AJNI | NAGPUR |
| KAROLBAGH | DELHI |
| CHANDI | DELHI |
| DHARAMPETH | NAGPUR |
| M.G.ROAD | BANGLORE |
| ANDHERI | BOMBAY |
| VIRAR | BOMBAY |
| NEHRU PLACE | DELHI |
| POWAI | BOMBAY |

**CUSTOMERS**

| | |
|---|---|
| ANIL | CALCUTTA |
| SUNIL | DELHI |
| MEHUL | BARODA |
| MANDAR | PATNA |
| MADHURI | NAGPUR |
| PRAMOD | NAGPUR |
| SANDIP | SURAT |
| SHIVANI | BOMBAY |
| KRANTI | BOMBAY |
| NAREN | BOMBAY |

**BORROW**

| LOANNO | CNAME | BNAME | AMOUNT |
|---|---|---|---|
| 201 | ANIL | VRCE | 1000.00 |
| 206 | MEHUL | AJNI | 5000.00 |
| 311 | SUNIL | DHARAMPETH | 3000.00 |
| 321 | MADHURI | ANDHERI | 2000.00 |
| 375 | PRMOD | VIRAR | 8000.00 |
| 481 | KRANTI | NEHRU PLACE | 3000.00 |

From the above given tables perform the following queries:

(1) Describe deposit, branch.
(2) Describe borrow, customers.
(3) List all data from table DEPOSIT.
(4) List all data from table BORROW.
(5) List all data from table CUSTOMERS.
(6) List all data from table BRANCH.
(7) Give account no and amount of depositors.
(8) Give name of depositors having amount greater than 4000.
(9) Give name of customers who opened account after date '1-12-96'.

2. **Create the below given table and insert the data accordingly**.

Create Table Job (job_id, job_title, min_sal, max_sal)

| COLUMN NAME | DATA TYPE |
|---|---|
| job_id | Varchar2(15) |
| job_title | Varchar2(30) |
| min_sal | Number(7,2) |
| max_sal | Number(7,2) |

Create table Employee (emp_no, emp_name, emp_sal, emp_comm, dept_no)

| COLUMN NAME | DATA TYPE |
|---|---|
| emp_no | Number(3) |
| emp_name | Varchar2(30) |
| emp_sal | Number(8,2) |
| emp_comm | Number(6,1) |
| dept_no | Number(3) |

Create table deposit(a_no,cname,bname,amount,a_date).

| COLUMN NAME | DATA TYPE |
|---|---|
| a_no | Varchar2(5) |
| cname | Varchar2(15) |
| bname | Varchar2(10) |
| amount | Number(7,2) |
| a_date | Date |

Create table borrow(loanno,cname,bname,amount).

| COLUMN NAME | DATA TYPE |
|---|---|
| loanno | Varchar2(5) |
| cname | Varchar2(15) |
| bname | Varchar2(10) |
| amount | Varchar2(7,2) |

Insert following values in the table **Employee**.

| emp_n | emp_name | emp_sal | emp_comm | dept _no |
|---|---|---|---|---|
| 101 | Smith | 800 | | 20 |
| 102 | Snehal | 1600 | 300 | 25 |
| 103 | Adama | 1100 | 0 | 20 |
| 104 | Aman | 3000 | | 15 |
| 105 | Anita | 5000 | 50,000 | 10 |
| 106 | Sneha | 2450 | 24,500 | 10 |
| 107 | Anamika | 2975 | | 30 |

Insert following values in the table **job**.

| job_id | job_name | min_sal | max_sal |
|---|---|---|---|
| IT_PROG | Programmer | 4000 | 10000 |
| MK_MGR | Marketing manager | 9000 | 15000 |
| FI_MGR | Finance manager | 8200 | 12000 |
| FI_ACC | Account | 4200 | 9000 |
| LEC | Lecturer | 6000 | 17000 |
| COMP_OP | Computer Operator | 1500 | 3000 |

Insert following values in the table **deposit**.

| A_no | cname | Bname | Amount | date |
|---|---|---|---|---|
| 101 | Anil | andheri | 7000 | 01-jan-06 |
| 102 | sunil | virar | 5000 | 15-jul-06 |
| 103 | jay | villeparle | 6500 | 12-mar-06 |
| 104 | vijay | andheri | 8000 | 17-sep-06 |

| | | | | |
|---|---|---|---|---|
| 105 | keyur | dadar | 7500 | 19-nov-06 |
| 106 | mayur | borivali | 5500 | 21-dec-06 |

Perform following queries

(1) Retrieve all data from **employee, jobs and deposit.**
(2) Give details of account no. and deposited rupees of customers having account opened between dates **01-01-06 and 25-07-06**.
(3) Display all jobs with minimum salary is greater than 4000.
(4) Display name and salary of employee whose department no is 20. Give alias name to name of employee.
(5) Display employee no,name and department details of those employee whose department lies **in(10,20)**

**To study various options of <u>LIKE</u> predicate**

(1) Display all employee whose name start with 'A' and third character is ' 'a'.

(2) Display name, number and salary of those employees whose name is 5 characters long and first three characters are 'Ani'.

(3) Display the non-null values of employees and also employee name second character should be 'n' and string should be 5 character long.

(4) Display the null values of employee and also employee name's third character should be 'a'.
(5) What will be output if you are giving LIKE predicate as '%_%' ESCAPE '\'

**3. To Perform various data manipulation commands, aggregate functions and sorting concept on all created tables.**

(1) List total deposit from deposit.
(2) List total loan from karolbagh branch
(3) Give maximum loan from branch vrce.
(4) Count total number of customers
(5) Count total number of customer's cities.
(6) Create table supplier from employee with all the columns.
(7) Create table sup1 from employee with first two columns.
(8) Create table sup2 from employee with no data
(9) Insert the data into sup2 from employee whose second character should be 'n' and string should be 5 characters long in employee name field.

(10) Delete all the rows from sup1.
(11) Delete the detail of supplier whose sup_no is 103.
(12) Rename the table sup2.
(13) Destroy table sup1 with all the data.
(14) Update the value dept_no to 10 where second character of emp. name is 'm'.
(15) Update the value of employee name whose employee number is 103.

**4. To study Single-row functions.**

(1) Write a query to display the current date. Label the column Date

(2) For each employee, display the employee number, job, salary, and salary increased by 15% and expressed as a whole number. Label the column New Salary
(3) Modify your query no 4.(2) to add a column that subtracts the old salary from the new salary. Label the column Increase
(4) Write a query that displays the employee's names with the first letter capitalized and all other letters lowercase, and the length of the names, for all employees whose name starts with J, A, or M. Give each column an appropriate label. Sort the results by the employees' last names.
(5) Write a query that produces the following for each employee: <employee last name> earns <salary> monthly
(6) Display the name, hire date, number of months employed and day of the week on which the employee has started. Order the results by the day of the week starting with Monday**.**
(7) Display the hiredate of emp in a format that appears as Seventh of June 1994 12:00:00 AM.
(8) Write a query to calculate the annual compensation of all employees (sal+comm.).

**5. Displaying data from Multiple Tables (join)**

(1) Give details of customers ANIL.
(2) Give name of customer who are borrowers and depositors and having living city nagpur
(3) Give city as their city name of customers having same living branch.
(4) Write a query to display the last name, department number, and department name for all employees.
(5) Create a unique listing of all jobs that are in department 30. Include the location of the department in the output
(6) Write a query to display the employee name, department number, and department name for all employees who work in NEW YORK.
(7) Display the employee last name and employee number along with their manager's last name and manager number. Label the columns Employee, Emp#, Manager, and Mgr#, respectively.
(8) Create a query to display the name and hire date of any employee hired after employee SCOTT**.**

**6. To apply the concept of Aggregating Data using Group functions.**

(1) List total deposit of customer having account date after 1-jan-96.
(2) List total deposit of customers living in city Nagpur.
(3) List maximum deposit of customers living in bombay.
(4) Display the highest, lowest, sum, and average salary of all employees. Label the columns Maximum, Minimum, Sum, and Average, respectively. Round your results to the nearest whole number.
(5) Write a query that displays the difference between the highest and lowest salaries. Label the column DIFFERENCE.
(6) Create a query that will display the total number of employees and, of that total, the number of employees hired in 1995, 1996, 1997, and 1998
(7) Find the average salaries for each department without displaying the respective department numbers.
(8) Write a query to display the total salary being paid to each job title, within each department.
(9) Find the average salaries > 2000 for each department without displaying the respective department numbers.
(10) Display the job and total salary for each job with a total salary amount exceeding 3000, in which excludes president and sorts the list by the total salary.

(11) List the branches having sum of deposit more than 5000 and located in city bombay.

**7. To solve queries using the concept of sub query.**

(1) Write a query to display the last name and hire date of any employee in the same department as SCOTT. Exclude SCOTT

(2) Give name of customers who are depositors having same branch city of mr. sunil.
(3) Give deposit details and loan details of customer in same city where pramod is living.
(4) Create a query to display the employee numbers and last names of all employees who earn more than the average salary. Sort the results in ascending order of salary.
(5) Give names of depositors having same living city as mr. anil and having deposit amount greater than 2000
(6) Display the last name and salary of every employee who reports to ford.
(7) Display the department number, name, and job for every employee in the Accounting department**.**
(8) List the name of branch having highest number of depositors.
(9) Give the name of cities where in which the maximum numbers of branches are located.
(10) Give name of customers living in same city where maximum depositors are located.

**8. Manipulating Data**

(1) Give 10% interest to all depositors.
(2) Give 10% interest to all depositors having branch vrce
(3) Give 10% interest to all depositors living in nagpur and having branch city bombay.
(4) Write a query which changes the department number of all employees with empno 7788's job to employee 7844'current department number.
(5) Transfer 10 Rs from account of anil to sunil if both are having same branch.
(6) Give 100 Rs more to all depositors if they are maximum depositors in their respective branch.
(7) Delete depositors of branches having number of customers between 1 to 3.
(8) Delete deposit of vijay.
(9) Delete borrower of branches having average loan less than 1000.

**9.** To apply the concept of security and privileges.

10. To study Transaction control commands

**Open Ended Problem:**

1) Develop a Online leave management system, Leave Management process includes defining the leave types, assigning entitlements and calculating carry over leaves, employees applying for leaves, managers approving or rejecting the leave requests, importing the leave data into payroll for calculations etc.
2) Develop a Library management system, where indexing of book according to the author or alphabetical order can be done. Issuing of books to the student can be managed and searching of books.
3) Make a SQL data base of student details and collaborate it with student semester performance and display each student performance individually.
4) Develop Inventory control and procurements for school management systems. School does have regular purchase of chalk box, chairs, benches etc.

**ACTIVE LEARNING ASSIGNMENTS**: Preparation of power-point slides, which include videos, animations, pictures, graphics for better understanding theory and practical work – The faculty will

allocate chapters/ parts of chapters to groups of students so that the entire syllabus to be covered. The power-point slides should be put up on the web-site of the College/ Institute, along with the names of the students of the group, the name of the faculty, Department and College on the first slide. The best three works should submit to GTU.

# GUJARAT TECHNOLOGICAL UNIVERSITY

## ELECTRONICS (10) / ELECTRONICS & COMMUNICATION (11) /COMPUTER ENGINEERING (07) / INFORMATION TECHNOLOGY (16) / INFORMATION & COMMUNICATION TECHNOLOGY (32)

DIGITAL ELECTRONICS

**SUBJECT CODE:** 2131004

B.E. 3RD SEMESTER

**Type of course:** Analysis and Design of Digital Circuits

**Prerequisite:** Basic Electronics and Number Systems

**Rationale:** The students need to learn basic concepts of digital circuits and system which leads to design of complex digital system such as microprocessors. The students need to know combinational and sequential circuits using digital logic fundamentals. This is the first course by which students get exposure to digital electronics world.

**Teaching and Examination Scheme:**

| Teaching Scheme | | | Credits | Examination Marks | | | | | | Total Marks |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Theory Marks | | | Practical Marks | | | |
| L | T | P | C | ESE (E) | PA (M) | | PA (V) | | PA (I) | |
| | | | | | PA | ALA | ESE | OEP | | |
| 4 | 0 | 2 | 6 | 70 | 20 | 10 | 20 | 10 | 20 | 150 |

**Content:**

| Sr. No. | Content | Total Hrs | % Weightage |
|---|---|---|---|
| **1** | Binary Systems and Logic Circuits: The Advantage of Binary, Number Systems, The Use of Binary in Digital Systems, Logic Gates, Logic Family Terminology. | **3** | **5** |
| **2** | Boolean Algebra and Mapping Methods: Boolean Algebra, Karnaugh Maps, Variable Entered Maps, Realizing Logic Function with Gates, Combinational Design Examples. | **7** | **15** |
| **3** | Logic Function Realization with MSI Circuits: Combinational Logic with Multiplexers and Decoders, Standard Logic Functions with MSI Circuits, Design Problem Using MSI Circuits. | **7** | **15** |
| **4** | Flip Flops, Counters and Registers: Flip Flops and its Applications | **8** | **15** |
| **5** | Introduction to State Machines: The Need for State Machines, The State Machine, Basic Concepts in State Machine Analysis. | **3** | **5** |
| **6** | Synchronous State Machine Design: Sequential Counters, State Changes Referenced to Clock, Number of State Flip-Flops, Input Forming Logic, Output Forming Logic, Generation of a State Diagram from a Timing Chart, Redundant States, General State Machine Architecture | **8** | **15** |
| **7** | Asynchronous State Machines: The Fundamental-Mode Model, Problems of Asynchronous Circuits Basic Design Principles, An Asynchronous Design Example. | **7** | **15** |
| **8** | Logic Families: Transistor-Transistor Logic(TTL), Emitter-Coupled Logic(ECL), MOSFET Logic, TTL Gates. | **4** | **5** |
| **9** | Programmable Logic Devices: Introduction to Programmable Logic Devices, | **5** | **10** |

| | | | |
|---|---|---|---|
| | Read-Only Memory, Programmable Logic Arrays (PLA), Programmable Array Logic (PAL), Combinational PLD-Based State Machines, State Machines on a Chip. | | |
| **Total** | | **52** | |

**Reference Books:**


1. Digital Logic & State Machine Design By David J. Comer, Third Indian Edition, Oxford University Press
2. Digital Logic and Computer Design By M Morris Mano, Fourth Edition, Prentice Hall Publication
3. Digital Principles and Applications By Malvino & Leach, Seventh Edition, McGraw-Hill Education
4. Modern Digital Electronics By R.P.Jain, Fourth Edition, Tata McGraw-Hill Education.
5. Digital Electronics: Principles and Integrated Circuits By A.K. Maini, Wiley India Publications
6. Digital Design M. Morris Mano and Michael D. Ciletti, Pearson Education
7. Digital Electronics and Design with With VHDL, Volnei A. Pedroni, Elsevier (Morgan Kaufmann Publishers)


**Course Outcome:**

After learning the course the students should be able to explain about digital number systems and logic circuits. The student should be able to solve logic function minimization. The students should be able to differentiate between combinational and sequential circuits such as decoders, encoders, multiplexers, demultiplexers, flip-flops, counters, registers. They should be able to design using FSM. In the laboratory, they should be able to verify the functions of various digital integrated circuits. The students should be able state the specifications of logic families. They should be able to start writing HDL codes for various digital circuits. The student should be able to compare the design using digital circuits and PLDs. At the end they should be able to develop a course project using digital integrated circuits.

**List of Experiments:**

1. Getting familiar with various digital integrated circuits of different logic families. Study of data sheet of these circuits and see how to test these circuits using Digital IC Tester.
2. Digital IC Testers and Logic State Analyzer as well as digital pattern generators should be demonstrated to the students.
3. Configure diodes and transistor as logic gates and Digital ICs for verification of truth table of logic gates.
4. Configuring NAND and NOR logic gates as universal gates.
5. Implementation of Boolean Logic Functions using logic gates and combinational circuits.
   Measure digital logic gate specifications such as propagation delay, noise margin, fan in and fan out.
6. Study and configure of various digital circuits such as adder, subtractor, decoder, encoder, code converters.
7. Study and configurations of multiplexer and demultiplexer circuits.
8. Study and configure of flip-flop, registers and counters using digital ICs. Design digital system using these circuits.
9. Perform an experiment which demonstrates function of 4 bit or 8 bit ALU.
10. Introduction to HDL. Use of HDL in simulation of digital circuits studied in previous sessions using integrated circuits. Illustrative examples using FPGA or CPLD boards.

**Design based Problems (DP)/Open Ended Problem:**

1. Design of combinational lock circuits with varying number of bits (For example 4, 8 …..)
2. Design of various types of counters.
3. Design of Arithmetic and Logic Unit using digital integrated circuits.
4. Design of digital integrated circuit tester

5. Measurement of logic family specifications.
6. Design project for example digital clock, digital event counter, timers, and various multi-vibrator Circuits, small processor, ports or scrolling display.

A student and faculty may choose any other such problem which includes the concept used in the course.

**Major Equipments:**

1. Pattern Generators
2. Logic State Analyzers
3. Digital Storage Oscilloscopes
4. Digital Integrated Circuits Tester.
5. Complete Bread Board Systems, switches and I/O indicators, multimeters, pulse, square wave generators and display faciltity.

**List of Open Source Software/learning website:**

1. Web packages for HDL, GHDL, FreeHDL
2. PSpices and NGSpice
3. Xcircuit and Scilab
4. NPTEL website and IITs virtual laboratory

**ACTIVE LEARNING ASSIGNMENTS**: Preparation of power-point slides, which include videos, animations, pictures, graphics for better understanding theory and practical work – The faculty will allocate chapters/ parts of chapters to groups of students so that the entire syllabus to be covered. The power-point slides should be put up on the web-site of the College/ Institute, along with the names of the students of the group, the name of the faculty, Department and College on the first slide. The best three works should submit to GTU.