UNIVERSITY OF MUMBAI

Bachelor of Engineering

in

Information Technology Engineering

Second Year with Effect from AY 2020-21

Third Year with Effect from AY 2021-22

Final Year with Effect from AY 2022-23

(REV- 2019 'C' Scheme) from Academic Year 2019 – 20

Under

FACULTY OF SCIENCE & TECHNOLOGY

(As per AICTE guidelines with effect from the academic year 2019–2020)

Preamble

To meet the challenge of ensuring excellence in engineering education, the issue of quality needs to be addressed, debated and taken forward in a systematic manner. Accreditation is the principal means of quality assurance in higher education. The major emphasis of accreditation process is to measure the outcomes of the program that is being accredited. In line with this Faculty of Science and Technology (in particular Engineering)of University of Mumbai has taken a lead in incorporating philosophy of outcome based education in the process of curriculum development.

Faculty resolved that course objectives and course outcomes are to be clearly defined for each course, so that all faculty members in affiliated institutes understand the depth and approach of course to be taught, which will enhance learner's learning process. Choice based Credit and grading system enables a much-required shift in focus from teacher-centric to learner-centric education since the workload estimated is based on the investment of time in learning and not in teaching. It also focuses on continuous evaluation which will enhance the quality of education. Credit assignment for courses is based on 15 weeks teaching learning process, however content of courses is to be taught in 12-13 weeks and remaining 2-3 weeks to be utilized for revision, guest lectures, coverage of content beyond syllabus etc.

There was a concern that the earlier revised curriculum more focused on providing information and knowledge across various domains of the said program, which led to heavily loading of students in terms of direct contact hours. In this regard, faculty of science and technology resolved that to minimize the burden of contact hours, total credits of entire program will be of 170, wherein focus is not only on providing knowledge but also on building skills, attitude and self learning. Therefore in the present curriculum skill based laboratories and mini projects are made mandatory across all disciplines of engineering in second and third year of programs, which will definitely facilitate self learning of students. The overall credits and approach of curriculum proposed in the present revision is in line with AICTE model curriculum.

The present curriculum will be implemented for Second Year of Engineering from the academic year 2020-21. Subsequently this will be carried forward for Third Year and Final Year Engineering in the academic years 2021-22, 2022-23, respectively.

Dr. S. K. Ukarande
Associate Dean
Faculty of Science and Technology
Member, Academic Council, RRC in Engineering
University of Mumbai

Incorporation and implementation of Online Contents from NPTEL/ Swayam Platform

The curriculum revision is mainly focused on knowledge component, skill based activities and project based activities. Self learning opportunities are provided to learners. In the revision process this time in particular Revised syllabus of ‘C ‘ scheme wherever possible additional resource links of platforms such as NPTEL, Swayam are appropriately provided. In an earlier revision of curriculum in the year 2012 and 2016 in Revised scheme ‘A' and ‘B' respectively, efforts were made to use online contents more appropriately as additional learning materials to enhance learning of students.

In the current revision based on the recommendation of AICTE model curriculum overall credits are reduced to 171, to provide opportunity of self learning to learner. Learners are now getting sufficient time for self learning either through online courses or additional projects for enhancing their knowledge and skill sets.

The Principals/ HoD’s/ Faculties of all the institute are required to motivate and encourage learners to use additional online resources available on platforms such as NPTEL/ Swayam. Learners can be advised to take up online courses, on successful completion they are required to submit certification for the same. This will definitely help learners to facilitate their enhanced learning based on their interest.

Dr. S. K. Ukarande
Associate Dean
Faculty of Science and Technology
Member, Academic Council, RRC in Engineering
University of Mumbai

Preamble

It is our honor and a privilege to present the Rev-2019 'C' scheme syllabus of Bachelor of Engineering in Information Technology (effective from year 2019-20) with inclusion of cutting edge technology. Information Technology is comparatively a young branch among other engineering disciplines in the University of Mumbai. It is evident from the placement statistics of various colleges affiliated to the University of Mumbai that IT branch has taken the lead in the placement.

The branch also provides multi-faceted scope like better placement and promotion of entrepreneurship culture among students, and increased Industry Institute Interactions. Industries views are considered as stakeholders will design of the syllabus of Information Technology. As per Industries views only 16 % graduates are directly employable. One of the reasons is a syllabus which is not in line with the latest technologies. Our team of faculties has tried to include all the latest technologies in the syllabus. Also first time we are giving skill-based labs and Mini-project to students from third semester onwards which will help students to work on latest IT technologies. Also the first time we are giving the choice of elective from fifth semester such that students will be master in one of the IT domain. The syllabus is peer reviewed by experts from reputed industries and as per their suggestions it covers future trends in IT technology and research opportunities available due to these trends.

We would like to thank senior faculties of IT department of all colleges affiliated to University of Mumbai for significant contribution in framing the syllabus. Also on behalf of all faculties we thank all the industry experts for their valuable feedback and suggestions. We sincerely hope that the revised syllabus will help all graduate engineers to face the future challenges in the field of information and technology

Program Specific Outcome for graduate Program in Information Technology

1. Apply Core Information Technology knowledge to develop stable and secure IT system.
2. Design, IT infrastructures for an enterprise using concepts of best practices in information Technology and security domain.
3. Ability to work in multidisciplinary projects and make it IT enabled.
4. Ability to adapt latest trends and technologies like **A**nalytics, **B**lockchain, **C**loud, **D**ata science.

BoS – IT Team
Dr. Deven Shah (BoS-Chairman)
Dr. Lata Ragha (BoS-Member)
Dr. Vaishali D. Khairnar (BoS-Member)
Dr. Sharvari Govilkar (BoS-Member)
Dr. Sunil B. Wankhade (BoS-Member)
Dr. Anil Kale (BoS-Member)
Dr. Vaibhav Narwade (BoS-Member)
Dr. GV Choudhary (BoS-Member)
Ad-hoc Board Information Technology
University of Mumbai

Program Structure for Second Year
Engineering Semester III & IV
UNIVERSITY OF MUMBAI
(With Effect from 2020-2021)

Semester III

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ITC301	Engineering Mathematics-III	3	--	1	3	--	1	4
ITC302	Data Structure and Analysis	3		--	3		--	3
ITC303	Database Management System	3	--	--	3	--	--	3
ITC304	Principle of Communication	3	--	--	3	--	--	3
ITC305	Paradigms and Computer Programming Fundamentals	3	--	--	3	--	--	3
ITL301	Data Structure Lab	--	2	--	--	1	--	1
ITL302	SQL Lab	--	2	--	--	1	--	1
ITL303	Computer programming Paradigms Lab	--	2	--	--	1	--	1
ITL304	Java Lab (SBL)	--	4	--	--	2	--	2
ITM301	Mini Project – 1 A for Front end /backend Application using JAVA	--	4[$]	--	--	2	--	2
Total		**15**	**14**	**1**	**15**	**07**	**1**	**23**

Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Pract/ oral	Total
		Internal Assessment			End Sem. Exam	Exam. Duration (in Hrs)			
		Test 1	Test2	Avg.					
ITC301	Engineering Mathematics-III	20	20	20	80	3	25	--	125
ITC302	Data Structure and Analysis	20	20	20	80	3	--	--	100
ITC303	Database Management System	20	20	20	80	3	--	--	100
ITC304	Principle of Communication	20	20	20	80	3	--	--	100
ITC305	Paradigms and Computer Programming Fundamentals	20	20	20	80	3	--	--	100
ITL301	Data Structure Lab	--	--	--	--	--	25	25	50
ITL302	SQL Lab	--	--	--	--	--	25	25	50
ITL303	Computer programming Paradigms Lab	--	--	--	--	--	25	25	50
ITL304	Java Lab (SBL)	--	--	--	--	--	25	25	50
ITM301	Mini Project – 1 A for Front end /backend Application using JAVA	--	--	--	--	--	25	25	50
Total		**--**	**--**	**100**	**400**	**--**	**150**	**125**	**775**

$ indicates work load of Learner (Not Faculty), for Mini Project

Program Structure for Second Year
Engineering Semester III & IV
UNIVERSITY OF MUMBAI
(With Effect from 2020-2021)

Semester IV

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	**Pract.**	**Tut.**	**Theory**	**Pract.**	**Tut.**	**Total**
ITC401	Engineering Mathematics-IV	3	--	1	3	--	1	4
ITC402	Computer Network and Network Design	3	--	--	3	--	--	3
ITC403	Operating System	3	--	--	3	--	--	3
ITC404	Automata Theory	3	--	--	3	--	--	3
ITC405	Computer Organization and Architecture	3	--	--	3	--	--	3
ITL401	Network Lab	--	2	--	--	1	--	1
ITL402	Unix Lab	--	2	--	--	1	--	1
ITL403	Microprocessor Lab	--	2	--	--	1	--	1
ITL404	Python Lab (SBL)	--	4	--	--	2	--	2
ITM401	Mini Project – 1 B for Python based automation projects	--	4$	--	--	2	--	2
Total		**15**	**14**	**1**	**15**	**7**	**1**	**23**

Course Code	Course Name	Examination Scheme							
		Theory					**Term Work**	**Pract/ oral**	**Total**
		Internal Assessment			**End Sem. Exam.**	**Exam. Duration (in Hrs)**			
		Test 1	**Test 2**	**Avg.**					
ITC401	Engineering Mathematics-IV	20	20	20	80	3	25	--	125
ITC402	Computer Network and Network Design	20	20	20	80	3	--	--	100
ITC403	Operating System	20	20	20	80	3	--	--	100
ITC404	Automata Theory	20	20	20	80	3	--	--	100
ITC405	Computer Organization and Architecture	20	20	20	80	3	--	--	100
ITL401	Network Lab	--	--	--	--	--	25	25	50
ITL402	Unix Lab	--	--	--	--	--	25	25	50
ITL403	Microprocessor Lab	--	--	--	--	--	25	25	50
ITL404	Python Lab (SBL)	--	--	--	--	--	25	25	50
ITM401	Mini Project – 1 B for Python based automation projects	--	--	--	--	--	25	25	50
Total		**--**	**--**	**100**	**400**	**--**	**150**	**75**	**775**

$ indicates work load of Learner (Not Faculty), for Mini Project

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract	Tut.	Theory	TW/Pract	Tut.	Total
ITC301	Engineering Mathematics-III	03	-	01	03	-	01	04

Course Code	Course Name	Examination Scheme							
		Theory				Term Work	Pract	Oral	Total
		Internal Assessment			End Sem Exam				
		Test1	Test2	Avg of Test 1 & 2					
ITC301	Engineering Mathematics-III	20	20	20	80	25	-	-	125

Pre-requisite: Engineering Mathematics-I, Engineering Mathematics-II

Course Objectives:

Sr. No.	Course Objectives
The course aims:	
1	To learn the Laplace Transform, Inverse Laplace Transform of various functions, its applications.
2	To understand the concept of Fourier Series, its complex form and enhance the problem solving skills.
3	To understand the concept of complex variables, C-R equations with applications.
4	The fundamental knowledge of Trees, Graphs etc.
5	To understand the basic techniques of statistics like correlation, regression, and curve fitting for data analysis, Machine learning, and AI.
6	To understand some advanced topics of probability, random variables with their distributions and expectations.

Course Outcomes:

Sr. No.	Course Outcomes	Cognitive levels of attainment as per Bloom's Taxonomy
On successful completion, of course, learner/student will be able to:		
1	Understand the concept of Laplace transform and its application to solve the real integrals in engineering problems.	L1, L2
2	Understand the concept of inverse Laplace transform of various functions and its applications in engineering problems.	L1, L2
3	Expand the periodic function by using the Fourier series for real-life problems and complex engineering problems.	L1, L2, L3
4	Understand complex variable theory, application of harmonic conjugate to get orthogonal trajectories and analytic functions.	L1, L2, L3
5	Apply the concept of Correlation and Regression to the engineering problems in data science, machine learning, and AI.	L2, L3
6	Understand the concepts of probability and expectation for getting the spread of the data and distribution of probabilities.	L1, L2

Module	Detailed Contents	Hours	CO Mapping
01	**Module: Laplace Transform** 1.1 Definition of Laplace transform, Condition of Existence of Laplace transform. 1.2 Laplace Transform (L) of standard functions like $e^{at}, sin(at), cos(at), sinh(at), cosh(at)$ and $t^n, n \geq 0$. 1.3 Properties of Laplace Transform: Linearity, First Shifting Theorem, Second Shifting Theorem, Change of Scale, Multiplication by *t*, Division by *t*, Laplace Transform of derivatives and integrals (Properties without proof). 1.4 Evaluation of real improper integrals by using Laplace Transformation. **Self-learning Topics:**Laplace Transform: Periodic functions, Heaviside's Unit Step function, Dirac Delta Function , Special functions (Error and Bessel)	6	CO1
02	**Module: Inverse Laplace Transform** 2.1 Definition of Inverse Laplace Transform, Linearity property, Inverse Laplace Transform of standard functions, Inverse Laplace transform using derivatives. 2.2 Partial fractions method to find Inverse Laplace transform. 2.3 Inverse Laplace transform using Convolution theorem (without proof) **Self-learning Topics:** Applications to solve initial and boundary value problems involving ordinary differential equations.	6	CO1, CO2
03	**Module: Fourier Series:** 3.1 Dirichlet's conditions, Definition of Fourier series and Parseval's Identity (without proof). 3.2 Fourier series of periodic function with period 2□□□and 2*l*. 3.3□□Fourier series of even and odd functions. 3.4 Half range Sine and Cosine Series.	6	CO3

	Self-learning Topics: Orthogonal and orthonormal set of functions, Complex form of Fourier Series, Fourier Transforms.		
04	**Module: Complex Variables:** 4.1 Function *f(z)* of complex variable, Limit, Continuity and Differentiability of *f(z)*, Analytic function: Necessary and sufficient conditions for *f(z)* to be analytic (without proof). 4.2 Cauchy-Riemann equations in Cartesian coordinates (without proof). 4.3 Milne-Thomson method: Determine analytic function *f(z)* when real part (u), imaginary part (v) or its combination (u+v / u-v) is given. 4.4 Harmonic function, Harmonic conjugate and Orthogonal trajectories. **Self-learning Topics:** Conformal mapping, Linear and Bilinear mappings, cross ratio, fixed points and standard transformations.	6	CO4
05	**Module: Statistical Techniques** 5.1 Karl Pearson's coefficient of correlation (r) 5.2 Spearman's Rank correlation coefficient (R) (with repeated and non-repeated ranks) 5.3 Lines of regression 5.4 Fitting of first and second degree curves. **Self-learning Topics:** Covariance, fitting of exponential curve.	6	CO5
06	**Module: Probability** 6.1 Definition and basics of probability, conditional probability. 6.2 Total Probability theorem and Bayes' theorem. 6.3 Discrete and continuous random variable with probability distribution and probability density function. 6.4 Expectation, Variance, Moment generating function, Raw and central moments up to 4^{th} order. **Self-learning Topics:** Skewness and Kurtosis of distribution (data).	6	CO6

References:

1. Higher Engineering Mathematics, Dr. B. S. Grewal, Khanna Publication.
2. Advanced Engineering Mathematics, Erwin Kreyszig, Wiley Eastern Limited.
3. Advanced Engineering Mathematics, R. K. Jain and S. R. K. Iyengar, Narosa Publication.
4. Complex Variables and Applications, Brown and Churchill, McGraw-Hill Education.
5. Probability, Statistics and Random Processes, T. Veerarajan, McGraw-Hill Education.
6. Theory and Problems of Fourier Analysis with applications to BVP, Murray Spiegel, Schaum's Outline Series.

Online References:

Sr. No.	Website Name
1.	https://www.nptel.ac.in

Term Work:

General Instructions:

1. Batch wise tutorials have to be conducted. The number of students per batch will be as per University pattern for practicals.
2. Students must be encouraged to write at least 6 class tutorials on the entire syllabus.
3. A group of 4-6 students should be assigned a self-learning topic. Students should prepare a presentation/problem solving of 10-15 minutes. This will be considered as a mini project in Engineering Mathematics. This project will be graded out of 10 marks depending on the performance of the students.

The distribution of Term Work marks will be as follows –

1.	Attendance (Theory and Tutorial)	05 marks
2.	Class Tutorials on entire syllabus	10 marks
3.	Mini project	10 marks

Assessment:

Internal Assessment (IA) for 20 marks:

- IA will consist of Two Compulsory Internal Assessment Tests. Approximately 40% to 50% of syllabus content must be covered in First IA Test and remaining 40% to 50% of syllabus content must be covered in Second IA Test

➢ **Question paper format**

- The question paper will comprise a total of 6 questions, each carrying 20 marks.
- Out of the 6 questions, 4 questions have to be attempted.
- Question 1, based on the entire syllabus, will have 4 sub-questions of 5 marks each and is compulsory.
- Question 2 to Question 6 will have 3 sub-questions, each of 6, 6, and 8 marks, respectively.
- Each sub-question in (4) will be from different modules of the syllabus.
- Weight age of each module will be proportional to the number of lecture hours, as mentioned in the syllabus.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical /Oral	Tutorial	Total
ITC302	Data Structure and Analysis	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Pract. /Oral	Total
		Internal assessment			End Sem. Exam			
		Test1	Test 2	Avg.				
ITC302	Data Structure and Analysis	20	20	20	80	--	--	100

Course Objectives:

Sr. No.	Course Objectives
The course aims:	
1	The fundamental knowledge of data structures.
2	The programming knowledge which can be applied to sophisticated data structures.
3	The fundamental knowledge of stacks queue, linked list etc.
4	The fundamental knowledge of Trees, Graphs etc.
5	The fundamental knowledge of different sorting, searching, hashing and recursion techniques
6	The real time applications for stacks, queue, linked list, trees, graphs etc.

Course Outcomes:

Sr. No.	Course Outcomes	Cognitive levels of attainment as per Bloom's Taxonomy
On successful completion, of course, learner/student will be able to:		
1	Classify and Apply the concepts of stacks, queues and linked list in real life problem solving.	L1, L2, L3
2	Classify, apply and analyze the concepts trees in real life problem solving.	L2, L3,L4
3	Illustrate and justify the concepts of graphs in real life problem solving.	L3, L5
4	List and examine the concepts of sorting, searching techniques in real life problem solving.	L2, L3, L4
5	Use and identify the concepts of recursion, hashing in real life problem solving.	L3, L4
6	Examine and justify different methods of stacks, queues, linked list, trees and graphs to various applications.	L3, L4, L5

Prerequisite: C Programming

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours	CO Mapping
0	Prerequisite	Defining, Declaring and Initialization of structure variables. Accessing members of a structure, Array of structures, Nested structures, Pointers to structures. Passing structure, structure members, structure arrays and pointer to structure as function parameters. Self-referential structures.	**02**	---
I	Introduction to Stacks, Queues and Linked Lists	Introduction to Data Structures: Linear and Non Linear Data Structures, Static and Dynamic Data Structures. Concept of Stack and Queue. Array Implementation of Stack and Queue, Circular Queue, Double Ended Queue, Priority Queue. Concept of Linked Lists. Singly linked lists, doubly linked lists and circular linked lists. Insertion, deletion, update and copying operations with Singly linked lists, doubly linked lists and circular linked lists. Reversing a singly linked list. **Self-learning Topics:** Linked List Implementation of Stack, Linked List implementation of Queue, Circular Queue, Double Ended Queue, Priority Queue.	**08**	CO1
II	Trees	Introduction to Trees: Terminology, Types of Binary trees. Non recursive Preorder, in-order and post-order traversal. Creation of binary trees from the traversal of binary trees. Binary search tree: Traversal, searching, insertion and deletion in binary search tree. Threaded Binary Tree: Finding in-order successor and predecessor of a node in threaded tree. Insertion and deletion in threaded binary tree. AVL Tree: Searching and traversing in AVL trees. Tree Rotations: Right Rotation, Left Rotation. Insertion and Deletion in an AVL Tree. B-tree: Searching, Insertion, Deletion from leaf node and non-leaf node. B+ Tree, Digital Search Tree, Game Tree & Decision Tree **Self-learning Topics:** Implementation of AVL and B+ Tree	**07**	CO1, CO 2
III	Graphs	Introduction to Graphs: Undirected Graph, Directed Graph, graph terminology, Connectivity in Undirected and Directed Graphs. Spanning tree. Representation of graph: adjacency matrix, adjacency list, Transitive closure of a directed graph and path matrix.	**05**	CO1, CO3

		Traversals: Breadth First Search, Depth First Search. **Self-learning Topics:** Implementation of BFS, DFS		
IV	Recursion and Storage Management	Recursion: Writing a recursive function, Flow of control in recursive functions, Winding and unwinding phase, Recursive data structures, Implementation of recursion. Tail recursion. Indirect and Direct Recursion. Storage Management: Sequential Fit Methods: First Fit, Best Fit and Worst Fit methods. Fragmentation, Freeing Memory, Boundary Tag Method. Buddy Systems: Binary Buddy System, Fibonacci Buddy System. Compaction, Garbage Collection. **Self-learning Topics:** Implementation of recursion function.	**06**	CO5
V	Searching and Sorting	Searching: Sequential Search, Binary Search. Hashing: Hash Functions: Truncation, Mid-square Method, Folding Method, Division Method. Collision Resolution: Open Addressing: Linear Probing, Quadratic Probing, Double Hashing, Separate Chaining Bucket Hashing. Analysis of all searching techniques Sorting: Insertion sort, Selection sort, Merge sort, Quick sort and Radix sort. Analysis of all sorting techniques **Self-learning Topics:** Implementation of different sorting techniques and searching.	**05**	CO 4, CO5
VI	Applications of Data Structures	Applications of Linked Lists: Addition of 2 Polynomials and Multiplication of 2 polynomials. Applications of Stacks: Reversal of a String, Checking validity of an expression containing nested parenthesis, Function calls, Polish Notation: Introduction to infix, prefix and postfix expressions and their evaluation and conversions. Application of Queues: Scheduling, Round Robin Scheduling Applications of Trees: Huffman Tree and Heap Sort. Applications of Graphs: Dijkstra's Algorithm, Minimum Spanning Tree: Prim's Algorithm, Kruskal's Algorithm. **Self-learning Topics:** Implementation of applications for Stack, Queues, Linked List, Trees and Graph.	**06**	CO6

Text Books:

1. S. K Srivastava, Deepali Srivastava; Data Structures through C in Depth; BPB Publications; 2011.
2. Yedidya Langsam, Moshej Augenstein, Aaron M. Tenenbaum; Data Structure Using C & C++; Prentice Hall of India; 1996.
3. Reema Thareja; Data Structures using C; Oxford.

References:

1. Ellis Horowitz, Sartaj Sahni; Fundamentals of Data Structures; Galgotia Publications; 2010.
2. Jean Paul Tremblay, Paul G. Sorenson; An introduction to data structures with applications; Tata McGrawHill; 1984.
3. Rajesh K. Shukla; Data Structures using C and C++; Wiley India; 2009.

Online References:

Sr. No.	Website Name
2.	https://www.nptel.ac.in
3.	https://opendatastructures.org/
3.	https://www.coursera.org/

Assessment:

Internal Assessment (IA) for 20 marks:

- IA will consist of Two Compulsory Internal Assessment Tests. Approximately 40% to 50% of syllabus content must be covered in First IA Test and remaining 40% to 50% of syllabus content must be covered in Second IA Test

➢ **Question paper format**

- Question Paper will comprise of a total of **six questions each carrying 20 marksQ.1** will be **compulsory** and should **cover maximum contents of the syllabus**
- **Remaining questions** will be **mixed in nature** (part (a) and part (b) of each question must be from different modules. For example, if Q.2 has part (a) from Module 3 then part (b) must be from any other Module randomly selected from all the modules)
- A total of **four questions** need to be answered

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical /Oral	Tutorial	Total
ITC303	Database Management System	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Pract. /Oral	Total
		Internal assessment			End Sem. Exam			
		Test1	Test 2	Avg.				
ITC303	Database Management System	20	20	20	80	--	--	100

Course Objectives:

Sr. No.	Course Objectives
The course aims:	
1	To learn the basics and understand the need of database management system.
2	To construct conceptual data model for real world applications
3	To Build Relational Model from ER/EER.
4	To introduce the concept of SQL to store and retrieve data efficiently.
5	To demonstrate notions of normalization for database design.
6	To understand the concepts of transaction processing- concurrency control & recovery procedures.

Course Outcomes:

Sr. No.	Course Outcomes	Cognitive levels of attainment as per Bloom's Taxonomy
On successful completion, of course, learner/student will be able to:		
1	Identify the need of Database Management System.	L1, L2
2	Design conceptual model for real life applications.	L6
3	Create Relational Model for real life applications	L6
4	Formulate query using SQL commands.	L3
5	Apply the concept of normalization to relational database design.	L3
6	Demonstrate the concept of transaction, concurrency and recovery.	L2

Prerequisite: C Programming

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours	CO Mapping
0	Prerequisite	**Comment**Basic knowledge of operating systems and file systems, Any programming	**02**	--
I	**Database System Concepts and Architecture**	Introduction, Characteristics of Databases, File system v/s Database system, Data abstraction and Data Independence, DBMS system architecture, Database Administrator (DBA), Role of DBA **Self-learning Topics:** Identify the types of Databases.	**05**	CO1
II	**The Entity-Relationship Model**	Conceptual Modeling of a database, The Entity-Relationship (ER) Model, Entity Type, Entity Sets, Attributes and Keys, Relationship Types, Relationship Sets, Weak entity Types Generalization, Specialization and Aggregation, Extended Entity-Relationship (EER) Model. **Self-learning Topics:** Design an ER model for any real time case study.	**05**	CO2
III	**Relational Model & Relational Algebra**	Introduction to Relational Model, Relational Model Constraints and Relational Database Schemas, Concept of Keys: Primary Kay, Secondary key, Foreign Key, Mapping the ER and EER Model to the Relational Model, Introduction to Relational Algebra, Relational Algebra expressions for Unary Relational Operations, • Set Theory operations, • Binary Relational operation Relational Algebra Queries **Self-learning Topics:** Map the ER model designed in module II to relational schema..	**05**	CO3
IV	**Structured Query Language (SQL) & Indexing**	Overview of SQL, Data Definition Commands, Set operations, aggregate function, null values, Data Manipulation commands, Data Control commands, Complex Retrieval Queries using Group By, Recursive Queries, nested Queries ; Integrity constraints in SQL. Database Programming with JDBC, Security and authorization: Grant & Revoke in SQL Functions and Procedures in SQL and cursors. Indexing:Basic Concepts, Ordered Indices, Index Definition in SQL **Self-learning Topics:** Physical design of database for the relational model designed in module III and fire various queries.	**08**	CO4

V	**Relational Database Design**	Design guidelines for relational Schema, Functional Dependencies, Database tables and normalization, The need for normalization, The normalization process, Improving the design, Definition of Normal Forms- 1NF, 2NF, 3NF & The Boyce-Codd Normal Form (BCNF). **Self-learning Topics:** Consider any real time application and normalization upto 3NF/BCNF	**07**	CO5
VI	**Transactions Management and Concurrency and Recovery**	Transaction: Transaction concept, State Diagram, ACID Properties, Transaction Control Commands, Concurrent Executions, Serializability – Conflict and View, Concurrency Control: Lock-based-protocols, Deadlock handling Timestamp-based protocols, Recovery System: Recovery Concepts, Log based recovery. **Self-learning Topics:** Study the various deadlock situation which may occur for a database designed in module V.	**07**	CO6

Text Books:

1. Korth, Slberchatz, Sudarshan, Database System Concepts, 6th Edition, McGraw Hill
2. Elmasri and Navathe, Fundamentals of Database Systems, 6th Edition, Pearson education
3. Raghu Ramkrishnan and Johannes Gehrke, Database Management Systems, TMH

References:

1. Peter Rob and Carlos Coronel, ―Database Systems Design, Implementation and Management‖, Thomson Learning, 9th Edition.
2. SQL & PL / SQL for Oracle 11g Black Book, Dreamtech Press
3. G. K. Gupta : "Database Management Systems", McGraw – Hill

Online References:

Sr. No.	Website Name
1.	https://www.nptel.ac.in
2.	https://www.oreilly.com
3.	https://www.coursera.org/

Assessment:

Internal Assessment (IA) for 20 marks:

- IA will consist of Two Compulsory Internal Assessment Tests. Approximately 40% to 50% of syllabus content must be covered in First IA Test and remaining 40% to 50% of syllabus content must be covered in Second IA Test

➢ **Question paper format**

- Question Paper will comprise of a total of **six questions each carrying 20 marks Q.1** will be **compulsory** and should **cover maximum contents of the syllabus**
- **Remaining questions** will be **mixed in nature** (part (a) and part (b) of each question must be from different modules. For example, if Q.2 has part (a) from Module 3 then part (b) must be from any other Module randomly selected from all the modules)
- A total of **four questions** need to be answered

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical /Oral	Tutorial	Total
ITC304	Principle of Communication	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Pract. /Oral	Total
		Internal assessment			End Sem. Exam			
		Test1	Test 2	Avg.				
ITC304	Principle of Communication	20	20	20	80	--	--	100

Course Objectives:

Sr. No.	Course Objectives
The course aims:	
1	Study the basic of Analog and Digital Communication Systems.
2	Describe the concept of Noise and Fourier Transform for analyzing communication systems.
3	Acquire the knowledge of different modulation techniques such as AM, FM and study the block diagram of transmitter and receiver.
4	Study the Sampling theorem and Pulse Analog and digital modulation techniques
5	Learn the concept of multiplexing and digital band pass modulation techniques
6	Gain the core idea of electromagnetic radiation and propagation of waves.

Course Outcomes:

Sr. No.	Course Outcomes	Cognitive levels of attainment as per Bloom's Taxonomy
On successful completion, of course, learner/student will be able to:		
1	Describe analog and digital communication systems	L1
2	Differentiate types of noise, analyses the Fourier transform of time and frequency domain.	L1, L2, L3, L4
3	Design transmitter and receiver of AM, DSB, SSB and FM.	L2,L3
4	Describe Sampling theorem and pulse modulation systems.	L1
5	Explain multiplexing and digital band pass modulation techniques.	L1, L2
6	Describe electromagnetic radiation and propagation of waves.	L1

Prerequisite: Basic of electrical engineering

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours	CO Mapping
0	Prerequisite	Terminologies in communication systems, analog and digital electronics	**02**	
I	**Introduction**	Basics of analog communication and digital communication systems (Block diagram), Electromagnetic Spectrum and application, Types of Communication channels. **Self-learning Topics:** Difference between Analog and Digital Communication. List the examples.	**03**	**CO1**
II	**Noise and Fourier Representation of Signal and System**	Basics of signal representation and analyses, Introduction to Fourier Transform, its properties (time and frequency shifting, Fourier transform of unit step, delta and gate function. Types of Noise, Noise parameters –Signal to noise ratio, Noise factor, Noise figure, Friss formula and Equivalent noise temperature. **Self-learning Topics:** Practice Numerical on above topic.	**06**	**CO2**
III	**Amplitude and Angle modulation Techniques.**	Need for modulation, Amplitude Modulation Techniques: DSBFC AM,DSBSC-AM, SSB SC AM- block diagram spectrum, waveforms, bandwidth, Power calculations. Generation of AM using Diode, generation of DSB using Balanced modulator, Generation of SSB using Phase Shift Method. AM Transmitter (Block Diagram) AM Receivers – Block diagram of TRF receivers and Super heterodyne receiver and its characteristics- Sensitivity, Selectivity, Fidelity, Image frequency and its rejection and double spotting **Angle Modulation** **FM:** Principle of FM- waveforms, spectrum, bandwidth. Pre- emphasis and de-emphasis in FM, FM generation: Direct method –Varactor diode Modulator, Indirect method (Armstrong method) block diagram and waveforms. FM demodulator: Foster Seeley discriminator, Ratio detector. **Self-learning Topics:** Define AM and FM. Differentiate between FM and AM. List examples of FM and AM.	**12**	**CO1, CO2, CO3**
IV	**Pulse Analog Modulation and Digital Modulation**	Sampling theorem for low pass and band pass signals with proof, Anti- aliasing filter, PAM, PWM and PPM generation and Degeneration. Quantization process, Pulse code modulation, Delta modulation, Adaptive delta modulation.	**08**	**CO1, CO2, CO4**

		Introduction to Line Codes and ISI. **Self-learning Topics:** Implementation of Pulse code modulation and demodulation.		
V	**Multiplexing and Digital Band Pass Modulation Techniques**	Principle of Time Division Multiplexing, Frequency Division Multiplexing , Orthogonal Frequency Division Multiplexing and its applications .ASK, FSK, PSK QPSK Generation and detection. **Self-learning Topics:** Implement TDM, FDM, OFDM.	**04**	**CO1, CO2, CO5**
VI	**Radiation and Propagation of Waves**	Electromagnetic radiation, fundamentals, types of propagation, ground wave, sky wave, space wave tropospheric scatter propagation **Self-learning Topics:** List the real time examples for different types of propagation waves.	**04**	**CO6**

Text Books:

[1]. George Kennedy, Bernard Davis, SRM Prasanna, Electronic Communication Systems, Tata McGraw Hill, 5th Ed
[2]. Simon Haykin, Michael Moher, Introduction to Analog & Digital Communications, Wiley India Pvt. Ltd., 2nd Ed.
[3].Wireless Communication and Networking, Vijay Garg

References:

[1]. Wayne Tomasi, Electronic Communications Systems, Pearson Publication, 5th Ed.
[2]. B P Lathi, Zhi Ding, Modern Digital and Analog Communication Systems, Oxford University
[3]. Herbert Taub, Donald L Schilling, Goutam Saha, Principles of Communication Systems, Tata McGraw Hill, 3rdEd.
[4]. K Sam Shanmugam, Digital and Analog Communication Systems, Wiley India Pvt. Ltd, 1st Ed.

Online References:

Sr. No.	Website Name
1.	https://www.nptel.ac.in
2.	https://www.classcentral.com
3.	http://www.vlab.co.in/

Assessment:
Internal Assessment (IA) for 20 marks:

- IA will consist of Two Compulsory Internal Assessment Tests. Approximately 40% to 50% of syllabus content must be covered in First IA Test and remaining 40% to 50% of syllabus content must be covered in Second IA Test

➢ **Question paper format**

- Question Paper will comprise of a total of **six questions each carrying 20 marks Q.1** will be **compulsory** and should **cover maximum contents of the syllabus**
- **Remaining questions** will be **mixed in nature** (part (a) and part (b) of each question must be from different modules. For example, if Q.2 has part (a) from Module 3 then part (b) must be from any other Module randomly selected from all the modules)
- A total of **four questions** need to be answered

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical /Oral	Tutorial	Total
ITC305	Paradigms and Computer Programming Fundamentals	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Pract. /Oral	Total
		Internal assessment			End Sem. Exam			
		Test1	Test 2	Avg.				
ITC305	Paradigms and Computer Programming Fundamentals	20	20	20	80	--	--	100

Course Objectives:

Sr. No.	Course Objectives
The course aims:	
1	To introduce various programming paradigms and the basic constructs that underline any programming language.
2	To understand data abstraction and object orientation.
3	To introduce the basic concepts of declarative programming paradigms through functional and logic programming.
4	To design solutions using declarative programming paradigms through functional and logic programming.
5	To introduce the concepts of concurrent program execution.
6	To understand use of scripting language for different problem domains.

Course Outcomes:

Sr. No.	Course Outcomes	Cognitive levels of attainment as per Bloom's Taxonomy
On successful completion, of course, learner/student will be able to:		
1	Understand and Compare different programming paradigms.	L1, L2
2	Understand the Object Oriented Constructs and use them in program design.	L1, L2
3	Understand the concepts of declarative programming paradigms through functional and logic programming.	L1, L2
4	Design and Develop programs based on declarative programming paradigm using functional and/or logic programming.	L5, L6
5	Understand role of concurrency in parallel and distributed programming.	L1, L2
6	Understand different application domains for use of scripting languages.	L1. L2

Prerequisite: Students must have learned C Programming (FEC205 and FEL204),

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours	CO Mapping
0	Prerequisite	Compilation and interpretation Focus on overview of compilation steps.	**02**	CO1
I	Introduction to Programming Paradigms and Core Language Design Issues	Introduction to different programming paradigms. Names, Scopes, and Bindings, Scope Rules, Storage Management. Type Systems, Type Checking, Equality Testing and Assignment. Subroutine and Control Abstraction: Stack Layout, Calling sequence, parameter passing Generic subroutines and modules. Exception handling, Co-routines and Events. **Self-learning Topics:** Implementation of basic concepts using any programming language.	**10**	CO1
II	Imperative Paradigm: Data Abstraction in Object Orientation	Grouping of data and Operations- Encapsulation, Overloading, Polymorphism, Inheritance, Initialization and Finalization, Dynamic Binding. **Self-learning Topics:** Implementation of OOP concepts using OOP language.	**05**	CO2
III	Declarative Programming Paradigm: Functional Programming	Introduction to Lambda Calculus, Functional Programming Concepts, Evaluation order, Higher order functions, I/O- Streams and Monads. **Self-learning Topics:** Implementation of I/O using any programming language.	**07**	CO3, CO4
IV	Declarative Programming Paradigm: Logic	Logic Programming with PROLOG - Resolution and Unification, Lists, Arithmetic execution order, imperative control flow, database manipulation,	**06**	CO3, CO4

	Programming	PROLOG facilities and deficiencies **Self-learning Topics:** Implementation of basic operation and control flow using PROLOG in healthcare.		
V	Alternative Paradigms: Concurrency	Concurrent Programming Fundamentals, Implementing synchronization, Message Passing - Background and Motivation, Multi threaded programs, Communication and Synchronization, Language and Libraries, Thread creation Syntax **Self-learning Topics:** Implementation of module IV concepts for real time application.	**04**	CO5
VI	Alternative Paradigms: Scripting Languages	Common characteristics, Different Problem domains for using scripting,Use of scripting in Web development–server and clients side scripting, Innovative features of scripting languages - Names and Scopes, string and pattern manipulation ,data types ,object orientation. **Self-learning Topics:** Implement a simple website for client-server.	**05**	CO6

Text Books:

1. Graham Hutton, Programming in Haskell, 2nd Edition, Cambridge University Press, 2016
2. Scott M L, Programming Language Pragmatics, 3rd Edn., Morgan Kaufmann Publishers, 2009
3. Programming Languages: Concepts and Constructs; 2nd Edition, Ravi Sethi, Pearson Education Asia, 1996.

References:

1. Harold Abelson and Gerald Jay Sussman with Julie Sussman foreword by Alan J. Perlis, Structure and Interpretation of Computer Programs (2nd Edition) (February 2, 2016)
2. Programming Languages: Design and Implementation (4th Edition), by Terrence W. Pratt, Marvin V. Zelkowitz, Pearson, 2000
3. Yogesh Sajanikar, Haskell Cookbook, Packt Publishing, 2017.

Online References:

Sr. No.	Website Name
1.	https://www.nptel.ac.in
2.	https://www.classcentral.com
3.	https://www.udemy.com

Assessment:

Internal Assessment (IA) for 20 marks:

- IA will consist of Two Compulsory Internal Assessment Tests. Approximately 40% to 50% of syllabus content must be covered in First IA Test and remaining 40% to 50% of syllabus content must be covered in Second IA Test

➢ **Question paper format**

- Question Paper will comprise of a total of **six questions each carrying 20 marks Q.1** will be **compulsory** and should **cover maximum contents of the syllabus**
- **Remaining questions** will be **mixed in nature** (part (a) and part (b) of each question must be from different modules. For example, if Q.2 has part (a) from Module 3 then part (b) must be from any other Module randomly selected from all the modules)
- A total of **four questions** need to be answered

Lab Code	Lab Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ITL301	Data Structure Lab	--	02	--	--	01	--	01

Lab Code	Lab Name	Examination Scheme						
		Theory Marks				Term Work	Pract. /Oral	Total
		Internal assessment			End Sem. Exam			
		Test1	Test 2	Avg.				
ITL301	Data Structure Lab	--	--	--	--	25	25	50

Lab Objectives:

Sr. No.	Lab Objectives
The Lab experiments aims:	
1	To use data structures as the introductory foundation for computer automation to engineering problems.
2	To use the basic principles of programming as applied to complex data structures.
3	To learn the principles of stack, queue, linked lists and its various operations.
4	To learn fundamentals of binary search tree, implementation and use of advanced tree like AVL, B trees and graphs.
5	To learn about searching, hashing and sorting.
6	To learn the applications of linked lists, stacks, queues, trees and graphs.

Lab Outcomes:

Sr. No.	Lab Outcomes	Cognitive levels of attainment as per Bloom's Taxonomy
On successful completion, of course, learner/student will be able to:		
1	Understand and use the basic concepts and principles of various linked lists, stacks and queues.	L1, L2, L3
2	Understand the concepts and apply the methods in basic trees.	L1, L2
3	Use and identify the methods in advanced trees.	L3, L4
4	Understand the concepts and apply the methods in graphs.	L2, L3
5	Understand the concepts and apply the techniques of searching, hashing and sorting	L2, L3
6	Illustrate and examine the methods of linked lists, stacks, queues, trees and	L3, L4

	graphs to various real time problems	

Prerequisite: C Programming

Hardware & Software Requirements:

Hardware Requirement:	**Software requirement:**
PC i3 processor and above	Turbo/Borland C complier

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours	LO Mapping
0	Prerequisite	Introduction of C programming language.	**02**	----
I	Stacks, Queues and Linked Lists	• Array Implementation of Stack and Queue. • Insertion, deletion operations with Singly linked lists • Insertion, deletion operations Doubly linked lists • Insertion, deletion operations Circular linked lists. • Reversing a singly linked list. • *** Linked List implementation of Stack and Queue**	**04**	LO 1
II	Trees	• *** Implementation of operations (insertion, deletion, counting of nodes, counting of leaf nodes etc.) in a binary search tree.** • Implementation of insertion, deletion and traversal for fully in-threaded binary search tree.	**04**	LO 2
III	Advanced Trees	• *** Implementation of AVL tree.** • Implementation of operations in a B tree.	**04**	LO 3
IV	Graphs	• Implementation of adjacency matrix creation. • Implementation of addition and deletion of edges in a directed graph using adjacency matrix. • Implementation of insertion and deletion of vertices and edges in a directed graph using adjacency list. •	**04**	LO 4
V	Searching and Sorting	• Implementation of Heap Sort • Implementation of Binary Search. • Implementation of Selection sort, Bubble sort,	**04**	LO 5

		Insertion sort, Quick sort		
VI	Applications of Data Structures	• *** Implementation of infix to postfix conversion and evaluation of postfix expression** • *** Implementation of Josephus Problem using circular linked list** • *** Implementation of traversal of a directed graph through BFS and DFS.** • Implementation of finding shortest distances using Dijkstra's algorithm • ***Implementation of hashing functions with different collision resolution techniques**	**04**	LO 6

Text Books:

1. S. K Srivastava, Deepali Srivastava; Data Structures through C in Depth; BPB Publications; 2011.
2. Yedidya Langsam, Moshej Augenstein, Aaron M. Tenenbaum; Data Structure Using C & C++; Prentice Hall of India; 1996.
3. Reema Thareja; Data Structures using C; Oxford.

References:

1. Ellis Horowitz, Sartaj Sahni; Fundamentals of Data Structures; Galgotia Publications; 2010.
2. Jean Paul Tremblay, Paul G. Sorenson; An introduction to data structures with applications; Tata McGrawHill; 1984.
3. Rajesh K. Shukla; Data Structures using C and C++; Wiley India; 2009.

Term Work: Term Work shall consist of at least 10 to 12 practical's based on the above list. Also Term work Journal must include at least 2 assignments.

Term Work Marks: 25 Marks (Total marks) = 15 Marks (Experiment) + 5 Marks (Assignments) + 5 Marks (Attendance)

Practical& Oral Exam: An Oral & Practical exam will be held based on the above syllabus.

Lab Code	Lab Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ITL302	SQL Lab	--	02	--	--	01	--	01

Lab Code	Lab Name	Examination Scheme						
		Theory Marks				Term Work	Pract. /Oral	Total
		Internal assessment			End Sem. Exam			
		Test1	Test 2	Avg.				
ITL302	SQL Lab	--	--	--	--	25	25	50

Lab Objectives:

Sr. No.	Lab Objectives
The Lab experiments aims:	
1	To identify and define problem statements for real life applications
2	To construct conceptual data model for real life applications
3	To Build Relational Model from ER/EER and demonstrate usage of relational algebra.
4	To Apply SQL to store and retrieve data efficiently
5	To implement database connectivity using JDBC
6	To understand the concepts of transaction processing- concurrency control & recovery procedures.

Lab Outcomes:

Sr. No.	Lab Outcomes	Cognitive levels of attainment as per Bloom's Taxonomy
On successful completion, of course, learner/student will be able to:		
1	Define problem statement and Construct the conceptual model for real life application.	L1, L3, L4, L6
2	Create and populate a RDBMS using SQL.	L3, L4
3	Formulate and write SQL queries for efficient information retrieval	L3, L4
4	Apply view, triggers and procedures to demonstrate specific event handling.	L1, L3, L4
5	Demonstrate database connectivity using JDBC.	L3
6	Demonstrate the concept of concurrent transactions.	L3, L4

Prerequisite: C Programming

Hardware & Software Requirements:

Hardware Requirement:	**Software requirement:**
PC i3 processor and above	Any SQL Compiler, Java Programming Language

DETAILED SYLLABUS:

Sr. No.	**Detailed Content**	**Hours**	**LO Mapping**
1.	Identify real world problem and develop the problem statement. Design an Entity-Relationship (ER) / Extended Entity-Relationship (EER) Model.	**02**	LO1
2.	Mapping ER/EER to Relational schema model.	**02**	LO1
3.	Create a database using DDL and apply integrity constraints.	**02**	LO2, LO3
4.	Perform data manipulations operations on populated database.	**02**	LO3
5.	Perform Authorization using Grant and Revoke.	**02**	LO2, LO3
6.	Implement Basic and complex SQL queries.	**02**	LO3, LO4
7.	Implementation of Views and Triggers.	**02**	LO4
8.	Demonstrate database connectivity using JDBC.	**02**	LO5
9.	Execute TCL commands.	**02**	LO4
10.	Implement functions and procedures in SQL	**02**	LO3, LO4
11.	Implementation of Cursor.	**02**	LO3, LO4
12.	Implementation and demonstration of Transaction and Concurrency control techniques using locks.	**02**	LO6

Text Books:

1. Korth, Slberchatz, Sudarshan, Database System Concepts, 6th Edition, McGraw Hill
2. Elmasri and Navathe, Fundamentals of Database Systems, 6th Edition, Pearson education
3. Raghu Ramkrishnan and Johannes Gehrke, Database Management Systems, TMH

References:

1. Peter Rob and Carlos Coronel, ―Database Systems Design, Implementation and Management‖, Thomson Learning, 9th Edition.
2. SQL & PL / SQL for Oracle 11g Black Book, Dreamtech Press
3. G. K. Gupta : "Database Management Systems", McGraw – Hill

Term Work:

Term Work shall consist of at least 10 Practical's based on the above list, but not limited to. Also, Term work Journal must include at least 2 assignments:

The first assignment may be based on: Relational Algebra and Second may be based on Transactions

Term Work Marks: 25 Marks (Total marks) = 15 Marks (Experiment) + 5 Marks (Assignments) + 5 Marks (Attendance)

Practical & Oral Exam: An Oral & Practical exam will be held based on the above syllabus.

Lab Code	Lab Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ITL303	Computer programming Paradigms Lab	--	02	--	--	01	--	01

Lab Code	Lab Name	Examination Scheme						
		Theory Marks				Term Work	Pract. /Oral	Total
		Internal assessment			End Sem. Exam			
		Test1	Test 2	Avg.				
ITL303	Computer programming Paradigms Lab	--	--	--	--	25	25	50

Lab Objectives:

Sr. No.	Lab Objectives
The Lab experiments aims:	
1	Understand data abstraction and object orientation
2	Design and implement declarative programs in functional and logic programming languages
3	Introduce the concepts of concurrent program execution
4	Understand run time program management
5	Understand how to implement a programming solution using different programming paradigms
6	Learn to compare implementation in different programming paradigms.

Lab Outcomes:

Sr. No.	Lab Outcomes	Cognitive levels of attainment as per Bloom's Taxonomy
On successful completion, of course, learner/student will be able to:		
1	Apply Object Oriented concepts in C++.	L1, L2, L3
2	Design and Develop solution based on declarative programming paradigm using functional and logic programming using Haskell.	L6
3	Understand the multithreaded programs in Java and C++	L1, L2
4	Understand the need and use of exception handling and garbage collection in	L2, L3

	C++ and JAVA	
5	Design and Develop a solution to the same problem using multiple paradigms.	L6
6	Compare the implementations in multiple paradigms at coding and execution level	L4

Prerequisite: C Programming

Hardware & Software Requirements:

Hardware Requirement:	**Software requirement:**
PC i3 processor and above	Any SQL Compiler, Java Programming Language

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours	LO Mapping
0	Prerequisite	Demonstrate Compilation and interpretation stages to students for C, C++, JAVA along with how to debug the code.	**02**	--
I	Imperative Paradigm: Data Abstraction in Object Orientation	At least two Programming Implementations Preferably in C++ to demonstrate concepts like - Encapsulation, Inheritance, Initialization and Finalization, Dynamic Binding.	**05**	LO1
II	Declarative Programming Paradigm: Functional Programming	● Installation and starting Haskell compiler. ● Try the simple exercise on operators, types etc. ● Consider a function safetail that behaves in the same way as tail, except that safetail maps the empty list to the empty list, whereas tail gives an error in this case. Define safetail using: (a) a conditional expression; (b) guarded equations; (c) pattern matching. Hint: the library function null :: [a]-> Bool can be used to test if a list is empty. ● Simple List Comprehension ● Recursion Function ● Higher-Order Functions ● Using recursion and the function add, define a function that multiplies two natural numbers. ● Implement the game of nim in Haskell, where the rules of the game are as follows: The board comprises five rows of stars: 1:***** 2:**** 3:*** 4:** 5:* Two players take it turn about to remove one or more stars from the end of a single row.	**06**	LO2

		The winner is the player who removes the last star or stars from the board. Hint: Represent the board as a list of five integers that give the number of stars remaining on each row. For example, the initial board is [5,4,3,2,1]. • The Fibonacci sequence 0, 1, 1, 2, 3, 5, 8, 13, 21, 34, …starts with 0 and 1, with each further number being the sum of the previous two. Using a list comprehension, define an expression fibs :: [Integer] that generates this infinite sequence. Students should implement tic-tac-toe or simple calculator to clearly understand the syntax and the execution of the Functional Implementation using Haskell language.		
III	Declarative Programming Paradigm: Logic Programming	● Tutorial Introduction to SWI Prolog ● Implement at least five Prolog programs to understand declarative programming concepts. Students should clearly understand the syntax and the execution of the Prolog code Implementation.	**05**	LO2
IV	Alternative Paradigms: Concurrency	At least two Programs preferably in c++ and java to demonstrate Thread management and synchronization	**02**	LO4
V	Run Time Program Management	A Program to understand Exception handling and Garbage collection, preferably in C++ and JAVA Students should underline the syntactic differences in the solutions in both Object Oriented Languages.	**02**	LO4
VI	Programming Assignment For comparative study of Different Paradigms	At Least two implementations each implemented on multiple paradigms like procedural, object oriented, functional, logic. The implementations should be done in a group of two/three students with appropriate difficulty level. Student should present the solution code and demonstrate execution for alternative solutions they build.	**04**	LO5, LO6

Text Books:

1. Scott M.L., Programming Language Pragmatics 3rd Ed, Morgan – Kaufman Publishers.
2. Harold Abelson and Gerald Jay Sussman with Julie Sussman foreword by Alan J. Perlis, Structure and Interpretation of Computer Programs (2nd Edition)
3. Graham Hutton, Programming in Haskell, 2nd Edition, Cambridge University Press, 2016

References:

1. Sethi R, Programming Languages Concepts and Constructs , 2nd Ed, Pearson Education
2. Yogesh Sajanikar, Haskell Cookbook, Packt Publishing, 2017

Online Reference:

1. University Stuttgart Germany Lab Course on Programming Paradigms http://software-lab.org/teaching/winter2019/pp/
2. Course at MIT Structure and Interpretation of Computer Programs [2019] https://web.mit.edu/u/6.037/
3. https://www.tutorialspoint.com/haskell

List of Experiments:

Faculty teaching the subject must design appropriate tutorials and Experiments as mentioned in every module of syllabus. There must be at least 15 experiments, 03 Tutorials and 01 Write up for Module VI Programming Assignment conducted as part of the laboratory.

Term Work:

Term Work shall consist of at least 15 Practical's and tutorials based on the above modules, but not limited to. Also, Term work Journal must include at least 2 assignments/tutorial and 01 write up as mentioned above.

Term Work Marks: 25 Marks (Total marks) = 15 Marks (Experiment) + 5 Marks (Assignments/tutorial/write up) + 5 Marks (Attendance)

Practical & Oral Exam: An Oral & Practical exam will be held based on the above syllabus.

Lab Code	Lab Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ITL304	Java Lab (SBL)	--	04	--	--	02	--	02

Lab Code	Lab Name	Examination Scheme						
		Theory Marks				Term Work	Pract. /Oral	Total
		Internal assessment			End Sem. Exam			
		Test1	Test 2	Avg.				
ITL304	Java Lab (SBL)	--	--	--	--	25	25	50

Lab Objectives:

Sr. No.	Lab Objectives
The Lab experiments aims:	
1	To understand the concepts of object-oriented paradigm in the Java programming language.
2	To understand the importance of Classes & objects along with constructors, Arrays ,Strings and vectors
3	To learn the principles of inheritance, interface and packages and demonstrate the concept of reusability for faster development.
4	To recognize usage of Exception Handling, Multithreading, Input Output streams in various applications
5	To learn designing, implementing, testing, and debugging graphical user interfaces in Java using Swings and AWT components that can react to different user events.
6	To develop graphical user interfaces using JavaFX controls.

Lab Outcomes:

Sr. No.	Lab Outcomes	Cognitive levels of attainment as per Bloom's Taxonomy
On successful completion, of course, learner/student will be able to:		
1	Explain the fundamental concepts of Java Programing.	L1, L2
2	Use the concepts of classes, objects, members of a class and the relationships among them needed for a finding the solution to specific problem.	L3
3	Demonstrate how to extend java classes and achieve reusability using Inheritance, Interface and Packages.	L3
4	Construct robust and faster programmed solutions to problems using concept of Multithreading, exceptions and file handling	L3
5	Design and develop Graphical User Interface using Abstract Window Toolkit and Swings along with response to the events.	L6

6	Develop Graphical User Interface by exploring JavaFX framework based on MVC architecture.	L6

Prerequisite: Basics of Computer Programming

Hardware & Software Requirements:

Hardware Requirements	Software Requirements	Other Requirements
PC With Following Configuration 1. Intel PIV Processor 2. 2 GB RAM 3. 500 GB Harddisk 4. Network interface card	1. Windows or Linux Desktop OS 2. JDK 1.8 or higher 3. Notepad ++ 4.JAVA IDEs like Netbeans or Eclipse	1. Internet Connection for installing additional packages if required

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours	LO Mapping
0	Prerequisite	Basics of Computer Programming.	**02**	-
I	Java Fundamentals	**Overview of procedure and object oriented Programming**, Java Designing Goals and Features of Java Language. **Introduction to the principles of object-oriented programming**: Classes, Objects, Abstraction, Encapsulation, Inheritance, Polymorphism. Keywords, Data types, Variables, Operators, Expressions, Types of variables and methods. **Control Statements**: If Statement, If-else, Nested if, switch Statement, break, continue. **Iteration Statements:** for loop, while loop, and do-while loop (Perform any 2 programs that covers Classes, Methods, Control structures and Looping statements) 1) Implement a java program to calculate gross salary & net salary taking the following data. Input: empno, empname, basic Process: DA=70% of basic HRA=30% of basic CCA=Rs240/- PF=10% of basic PT= Rs100/- 2) Five Bikers Compete in a race such that they drive at a constant speed which may or may not be the same as the other. To qualify the race, the speed of a racer must be more than the average speed of all 5 racers. Write a Java program to take as input the speed of each racer and print back the speed of qualifying racers. 3) Write a Java program that prints all real solutions to the quadratic equation $ax^2+bx+c = 0$. Read in a, b, c and use the quadratic formula. If the discriminate b^2-	**07**	LO1

		4ac is negative, display a message stating that there are no real solutions? 4) Write a Menu driven program in java to implement simple banking application. Application should read the customer name, account number, initial balance, rate of interest, contact number and address field etc. Application should have following methods. 1. createAccount() 2. deposit() 3. withdraw() 4. computeInterest() 5. displayBalance() 5)Write a menu driven Java program which will read a number and should implement the following methods 1. factorial() 2. testArmstrong() 3. testPalindrome() 4. testPrime() 5. fibonacciSeries() 6) Create a Java based application to perform various ways of Method overloading.		
II	Classes, objects, Arrays and Strings	**Classes & Objects**: Reference Variables, Passing parameters to Methods and Returning parameters from the methods, Static members, Non-Static members Nested and Inner Classes. Static Initialization Block(SIB), Instance Initialization Block(IIB) **Constructors**: Parameterized Constructors, chaining of constructor, finalize() Method, Method overloading, Constructors Overloading. Recursion, Command-Line Arguments. Wrapper classes, InputBufferReader, OutputBufferReader, String Buffer classes, String functions. **Arrays & Vectors**: One and Two Dimensional arrays, Irregular arrays, dynamic arrays, Array List and Array of Object. (Perform any 3 programs that covers Classes & objects, Constructors, Command Line Arguments, Arrays/Vectors,String function and recursions). **Experiments:** 1) Write a program that would print the information (name, year of joining, salary, address) of three employees by creating a class named 'Employee'. The output should be as follows: Name Year of joining Address Robert 1994 64C- WallsStreat Sam 2000 68D- WallsStreat John 1999 26B- WallsStreat 2) Write a program to print the area of a rectangle by creating a class named 'Area' having two methods. First method named as 'setDim' takes length and breadth of rectangle as parameters and the second	**07**	LO1 LO2

		method named as 'getArea' returns the area of the rectangle. Length and breadth of rectangle are entered through keyboard. 3) Write a Java program to illustrate Constructor Chaining. 4) Create a class 'Student' with three data members which are name, age and address. The constructor of the class assigns default values name as "unknown", age as '0' and address as "not available". It has two members with the same name 'setInfo'. First method has two parameters for name and age and assigns the same whereas the second method takes has three parameters which are assigned to name, age and address respectively. Print the name, age and address of 10 students. Hint - Use array of objects. 5) Write a java programs to add n strings in a vector array. Input new string and check whether it is present in the vector. If it is present delete it otherwise add it to the vector. 6) Print the sum, difference and product of two complex numbers by creating a class named 'Complex' with separate methods for each operation whose real and imaginary parts are entered by user. 7)Write menu driven program to implement recursive Functions for following tasks. a) To find GCD and LCM b) To print n Fibonacci numbers c) To find reverse of number d) To solve 1 +2+3+4+.....+(n- l)+n 8) Print Reverse Array list in java by writing our own function.		
III	Inheritance, Packages and Interfaces.	**Inheritance**: Inheritance Basics, Types of Inheritance in Java, member access, using Super- to call superclass Constructor, to access member of super class(variables and methods), creating multilevel hierarchy, Constructors in inheritance, method overriding, Abstract classes and methods, using final, Dynamic Method Dispatch **Packages**: Defining packages, creating packages and Importing and accessing packages **Interfaces**: Defining, implementing and extending interfaces, variables in interfaces, Default Method in Interface ,Static Method in interface, Abstract Classes vs Interfaces. (Perform any 3 programs covering Inheritance, Interfaces and Packages). **Experiments** 1) Create a Teacher class and derive Professor/ Associate_Professor/Assistant_Professor class from Teacher class. Define appropriate constructor for all the classes. Also define a method to display information of Teacher. Make necessary assumptions as required.	**10**	LO1 LO3

2) Create a class Book and define a display method to display book information. Inherit Reference_Book and Magazine classes from Book class and override display method of Book class in Reference_Book and Magazine classes. Make necessary assumptions required.

3) A university has two types of students — graduate students and research students. The University maintains the record of name, age and programme of every student. For graduate students, additional information like percentage of marks and stream, like science, commerce, etc. is recorded; whereas for research students, additionally, specialization and years of working experience, if any, is recorded. Each class has a constructor. The constructor of subclasses makes a call to constructor of the superclass. Assume that every constructor has the same number of parameters as the number of instance variables. In addition, every subclass has a method that may update the instance variable values of that subclass. All the classes have a function display_student_info( ), the subclasses must override this method of the base class. Every student is either a graduate student or a research student.
Perform the following tasks for the description given above using Java :

(i) Create the three classes with proper instance variables and methods, with suitable inheritance.

(ii) Create at least one parameterised constructor for each class.

(iii) Implement the display_student_info( ) method in each class.

4) An employee works in a particular department of an organization. Every employee has an employee number, name and draws a particular salary. Every department has a name and a head of department. The head of department is an employee. Every year a new head of department takes over. Also, every year an employee is given an annual salary enhancement. Identify and design the classes for the above description with suitable instance variables and methods. The classes should be such that they implement information hiding. You must give logic in support of your design. Also create two objects of each class.

5) Consider a hierarchy, where a sportsperson can either be an athlete or a hockey player. Every sportsperson has a unique name. An athlete is characterized by the event in which he/she participates; whereas a hockey player is characterised by the number of goals scored by him/her.

Perform the following tasks using Java :

(i)Create the class hierarchy with suitable instance

		variables and methods. (ii) Create a suitable constructor for each class. (iii) Create a method named display_all_info with suitable parameters. This method should display all the information about the object of a class. (iv) Write the main method that demonstrates polymorphism. 6) Create an interface vehicle and classes like bicycle, car, bike etc, having common functionalities and put all the common functionalities in the interface. Classes like Bicycle, Bike, car etc implement all these functionalities in their own class in their own way 7) Create a class "Amount In Words" within a user defined package to convert the amount into words. (Consider amount not to be more than 100000).		
IV	Exception Handling, Multithreading, Input Output streams	**Exception Handling:** Exception-Handling Fundamentals, Exception Types, Exception class Hierarchy, Using try and catch, Multiple catch Clauses, Nested try Statements, throw, throws, finally , Java's Built-in Exceptions, Creating Your Own Exception Subclasses **Multithreaded Programming:** The Java Thread Model and Thread Life Cycle, Thread Priorities, Creating a Thread, Implementing Runnable, Extending Thread, Creating Multiple Threads, Synchronization: Using Synchronized Methods, The synchronized Statement **I/O Streams:** Streams, Byte Streams and Character, The Predefined Streams, Reading Console Input, Reading Characters, Reading Strings, Writing Console Output, Reading and Writing Files. (Perform any 3 programs that cover Exception Handling, Multithreading and I/O Streams). **Experiments:** 1) Write java program where user will enter loginid and password as input. The password should be 8 digit containing one digit and one special symbol. If user enter valid password satisfying above criteria then show "Login Successful Message". If user enter invalid Password then create InvalidPasswordException stating Please enter valid password of length 8 containing one digit and one Special Symbol. 2) Java Program to Create Account with 1000 Rs Minimum Balance, Deposit Amount, Withdraw Amount and Also Throws LessBalanceException. It has a Class Called LessBalanceException Which returns the Statement that Says WithDraw Amount(_Rs) is Not Valid. It has a Class Which Creates 2 Accounts, Both Account Deposite Money and One Account Tries to WithDraw more Money	**10**	LO1 LO3 LO4

		Which Generates a LessBalanceException Take Appropriate Action for the Same. 3) Create two threads such that one thread will print even number and another will print odd number in an ordered fashion. 4) Assume that two brothers, Joe and John, share a common bank account. They both can, independently, read the balance, make a deposit, and withdraw some money. Implement java application demonstrate how the transaction in a bank can be carried out concurrently. 5) You have been given the list of the names of the files in a directory. You have to select Java files from them. A file is a Java file if it's name ends with ".java". For e.g. File- "Names.java" is a Java file, "FileNames.java.pdf" is not. **Input:** test.java, ABC.doc, Demo.pdf, add.java, factorial.java, sum.txt **Output:** tset.java, add.java, factorial.java		
V	GUI programming- I (AWT, Event Handling, Swing)	**Designing Graphical User Interfaces in Java**: Components and Containers, Basics of Components, Using Containers, Layout Managers, AWT Components, Adding a Menu to Window, Extending GUI Features **Event-Driven Programming in Java**: Event-Handling Process, Event-Handling Mechanism, Delegation Modelof Event Handling, Event Classes, Event Sources, Event Listeners, Adapter Classes as Helper Classes in Event Handling. **Introducing Swing:** AWT vs Swings, Components and Containers, Swing Packages, A Simple Swing Application, Painting in Swing, Designing Swing GUI Application using Buttons, JLabels, Checkboxes, Radio Buttons, JScrollPane, JList, JComboBox, Trees, TablesScroll pane Menus and Toolbar (Perform any 3 programs that contain AWT, Event handling and Swing to build GUI application). 1)Write a Java program to implement Swing components namely Buttons, ,JLabels, Checkboxes, Radio Buttons, JScrollPane, JList, JComboBox, Trees, Tables Scroll pane Menus and Toolbars to design interactive GUI. 2) Write a program to create a window with four text fields for the name, street, city and pincode with suitable labels. Also windows contains a button MyInfo. When the user types the name, his street, city and pincode and then clicks the button, the types	**12**	LO1 LO4 LO5

		details must appear in Arial Font with Size 32, Italics. 3) Write a Java program to create a simple calculator using java AWT elements. .Use a grid layout to arrange buttons for the digits and basic operation +, -, /, *. Add a text felid to display the results. 4) Write a Java Program to create a Student Profile form using AWT controls. 5) Write a Java Program to simulate traffic signal light using AWT and Swing Components. 6) Write a Java Program to create a color palette. Declare a grid of Buttons to set the color names. Change the background color by clicking on the color button. 7) Build a GUI program that allows the user to add objects to a collection and perform search and sort on that collection.(Hint. Use Swing components like JButton, JList, JFrame, JPanel and JOptionPane.)		
VI	GUI Programming-II (JavaFX)	JavaFX Basic Concepts, JavaFX application skeleton, Compiling and running JavaFX program,Simple JavaFX control:Label,Using Buttons and events, Drawing directly on Canvas. (Perform any one program that contains the concept of JavaFX). 1)Write a Java program to design a Login Form using JavaFX Controls. 2)Write Java program to draw various shapes on Canvas using JavaFX.	**04**	LO1 LO5 LO6

Text Books:

1. Herbert Schildt, "Java-The Complete Reference", Tenth Edition, Oracle Press, Tata McGraw Hill Education.
2. E. Balguruswamy, "Programming with Java A primer", Fifth edition, Tata McGraw Hill Publication
3. Anita Seth, B.L.Juneja, " Java One Step Ahead", oxford university press.

References:

1. D.T. Editorial Services, "Java 8 Programming Black Book", Dreamtech Press.
2. Learn to Master Java by Star EDU Solutions

3. Yashvant Kanetkar, "Let Us Java" ,4th Edition ,BPB Publications.

Term Work:

The Term work shall consist of at least 15 practical based on the above list. The term work Journal must include at least 2 Programming assignments. The Programming assignments should be based on real world applications which cover concepts from more than one modules of syllabus**.**

Term Work Marks: 25 Marks (Total marks) = 15 Marks (Experiment) + 5 Marks (Assignments/tutorial/write up) + 5 Marks (Attendance)

Practical & Oral Exam: An Oral & Practical exam will be held based on the above syllabus.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ITM301	Mini Project – 1 A for Front end /backend Application using JAVA	--	04	--	--	02	--	02

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Pract. /Oral	Total
		Internal assessment			End Sem. Exam			
		Test1	Test 2	Avg.				
ITM301	Mini Project – 1 A for Front end /backend Application using JAVA	--	--	--	--	25	25	50

Course Objectives

1. To acquaint with the process of identifying the needs and converting it into the problem.
2. To familiarize the process of solving the problem in a group.
3. To acquaint with the process of applying basic engineering fundamentals to attempt solutions to the problems.
4. To inculcate the process of self-learning and research.

Course Outcome: Learner will be able to…

1. Identify problems based on societal /research needs.
2. Apply Knowledge and skill to solve societal problems in a group.
3. Develop interpersonal skills to work as member of a group or leader.
4. Draw the proper inferences from available results through theoretical/ experimental/simulations.
5. Analyse the impact of solutions in societal and environmental context for sustainable development.
6. Use standard norms of engineering practices
7. Excel in written and oral communication.
8. Demonstrate capabilities of self-learning in a group, which leads to life long learning.
9. Demonstrate project management principles during project work.

Guidelines for Mini Project

- Students shall form a group of 3 to 4 students, while forming a group shall not be allowed less than three or more than four students, as it is a group activity.
- Students should do survey and identify needs, which shall be converted into problem statement for mini project in consultation with faculty supervisor/head of department/internal committee of faculties.
- Students hall submit implementation plan in the form of Gantt/PERT/CPM chart, which will cover weekly activity of mini project.
- A log book to be prepared by each group, wherein group can record weekly work progress, guide/supervisor can verify and record notes/comments.
- Faculty supervisor may give inputs to students during mini project activity; however, focus shall be on self-learning.

- Students in a group shall understand problem effectively, propose multiple solution and select best possible solution in consultation with guide/ supervisor.
- Students shall convert the best solution into working model using various components of their domain areas and demonstrate.
- The solution to be validated with proper justification and report to be compiled in standard format of University of Mumbai.
- With the focus on the self-learning, innovation, addressing societal problems and entrepreneurship quality development within the students through the Mini Projects, it is preferable that a single project of appropriate level and quality to be carried out in two semesters by all the groups of the students. i.e. Mini Project 1 in semester III and IV. Similarly, Mini Project 2 in semesters V and VI.
- However, based on the individual students or group capability, with the mentor's recommendations, if the proposed Mini Project adhering to the qualitative aspects mentioned above gets completed in odd semester, then that group can be allowed to work on the extension of the Mini Project with suitable improvements/modifications or a completely new project idea in even semester. This policy can be adopted on case by case basis.

Guidelines for Assessment of Mini Project:

Term Work

- The review/ progress monitoring committee shall be constituted by head of departments of each institute. The progress of mini project to be evaluated on continuous basis, minimum two reviews in each semester.
- In continuous assessment focus shall also be on each individual student, assessment based on individual's contribution in group activity, their understanding and response to questions.
- Distribution of Term work marks for both semesters shall be as below;
    - Marks awarded by guide/supervisor based on log book : 10
    - Marks awarded by review committee : 10
    - Quality of Project report : 05

Review/progress monitoring committee may consider following points for assessment based on either one year or half year project as mentioned in general guidelines.

One-year project:

- In first semester entire theoretical solution shall be ready, including components/system selection and cost analysis. Two reviews will be conducted based on presentation given by students group.
    - First shall be for finalisation of problem
    - Second shall be on finalisation of proposed solution of problem.
- In second semester expected work shall be procurement of component's/systems, building of working prototype, testing and validation of results based on work completed in an earlier semester.
    - First review is based on readiness of building working prototype to be conducted.
    - Second review shall be based on poster presentation cum demonstration of working model in last month of the said semester.

Half-year project:

- In this case in one semester students' group shall complete project in all aspects including,
    - Identification of need/problem
    - Proposed final solution
    - Procurement of components/systems
    - Building prototype and testing
- Two reviews will be conducted for continuous assessment,
    - First shall be for finalisation of problem and proposed solution
    - Second shall be for implementation and testing of solution.

Assessment criteria of Mini Project.

Mini Project shall be assessed based on following criteria;

1. Quality of survey/ need identification
2. Clarity of Problem definition based on need.
3. Innovativeness in solutions
4. Feasibility of proposed problem solutions and selection of best solution
5. Cost effectiveness
6. Societal impact
7. Innovativeness
8. Cost effectiveness and Societal impact
9. Full functioning of working model as per stated requirements
10. Effective use of skill sets
11. Effective use of standard engineering norms
12. Contribution of an individual's as member or leader
13. Clarity in written and oral communication

- In **one year, project**, first semester evaluation may be based on first six criteria's and remaining may be used for second semester evaluation of performance of students in mini project.
- In case of **half year project** all criteria's in generic may be considered for evaluation of performance of students in mini project.

Guidelines for Assessment of Mini Project Practical/Oral Examination:

- Report should be prepared as per the guidelines issued by the University of Mumbai.
- Mini Project shall be assessed through a presentation and demonstration of working model by the student project group to a panel of Internal and External Examiners preferably from industry or research organisations having experience of more than five years approved by head of Institution.
- Students shall be motivated to publish a paper based on the work in Conferences/students competitions.

Mini Project shall be assessed based on following points;

1. Quality of problem and Clarity
2. Innovativeness in solutions
3. Cost effectiveness and Societal impact
4. Full functioning of working model as per stated requirements
5. Effective use of skill sets
6. Effective use of standard engineering norms
7. Contribution of an individual's as member or leader
8. Clarity in written and oral communication

Program Structure for Second Year
Engineering Semester III & IV
UNIVERSITY OF MUMBAI
(With Effect from 2020-2021)

Semester IV

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ITC401	Engineering Mathematics-IV	3	--	1	3	--	1	4
ITC402	Computer Network and Network Design	3	--	--	3	--	--	3
ITC403	Operating System	3	--	--	3	--	--	3
ITC404	Automata Theory	3	--	--	3	--	--	3
ITC405	Computer Organization and Architecture	3	--	--	3	--	--	3
ITL401	Network Lab	--	2	--	--	1	--	1
ITL402	Unix Lab	--	2	--	--	1	--	1
ITL403	Microprocessor Lab	--	2	--	--	1	--	1
ITL404	Python Lab (SBL)	--	4	--	--	2	--	2
ITM401	Mini Project – 1 B for Python based automation projects	--	4[$]	--	--	2	--	2
Total		**15**	**14**	**1**	**15**	**7**	**1**	**23**

Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Pract/ oral	Total
		Internal Assessment			End Sem. Exam.	Exam. Duration (in Hrs)			
		Test 1	Test 2	Avg.					
ITC401	Engineering Mathematics-IV	20	20	20	80	3	25	--	125
ITC402	Computer Network and Network Design	20	20	20	80	3	--	--	100
ITC403	Operating System	20	20	20	80	3	--	--	100
ITC404	Automata Theory	20	20	20	80	3	--	--	100
ITC405	Computer Organization and Architecture	20	20	20	80	3	--	--	100
ITL401	Network Lab	--	--	--	--	--	25	25	50
ITL402	Unix Lab	--	--	--	--	--	25	25	50
ITL403	Microprocessor Lab	--	--	--	--	--	25	25	50
ITL404	Python Lab (SBL)	--	--	--	--	--	25	25	50
ITM401	Mini Project – 1 B for Python based automation projects	--	--	--	--	--	25	25	50
Total		**--**	**--**	**100**	**400**	**--**	**150**	**75**	**775**

$ indicates work load of Learner (Not Faculty), for Mini Project

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	TW/Pract	Tut.	Total
ITC401	Engineering Mathematics-IV	03	-	01	03	-	01	04

Course Code	Course Name	Examination Scheme							
		Theory				Term Work	Pract	Oral	Total
		Internal Assessment			End Sem Exam				
		Test1	Test2	Avg of Test 1 & 2					
ITC401	Engineering Mathematics-IV	20	20	20	80	25	-	-	125

Pre-requisite: Engineering Mathematics-I, Engineering Mathematics-II, Engineering Mathematics-III, Binomial Distribution.

Course Objectives:

Sr. No.	Course Objectives
The course aims:	
1	Matrix algebra to understand engineering problems
2	Line and Contour integrals and expansion of a complex valued function in a power series.
3	Z-Transforms and Inverse Z-Transforms with its properties.
4	The concepts of probability distributions and sampling theory for small samples.
5	Linear and Non-linear programming problems of optimization.

Course Outcomes:

Sr. No.	Course Outcomes	Cognitive levels of attainment as per Bloom's Taxonomy
On successful completion, of course, learner/student will be able to:		
1	Apply the concepts of eigenvalues and eigenvectors in engineering problems.	L1, L2, L3
2	Use the concepts of Complex Integration for evaluating integrals, computing residues & evaluate various contour integrals.	L3
3	Apply the concept of Z- transformation and inverse in engineering problems.	L1,L2,L3
4	Use the concept of probability distribution and sampling theory to engineering problems.	L3
5	Apply the concept of Linear Programming Problems to optimization.	L1, L2, L3
6	Solve Non-Linear Programming Problems for optimization of engineering problems.	L3

Module	Detailed Contents	Hours	CO Mapping
01	**Module: Linear Algebra (Theory of Matrices)** 1.1 Characteristic Equation, Eigenvalues and Eigenvectors, and properties (without proof) 1.2 Cayley-Hamilton Theorem (without proof), verification and reduction of higher degree polynomials 1.3 Similarity of matrices, diagonalizable and non-diagonalizable matrices **Self-learning Topics:** Derogatory and non-derogatory matrices, Functions of Square Matrix, Linear Transformations, Quadratic forms.	6	CO1
02	**Module: Complex Integration** 2.1 Line Integral, Cauchy's Integral theorem for simple connected and multiply connected regions (without proof), Cauchy's Integral formula (without proof). 2.2 Taylor's and Laurent's series (without proof). 2.3 Definition of Singularity, Zeroes, poles of *f(z)*, Residues, Cauchy's Residue Theorem (without proof) **Self-learning Topics:** Application of Residue Theorem to evaluate real integrations.	7	CO2
03	**Module: Z Transform** 3.1 Definition and Region of Convergence, Transform of Standard Functions: $\{k^n a^k\}, \{a^{\lvert k\rvert}\}, \{{}^{k+n}_{n}C.\, a^k\}, \{c^k \sin(\alpha k+\beta)\}, \{c^k \sinh \alpha k\}, \{c^k \cosh \alpha k\}.$ 3.2 Properties of Z Transform: Change of Scale, Shifting Property, Multiplication, and Division by k, Convolution theorem. 3.3 Inverse Z transform: Partial Fraction Method, Convolution Method. **Self-learning Topics:** Initial value theorem, Final value theorem, Inverse of Z Transform by Binomial Expansion	5	CO3
04	**Module: Probability Distribution and Sampling Theory** 4.1 Probability Distribution: Poisson and Normal distribution 4.2 Sampling distribution, Test of Hypothesis, Level of Significance, Critical region, One-tailed, and two-tailed test, Degree of freedom. 4.3 Students' t-distribution (Small sample). Test the significance of mean and Difference between the means of two samples. Chi-Square Test: Test of goodness of fit and independence of attributes, Contingency table. **Self-learning Topics:** Test significance for Large samples, Estimate parameters of a population, Yate's Correction.	6	CO4
05	**Module: Linear Programming Problems** 5.1 Types of solutions, Standard and Canonical of LPP, Basic and Feasible solutions, slack variables, surplus variables, Simplex method. 5.2 Artificial variables, Big-M method (Method of penalty) 5.3 Duality, Dual of LPP and Dual Simplex Method	6	CO5

	Self-learning Topics: SensitivityAnalysis,Two-Phase Simplex Method, Revised Simplex Method.		
06	**Module: Nonlinear Programming Problems** 6.1 NLPP with one equality constraint (two or three variables) using the method of Lagrange's multipliers 6.2 NLPP with two equality constraints 6.3 NLPP with inequality constraint: Kuhn-Tucker conditions **Self-learning Topics:** Problems with two inequality constraints, Unconstrained optimization: One-dimensional search method (Golden Search method, Newton's method). Gradient Search method	6	CO6

References:

1. Advanced Engineering Mathematics, Erwin Kreyszig, John Wiley & Sons.
2. Advanced Engineering Mathematics, R. K. Jain and S. R. K. Iyengar, Narosa.
3. Complex Variables and Applications, Brown and Churchill, McGraw-Hill Education.
4. Probability, Statistics and Random Processes, T. Veerarajan, McGraw-Hill Education.
5. Operations Research: An Introduction, Hamdy A Taha, Pearson.
6. Engineering Optimization: Theory and Practice, S.S Rao, Wiley-Blackwell.
7. Operations Research, Hira and Gupta, S. Chand Publication.

Online References:

Sr. No.	Website Name
1.	https://www.nptel.ac.in

Term Work:

General Instructions:

1. Batch wise tutorials have to be conducted. The number of students per batch will be as per University pattern for practicals.
2. Students must be encouraged to write at least 6 class tutorials on the entire syllabus.
3. A group of 4-6 students should be assigned a self-learning topic. Students should prepare a presentation/problem solving of 10-15 minutes. This will be considered as a mini project in Engineering Mathematics. This project will be graded out of 10 marks depending on the performance of the students.

The distribution of Term Work marks will be as follows –

1.	Attendance (Theory and Tutorial)	05 marks
2.	Class Tutorials on entire syllabus	10 marks
3.	Mini project	10 marks

Assessment:

Internal Assessment (IA) for 20 marks:

- IA will consist of Two Compulsory Internal Assessment Tests. Approximately 40% to 50% of syllabus content must be covered in First IA Test and remaining 40% to 50% of syllabus content must be covered in Second IA Test

- **Question paper format**

1. The question paper will comprise a total of 6 questions, each carrying 20 marks.
2. Out of the 6 questions, 4 questions have to be attempted.
3. Question 1, based on the entire syllabus, will have 4 sub-questions of 5 marks each and is compulsory.
4. Question 2 to Question 6 will have 3 sub-questions, each of 6, 6, and 8 marks, respectively.
5. Each sub-question in (4) will be from different modules of the syllabus.
6. Weightage of each module will be proportional to the number of lecture hours, as mentioned in the syllabus.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical /Oral	Tutorial	Total
ITC402	Computer Network and Network Design	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Pract. /Oral	Total
		Internal assessment			End Sem. Exam			
		Test1	Test 2	Avg.				
ITC402	Computer Network and Network Design	20	20	20	80	--	--	100

Course Objectives:

Sr. No.	Course Objectives
The course aims:	
1	Understand the division of network functionalities into layers.
2	Understand the types of transmission media along with data link layer concepts, design issues and protocols
3	Analyze the strength and weaknesses of routing protocols and gain knowledge about IP addressing
4	Understand the data transportation, issues and related protocols for end to end delivery of data.
5	Understand the data presentation techniques used in presentation layer & client/server model in application layer protocols.
6	Design a network for an organization using networking concepts

Course Outcomes:

Sr. No.	Course Outcomes	Cognitive levels of attainment as per Bloom's Taxonomy
On successful completion, of course, learner/student will be able to:		
1	Describe the functionalities of each layer of the models and compare the Models.	L1
2	Categorize the types of transmission media and explain data link layer concepts, design issues and protocols.	L2, L3, L4
3	Analyze the routing protocols and assign IP address to networks.	L4
4	Explain the data transportation and session management issues and related protocols used for end to end delivery of data.	L1, L2
5	List the data presentation techniques and illustrate the client/server model in application layer protocols.	L1, L3
6	Use of networking concepts of IP address, Routing, and application services to design a network for an organization	L3

Prerequisite: PCOM

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours	CO Mapping
0	**Prerequisite**	Terminologies of communication	**02**	-
I	**Introduction to Computer Networks**	Uses Of Computer Networks, Network Hardware, Network Software, Protocol Layering, Reference Models: OSI, TCP/IP, Comparison of OSI & TCP/IP, Network Devices. **Self-learning Topics:** Identify the different devices used in Network connection. College campus	**03**	CO1
II	**Physical Layer & Data Link Layer**	**Physical layer:** Guided Media, Unguided Media, Wireless Transmission: Electromagnetic Spectrum. Switching: Circuit-Switched Networks, Packet Switching, Structure Of A Switch **DLL Design Issues** (Services, Framing, Error Control, Flow Control), Error Detection and Correction(Hamming Code,Parity, CRC, Checksum) , Elementary Data Link protocols : Stop and Wait, Sliding Window(Go Back N, Selective Repeat), Piggybacking, HDLC **Medium Access Protocols:** Random Access, Controlled Access, Channelization. Ethernet Protocol: Standard Ethernet, Fast Ethernet (100 Mbps), Gigabit Ethernet, 10-Gigabit Ethernet. **Self-learning Topics:** Differentiate link layer in IOT network and Normal Network.	**08**	CO2
III	**Network Layer**	Network Layer Services, Packet Switching, Network Layer Performance, IPv4 Addressing (classful and classless), Subnetting, Supernetting ,IPv4 Protocol, DHCP, Network Address Translation (NAT). **Routing algorithms**: Distance Vector Routing, Link state routing,Path Vector Routing. **Protocols** –RIP,OSPF,BGP. **Next Generation IP:** IPv6 Addressing,IPv6 Protocol, Transition fromIPV4 to IPV6 **Self-learning Topics:** Study difference between IPV4 and IPV6. Network Class A, B, C, D, E and subnet mask.	**08**	CO3

IV	**Transport Layer & Session Layer**	**Transport Layer:** Transport Layer Services, Connectionless & Connection-oriented Protocols, Transport Layer protocols: User Datagram Protocol: UDP Services, UDP Applications, Transmission Control Protocol: TCP Services, TCP Features, Segment, A TCP Connection, Windows in TCP, Flow Control, Error Control, TCP Congestion Control, TCP Timers. **Session Layer:** Session layer design issues, Session Layer protocol - Remote Procedure Call (RPC), **Self-learning Topics:** List real time example of UDP and TCP.	**07**	CO4
V	**Presentation Layer & Application Layer**	**Presentation layer** :Compression: Comparison between Lossy Compression and Lossless Compression, Huffman Coding, Speech Compression, LZW, RLE, Image Compression – GIF,JPEG. **Application layer:** Standard Client-Server Protocols: World Wide Web, HTTP, FTP, Electronic Mail, Domain Name System (DNS), SNMP **Self-learning Topics:** Difference between HTTP and FTP Protocol.	**05**	CO5
VI	**Network Design Concepts**	Introduction to VLAN ,VPN A case study to design a network for an organization meeting the following guidelines: Networking Devices, IP addressing: Subnetting, Supernetting, Routing Protocols to be used, Services to be used: TELNET, SSH, FTP server, Web server, File server, DHCP server and DNS server. **Self-learning Topics:** Study the Network Design of your college campus.	**06**	CO6

Text Books:

1. Andrew S Tanenbaum, Computer Networks -, 4th Edition, Pearson Education.
2. Behrouz A. Forouzan, Data Communications and Networking ,4th Edition,Mc Graw Hill education.

References:

1. S. Keshav, An Engineering Approach to Computer Networks, 2nd Edition, Pearson Education.
2.B. A. Forouzan, "TCP/IP Protocol Suite", Tata McGraw Hill edition, Third Edition.
3. Ranjan Bose, Information Theory, Coding and Cryptography, Ranjan Bose, Tata McGrawHill , Second Edition.
4. Khalid Sayood, Introduction to Data Compression, Third Edition, Morgan Kaufman.

Online References:

Sr. No.	Website Name
1.	https://www.nptel.ac.in
2.	https://swayam.gov.in
3.	https://www.coursera.org/

Assessment:

Internal Assessment (IA) for 20 marks:

- IA will consist of Two Compulsory Internal Assessment Tests. Approximately 40% to 50% of syllabus content must be covered in First IA Test and remaining 40% to 50% of syllabus content must be covered in Second IA Test

➢ **Question paper format**

- Question Paper will comprise of a total of **six questions each carrying 20 marks Q.1** will be **compulsory** and should **cover maximum contents of the syllabus**
- **Remaining questions** will be **mixed in nature** (part (a) and part (b) of each question must be from different modules. For example, if Q.2 has part (a) from Module 3 then part (b) must be from any other Module randomly selected from all the modules)
- A total of **four questions** need to be answered

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical /Oral	Tutorial	Total
ITC403	Operating System	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Pract. /Oral	Total
		Internal assessment			End Sem. Exam			
		Test1	Test 2	Avg.				
ITC403	Operating System	20	20	20	80	--	--	100

Course Objectives:

Sr. No.	Course Objectives
The course aims:	
1	To understand the major components of Operating System &its functions.
2	To introduce the concept of a process and its management like transition, scheduling, etc.
3	To understand basic concepts related to Inter-process Communication (IPC) like mutual exclusion, deadlock, etc. and role of an Operating System in IPC.
4	To understand the concepts and implementation of memory management policies and virtual memory.
5	To understand functions of Operating System for storage management and device management.
6	To study the need and fundamentalsof special-purpose operating system with the advent of new emerging technologies.

Course Outcomes:

Sr. No.	Course Outcomes	Cognitive levels of attainment as per Bloom's Taxonomy
On successful completion, of course, learner/student will be able to:		
1	Understand the basic concepts related to Operating System.	L1, L2
2	Describe the process management policies and illustrate scheduling of processes by CPU.	L1
3	Explain and apply synchronization primitives and evaluate deadlock conditionsas handled by Operating System.	L2
4	Describe and analyze the memory allocation and management functions of Operating System.	L1
5	Analyze and evaluate the services provided by Operating System for storage management.	L4, L5
6	Compare the functions of various special-purpose Operating Systems.	L2

Prerequisite: Programming Language C

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours	CO Mapping
0	Prerequisite	Programming Language C; Basic of Hardware i.e. ALU, RAM, ROM, HDD, etc.; Computer-System Organization.	**02**	-
I	Fundamentals of Operating System	Introduction to Operating Systems; Operating System Structure and Operations; Functions of Operating Systems; Operating System Services and Interface; System Calls and its Types; System Programs; Operating System Structure; System Boot. **Self-learning Topics:** Study of any three different OS. System calls with examples for different OS.	**03**	CO1
II	Process Management	Basic Concepts of Process; Operation on Process; Process State Model and Transition; Process Control Block; Context Switching; Introduction to Threads; Types of Threads, Thread Models; Basic Concepts of Scheduling; Types of Schedulers; Scheduling Criteria; Scheduling Algorithms. **Self-learning Topics:** Performance comparison of Scheduling Algorithms, Selection of Scheduling Algorithms for different situations, Real-time Scheduling	**06**	CO2
III	ProcessCoordination	Basic Concepts of Inter-process Communication and Synchronization; Race Condition; Critical Region and Problem; Peterson's Solution; Synchronization Hardware and Semaphores; Classic Problems of Synchronization; Message Passing; Introduction to Deadlocks; System Model, Deadlock Characterization; Deadlock Detection and Recovery; Deadlock Prevention; Deadlock Avoidance. **Self-learning Topics:** Study a real time case study for Deadlock detection and recovery.	**09**	CO3
IV	Memory Management	Basic Concepts of Memory Management; Swapping; Contiguous Memory Allocation; Paging; Structure of Page Table; Segmentation; Basic Concepts of Virtual Memory; Demand Paging, Copy-on Write; Page Replacement Algorithms; Thrashing. **Self-learning Topics:** Memory Management	**09**	CO4

		for any one Operating System, Implementation of Page Replacement Algorithms.		
V	Storage Management	Basic Concepts of File System; File Access Methods; Directory Structure; File-System Implementation; Allocation Methods; Free Space Management; Overview of Mass-Storage Structure; Disk Structure; Disk Scheduling; RAID Structure; Introduction to I/O Systems. **Self-learning Topics:** File System for Linux and Windows, Features of I/O facility for different OS.	**06**	CO5
VI	Special-purpose Operating Systems	Open-source and Proprietary Operating System; Fundamentals of Distributed Operating System; Network Operating System;Embedded Operating Systems;Cloud and IoT Operating Systems; Real-Time Operating System;Mobile Operating System; Multimedia Operating System;Comparison between Functions of various Special-purpose Operating Systems. **Self-learning Topics:** Case Study on any one Special-purpose Operating Systems.	**04**	CO6

Text Books:

1. A. Silberschatz, P. Galvin, G. Gagne, Operating System Concepts, 10th ed., Wiley, 2018.
2. W. Stallings, Operating Systems: Internal and Design Principles, 9th ed., Pearson, 2018.
3. A. Tanenbaum, Modern Operating Systems, Pearson, 4th ed., 2015.

Reference Books:

1. N. Chauhan, Principles of Operating Systems, 1st ed., Oxford University Press, 2014.
2. A. Tanenbaum and A. Woodhull, Operating System Design and Implementation, 3rd ed., Pearson.
3. R. Arpaci-Dusseau and A. Arpaci-Dusseau, Operating Systems: Three Easy Pieces, CreateSpace Independent Publishing Platform, 1st ed., 2018.

Online References:

Sr. No.	Website Name
1.	https://www.nptel.ac.in
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- **Remaining questions** will be **mixed in nature** (part (a) and part (b) of each question must be from different modules. For example, if Q.2 has part (a) from Module 3 then part (b) must be from any other Module randomly selected from all the modules)
- A total of **four questions** need to be answered

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical /Oral	Tutorial	Total
ITC404	Automata Theory	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Pract. /Oral	Total
		Internal assessment			End Sem. Exam			
		Test1	Test 2	Avg.				
ITC404	Automata Theory	20	20	20	80	--	--	100

Course Objectives:

Sr. No.	Course Objectives
The course aims:	
1	To learn fundamentals of Regular and Context Free Grammars and Languages.
2	To understand the relation between Regular Language and Finite Automata and machines.
3	To learn how to design Automata's as Acceptors, Verifiers and Translators.
4	To understand the relation between Regular Languages, Contexts free Languages, PDA and TM.
5	To learn how to design PDA as acceptor and TM as Calculators.
6	To learn applications of Automata Theory.

Course Outcomes:

Sr. No.	Course Outcomes	Cognitive levels of attainment as per Bloom's Taxonomy
On successful completion, of course, learner/student will be able to:		
1	Explain, analyze and design Regular languages, Expression and Grammars.	L2, L4, L6
2	Design different types of Finite Automata and Machines as Acceptor, Verifier and Translator.	L6
3	Analyze and design Context Free languages and Grammars.	L4, L6
4	Design different types of Push down Automata as Simple Parser.	L6
5	Design different types of Turing Machines as Acceptor, Verifier, Translator and Basic computing machine.	L6
6	Develop understanding of applications of various Automata.	L6

Prerequisite: Basic Mathematical Fundamentals: Sets, Logic, Relations, Functions.

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours	CO Mapping
0	Prerequisite	Basic Mathematical Fundamentals: Sets, Logic, Relations, Functions.	**02**	-
I	Introduction and Regular Languages	Languages: Alphabets and Strings. Regular Languages: Regular Expressions, Regular Languages, Regular Grammars, RL and LL grammars, Closure properties **Self-learning Topics:** Practice exercise on Regular Expressions. Identify the tools also.	**05**	CO1
II	Finite Automata	Finite Automata: FA as language acceptor or verifier, NFA (with and without ε) , DFA, RE to NFA, NFA to DFA, Reduced DFA , NFA-DFA equivalence, FA to RE. Finite State Machines with output : Moore and Mealy machines. Moore and Mealy M/C conversion. Limitations of FA. **Self-learning Topics:** Practice exercise on FA and NFA	**09**	CO2
III	Context Free Grammars	Context Free Languages: CFG, Leftmost and Rightmost derivations, Ambiguity, Simplification and Normalization (CNF & GNF) and Chomsky Hierarchy (Types 0 to 3) **Self-learning Topics:** Practice numerical or exercise on CFG	**08**	CO3
IV	Push Down Automata	Push Down Automata: Deterministic (single stack) PDA, Equivalence between PDA and CFG. Power and Limitations of PDA. **Self-learning Topics:** List the examples of PDA.	**05**	CO4
V	Turing Machine	Turing Machine: Deterministic TM, Variants of TM, Halting problem, Power of TM. **Self-learning Topics:** Practice numerical of TM.	**07**	CO5
VI	Applications of Automata	Applications of FA, CFG, PDA & TM. Introduction to Compiler & Its phases. **Self-learning Topics:** Case study on any one compiler.	**03**	CO2,CO 3, CO4,CO 5, CO6

Text books

1. J.C.Martin, "Introduction to languages and the Theory of Computation", TMH.
2. Kavi Mahesh, "Theory of Computation A Problem Solving Approach", Wiley India
3. A. V. Aho, R. Shethi, Monica Lam , J.D. Ulman , "Compilers Principles, Techniques and Tools ",Pearson Education.

References

1. John E. Hopcroft, Rajeev Motwani, Jeffrey D. Ullman, "Introduction to Automata Theory, Languages and Computation", Pearson Education.
2. Daniel I.A. Cohen, "Introduction to Computer Theory", John Wiley & Sons.
3. Vivek Kulkarni," Theory of Computation", Oxford University.
4. N.Chandrashekhar, K.L.P. Mishra, "Theory of Computer Science, Automata Languages & Computations", PHI publications.

5.J. J. Donovan, " Systems Programming", TMH.

Online References:

Sr. No.	Website Name
1.	https://www.nptel.ac.in
2.	https://online.stanford.edu
3.	https://www.coursera.org/

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- A total of **four questions** need to be answered

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Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical /Oral	Tutorial	Total
ITC405	Computer Organization and Architecture	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Pract. /Oral	Total
		Internal assessment			End Sem. Exam			
		Test1	Test 2	Avg.				
ITC405	Computer Organization and Architecture	20	20	20	80	--	--	100

Course Objectives:

Sr. No.	Course Objectives
The course aims:	
1	Learn the fundamentals of Digital Logic Design.
2	Conceptualize the basics of organizational and features of a digital computer.
3	Study microprocessor architecture and assembly language programming.
4	Study processor organization and parameters influencing performance of a processor.
5	Analyse various algorithms used for arithmetic operations.
6	Study the function of each element of memory hierarchy and various data transfer techniques used in digital computer.

Course Outcomes:

Sr. No.	Course Outcomes	Cognitive levels of attainment as per Bloom's Taxonomy
On successful completion, of course, learner/student will be able to:		
1	Demonstrate the fundamentals of Digital Logic Design	L1, L2
2	Describe basic organization of computer, the architecture of 8086 microprocessor and implement assembly language programming for 8086 microprocessors.	L1
3	Demonstrate control unit operations and conceptualize instruction level parallelism.	L1, L2
4	List and Identify integers and real numbers and perform computer arithmetic operations on integers.	L1,L4
5	Categorize memory organization and explain the function of each element of a memory hierarchy.	L4
6	Examine different methods for computer I/O mechanism.	L3

Prerequisite: Basics of Electrical Engineering, Fundamentals of Computer.

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours	CO Mapping
0	**Prerequisite**	Basics of Electrical Engineering, Fundamentals of Computer	**02**	
I	**Fundamentals of Logic Design**	Number systems: Introduction to Number systems, Binary Number systems, Signed Binary Numbers, Binary, Octal, Decimal and Hexadecimal number and their conversions, 1's and 2's complement Combinational Circuits: NOT,AND,OR,NAND,NOR,EX-OR,EX-NOR Gates. Half & Full Adder and subtractor, Reduction of Boolean functions using K-map method (2,3,4 Variable), introduction to Multiplexers and Demultiplexers, Encoders & Decoders. Sequential Circuits: Introduction to Flip Flops: SR, JK, D, T, master slave flip flop, Truth Table. **Self-learning Topics:** Number System, Quine-McCluskey,Flip-Flop conversion, Counter Design.	**07**	CO1
II	**Overview of Computer Architecture & Organization**	Introduction of Computer Organization and Architecture. Basic organization of computer and block level description of the functional units. Evolution of Computers, Von Neumann model. Performance measure of Computer Architecture, Amdahl's Law Architecture of 8086 Family, Instruction Set, Addressing Modes, Assembler Directives, Mixed-Language Programming, Stack, Procedure, Macro. **Self-learning Topics:** Interfacing of I/O devices with 8086(8255,ADC,DAC).	**08**	CO2
III	**Processor Organization and Architecture**	CPU Architecture, Instruction formats, basic instruction cycle with Interrupt processing. Instruction interpretation and sequencing. Control Unit: Soft wired (Microprogrammed) and hardwired control unit design methods. Microinstruction sequencing and execution. Micro operations, concepts of nano programming. Introduction to parallel processing concepts, Flynn's classifications, instruction pipelining, pipeline hazards. **Self-learning Topics**: Study the examples on instruction pipelining for practice.	**07**	CO3
IV	**Data Representation and Arithmetic Algorithms**	Booth's algorithm. Division of integers: Restoring and non-restoring division, signed division, basics of floating-point representation IEEE 754 floating point (Single & double precision) number representation. **Self-learning Topics:** Implement Booth's Algorithm and Division methods.	**04**	CO4
V	**Memory Organization**	Introduction to Memory and Memory parameters. Classifications of primary and secondary memories. Types of RAM and ROM, Allocation policies, Memory hierarchy and characteristics. Cache memory: Concept, architecture (L1, L2, L3), mapping techniques. Cache Coherency, Interleaved and Associative memory	**07**	CO5

		Self-learning Topics: Case study on Memory Organization, Numerical on finding EAT, Address mapping.		
VI	**I/O Organization**	Input/output systems, I/O module-need & functions and Types of data transfer techniques: Programmed I/O, Interrupt driven I/O and DMA **Self-learning Topics:** Comparison of all I/O methods.	**04**	CO6

Text Books:

1. R. P. Jain,"Modern Digital Electronics", TMH
2. M. Morris Mano,"Digital Logic and Computer Design", PHI
3. Carl Hamacher, Zvonko Vranesic and Safwat Zaky, Computer Organization, Fifth Edition, Tata McGraw-Hill.
4. William Stallings, Computer Organization and Architecture: Designing for Performance, Eighth Edition,, Pearson
5. John Uffenbeck, 8086/8088 family: Design Programming and Interfacing, (Pearson Education

References:

1. A. Anand Kumar, "Fundamentals of Digital Circuits",. PHI
2. Donald P Leach, Albert Paul Malvino, "Digital Principals & Applications", TMH.
3. B. Govindarajulu,, Computer Architecture and Organization: Design Principles and Applications, Computer Architecture and Organization: Design Principles and Applications, Tata McGraw-Hill
4. Dr. M. Usha, T. S. Srikanth, Computer System Architecture and Organization, First Edition, Wiley-India.
5. John P. Hayes, Computer Architecture and Organization, Third Edition., McGraw-Hill
6. K Bhurchandi, Advanced Microprocessors & Peripherals, Tata McGraw-Hill Education

Online References:

Sr. No.	Website Name
1.	https://www.nptel.ac.in
2.	https://www.geeksforgeeks.org
3.	https://www.coursera.org/

Assessment:

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- A total of **four questions** need to be answered

Lab Code	Lab Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ITL401	Network Lab	--	02	--	--	01	--	01

Lab Code	Lab Name	Examination Scheme						
		Theory Marks				Term Work	Pract. /Oral	Total
		Internal assessment			End Sem. Exam			
		Test1	Test 2	Avg.				
ITL401	Network Lab	--	--	--	--	25	25	50

Lab Objectives:

Sr. No.	Lab Objectives
The Lab experiments aims:	
1	To get familiar with the basic network administration commands
2	To install and configure network simulator and learn basics of TCL scripting.
3	To understand the network simulator environment and visualize a network topology and observe its performance
4	To implement client-server socket programs.
5	To observe and study the traffic flow and the contents of protocol frames.
6	To design and configure a network for an organization

Lab Outcomes:

Sr. No.	Lab Outcomes	Cognitive levels of attainment as per Bloom's Taxonomy
On successful completion, of course, learner/student will be able to:		
1	Execute and evaluate network administration commands and demonstrate their use in different network scenarios	L3, L5
2	Demonstrate the installation and configuration of network simulator.	L1, L2
3	Demonstrate and measure different network scenarios and their performance behavior.	L1, L2
4	Implement the socket programming for client server architecture.	L3
5	Analyze the traffic flow of different protocols	L4
6	Design a network for an organization using a network design tool	L6

Prerequisite: C /Java

Hardware & Software Requirements:

Hardware Requirement:	**Software requirement:**
PC i3 processor and above	NS2.34, Protocol Analyzer (eg. Wireshark), C/Java/python

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours	LO Mapping
0	**Prerequisite**	Programming Language (C/Java), Basic commands of windows and Unix/Linux operating system. editor commands (eg nano/vi editor etc)	**02**	-
I	**Fundamentals of Computer Network**	Understanding Basic networking Commands: ifconfig ,ip, traceroute, tracepath, ping, netstat, ss, dig, nslookup, route, host, arp, hostname, curl or wget, mtr, whois, tcpdump • Execute and analyze basic networking commands.	**02**	LO1
II	**Basics of Network simulation**	Installation and configuration of NS2. Introduction to Tcl Hello Programming • Installation and configuring of NS-2 simulator and introduction to Tcl using Hello program	**02**	LO2
III	**Simulation of Network Topology with different Protocols**	Implementation of Specific Network topology with respect to 1. Number of nodes and physical layer configuration 2. Graphical simulation ofnetwork with RoutingProtocols(Distance Vector/ Link State Routing) and trafficconsideration (TCP, UDP)using NAM. 3. Analysis of networkperformance for quality ofservice parameters such aspacket-delivery-ratio, delayand throughput 4. Comparative analysis of routing protocols with respect to QOS parametersusing Xgraph/gnuplot fordifferent load conditions. • Write TCL scripts to create topologies. Create and run traffics and analyze the result using NS2 • Write TCL scripts for topology with Graphical simulation of traffic consideration (TCP, UDP) using NAM and plot the graph • Implement distance vector and link state routing protocols in NS2.	**06**	LO3 LO5
IV	**Socket Programming**	Socket Programming with C/Java/python 1. TCP Client, TCP Server 2. UDP Client, UDP Server • To study and Implement Socket Programming using TCP. • To study and Implement Socket Programming	**04**	LO4

		using UDP		
V	**Protocol Analyzer**	1. Study of various Network Protocol Analyzer Tools likeWireshark, tcpdump, Windump, Microsoft Message Analyzer, Ettercap, Nirsoft SmartSniff etc. 2. Install one of the Network protocol analyzer tools and analyze the traffic • Study various network protocol analyzer tools and analyze the network traffics using one of the network protocol analyzer tools.	**04**	LO5
VI	**Network Design**	Network Design for an organization using the following concepts: 1. Addressing (IP Address Assignment), 2. Naming (DNS) 3. Routing • Perform remote login using Telnet Server • Design a network for an organization using the concepts of Addressing (IP Address Assignment), Naming (DNS) and Routing. Also mention the internetworking devices used	**06**	LO6

Text Books:

1. Computer Network Simulation in NS2 Basic Concepts and Protocol Implementation.-Prof Neeraj Bhargava,Pramod
Singh Rathore,Dr.Ritu Bhargava,Dr.Abhishek Kumar, First Edition.BPB Publication.
2. Packet analysis with Wire shark, Anish Nath, PACKT publishing
3. TCP/IP Protocol Suite 4th Edition by Behrouz A. Forouzan

References:

1. NS2.34 Manual
2. Practical Packet Analysis: Using Wireshark to Solve Real-World Network Problems by Chris Sanders

Term Work: Term Work shall consist of at least 10 to 12 practical's based on the above list. Also Term work Journal must include at least 2 assignments.

Term Work Marks: 25 Marks (Total marks) = 15 Marks (Experiment) + 5 Marks (Assignments) + 5 Marks (Attendance)

Practical & Oral Exam: An Oral & Practical exam will be held based on the above syllabus.

Lab Code	Lab Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ITL402	Unix Lab	--	02	--	--	01	--	01

Lab Code	Lab Name	Examination Scheme						
		Theory Marks				Term Work	Pract. /Oral	Total
		Internal assessment			End Sem. Exam			
		Test1	Test 2	Avg.				
ITL402	Unix Lab	--	--	--	--	25	25	50

Lab Objectives:

Sr. No.	Lab Objectives
The Lab experiments aims:	
1	To understand architecture and installation of Unix Operating System
2	To learn Unix general purpose commands and programming in Unix editor environment
3	To understand file system management and user management commands in Unix.
4	To understand process management and memory management commands in Unix
5	To learn basic shell scripting.
6	To learn scripting using awk and perl languages.

Lab Outcomes:

Sr. No.	Lab Outcomes	Cognitive levels of attainment as per Bloom's Taxonomy
On successful completion, of course, learner/student will be able to:		
1	Understand the architecture and functioning of Unix	L1, L2
2	Identify the Unix general purpose commands	L4
3	Apply Unix commands for system administrative tasks such as file system management and user management.	L3
4	Execute Unix commands for system administrative tasks such as process management and memory management	L4
5	Implement basic shell scripts for different applications.	L3
6	Implement advanced scripts using awk & perl languages and grep, sed, etc. commandsfor performing various tasks.	L3

Prerequisite: Programming Language C

Hardware & Software Requirements:

Hardware Requirement:	**Software requirement:**
PC i3 processor and above	Unix, Editor, Bash shell, Bourne shell and C shell

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours	LO Mapping
0	Prerequisite	Basic Programming Skills, Concepts of Operating System	**02**	-
I	Introduction to Unix	Case Study: Brief History of UNIX, Unix Architecture; Installation of Unix Operating System	**03**	LO1
II	Basic Commands	a) Execution of Unix General Purpose Utility Commands like echo, clear, exit, date, time, uptime, cal, cat, tty, man, which, history, id, pwd, whoami, ping, ifconfig, pr, lp, lpr, lpstat, lpq, lprm, cancel, mail, etc. b) Working with Editor Vi/other editor.	**03**	LO2
III	Commands for File System Management and User Management	a) Study of Unix file system (tree structure), file and directory permissions, single and multiuser environment. b) Execution of File System Management Commands like ls, cd, pwd, cat, mkdir, rmdir, rm, cp, mv, chmod, wc, piping and redirection, grep, tr, echo, sort, head, tail, diff, comm, less, more, file, type, wc, split, cmp, tar, find, vim, gzip, bzip2, unzip, locate, etc. c) Execution of User Management Commands like who, whoami, su, sudo, login, logout, exit, passwd, useradd/adduser, usermod, userdel, groupadd, groupmod, groupdel, gpasswd, chown, chage, chgrp, chfn, etc.	**04**	LO3
IV	Commands for Process Management and Memory Management	a) Execution of Process Management Commands like ps, pstree, nice, kill, pkill, killall, xkill, fg, bg, pgrep, renice, etc. b) Execution of Memory Management Commands like free, /proc/meminfo, top, htop, df, du, vmstat, demidecode, sar, pagesize, etc.	**04**	LO4
V	Basic Scripts	a) Study of Shell, Types of Shell, Variables andOperators b) Execute the following Scripts (at least 6): (i) Write a shell script to perform arithmetic operations. (ii) Write a shell script to calculate simple interest. (iii) Write a shell script to determine largest among three integer numbers. (iv) Write a shell script to determine a given year is leap year or not.	**04**	L02, L03, L05

		(v) Write a shell script to print multiplication table of given number using while statement. (vi) Write a shell script to search whether element is present is in the list or not. (vii) Write a shell script to compare two strings. (viii) Write a shell script to read and check if the directory / file exists or not, if not make the directory / file. (ix) Write a shell script to implement menu-driven calculator using case statement. (x) Write a shell script to print following pattern: * * * * * * * * * * (xi) Write a shell script to perform operations on directory like: display name of current directory; display list of directory contents; create another directory, write contents on that and copy it to a suitable location in your home directory; etc.		
VI	Advanced Scripts	a) Execute the following scripts using grep / sed commands: (i) Write a script using grep command to find the number of words character, words and lines in a file. (ii) Write ascriptusing egrep command to display list of specific type of files in the directory. (iii) Write a script using sed command to replace all occurrences of particular word in given a file. (iv) Write a script using sedcommand to print duplicated lines in input. b) Execute the following scripts using awk / perl languages: (i) Write an awk script to print all even numbers in a given range. (ii) Write an awk script to develop a Fibonacci series (take user input for number of terms). (iii) Write a perl script to sort elements of an array. (iv) Write a perl script to check a number is prime or not.	**06**	LO2, L03, L06

Text Books:

1. S. Das, Unix Concepts and Applications, 4th ed., McGraw Hill, 2017.
2. R. Michael, Mastering Unix Shell Scripting, 2nd ed., Wiley, 2008.
3. D. Ambawade, D. Shah, Linux Labs and Open Source Technologies, Dreamtech Press, 2014.

References:

1. Y. Kanetkar, Unix Shell Programming, BPB Publications, 2003.
2. B. Forouzan and R. Gilberg, Unix and Shell Programming, Cengage Learning, 2003.

Term Work: Term Work shall consist of at least 10 to 12 practical's based on the above list. Also Term work Journal must include at least 2 assignments.

Term Work Marks: 25 Marks (Total marks) = 15 Marks (Experiment) + 5 Marks (Assignments) + 5 Marks (Attendance)

Practical & Oral Exam: An Oral & Practical exam will be held based on the above syllabus.

Lab Code	Lab Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ITL403	Microprocessor Lab	--	02	--	--	01	--	01

Lab Code	Lab Name	Examination Scheme						
		Theory Marks				Term Work	Pract. /Oral	Total
		Internal assessment			End Sem. Exam			
		Test1	Test 2	Avg.				
ITL403	Microprocessor Lab	--	--	--	--	25	25	50

Lab Objectives:

Sr. No.	Lab Objectives
The Lab experiments aims:	
1	Learn assembling and disassembling of PC
2	Design, simulate and implement different digital circuits
3	Get hands on experience with Assembly Language Programming.
4	Study interfacing of peripheral devices with 8086 microprocessor.
5	Realize techniques for faster execution of instructions and improve speed of operation and performance of microprocessors.
6	Write and debug programs in TASM/MASM/hardware kits

Lab Outcomes:

Sr. No.	Lab Outcomes	Cognitive levels of attainment as per Bloom's Taxonomy
On successful completion, of course, learner/student will be able to:		
1	Demonstrate various components and peripheral of computer system	L2
2	Analyze and design combinational circuits	L4, L6
3	Build a program on a microprocessor using arithmetic & logical instruction set of 8086.	L3
4	Develop the assembly level programming using 8086 loop instruction set	L6
5	Write programs based on string and procedure for 8086 microprocessor.	L1
6	Design interfacing of peripheral devices with 8086 microprocessor.	L6

Prerequisite: Logic Design, Programming Languages(C, C++)

Hardware & Software Requirements:

NOTE: Programs can be executed on assembler or hardware boards.

Hardware Requirement:	**Software requirement:**
➢ Motherboard, RAM, Processor, Connectors, Cables, SMPS, HDD, Monitor, Graphics card (optional), and Cabinet. ➢ 8086 microprocessor experiment kits with specified interfacing study boards	➢ Microsoft Macro Assembler (TASM)/Turbo Assembler (TASM) ➢ Virtual simulator lab. ➢ Proteus design suite

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours	LO Mapping
I	PC Assembly	Study of PC Motherboard Technology (South Bridge and North Bridge), Internal Components and Connections used in computer system.	**02**	LO1
II	Implementation of combinational circuits	1. Verify the truth table of various logic gates (basic and universal gates) 2. Realize Half adder and Full adder 3. Implementation of MUX and DeMUX	**06**	LO2
III	Arithmetic and logical operations in 8086 Assembly language programming	1. Program for 16 bit BCD addition 2. Program to evaluate given logical expression. 3. Convert two digit Packed BCD to Unpacked BCD. (any two)	**05**	LO3
IV	Loop operations in 8086 Assembly language programming	1. Program to move set of numbers from one memory block to another. 2. Program to count number of 1's and 0's in a given 8 bit number 3. Program to find even and odd numbers from a given list 4. Program to search for a given number (any three)	**06**	LO4
V	String &Procedure in 8086 Assembly language programming	1. Check whether a given string is a palindrome or not. 2. Compute the factorial of a positive integer 'n' using procedure. OR Generate the first 'n' Fibonacci numbers.	**04**	LO5
VI	Interfacing with 8086 microprocessor	1. Interfacing Seven Segment Display 2. Interfacing keyboard matrix 3. Interfacing DAC (any one)	**03**	LO6

Text Books:

1. Scott Mueller, ”Upgrading and repairing PCs”, Pearson,
2. R. P. Jain, “Modern Digital Electronics”, Tata McGraw Hill.
3. John Uffenbeck, “8086/8088 family: Design Programming and Interfacing:”Pearson Education

Reference Books:

1. M. Morris Mano, “Digital Logic and computer Design”, PHI
2. K Bhurchandi, “Advanced Microprocessors & Peripherals”, Tata McGraw-Hill Education

Term Work: Term Work shall consist of at least 10 to 12 practical’s based on the above list. Also Term work Journal must include at least 2 assignments.

Term Work Marks: 25 Marks (Total marks) = 15 Marks (Experiment) + 5 Marks (Assignments) + 5 Marks (Attendance)

Practical & Oral Exam: An Oral & Practical exam will be held based on the above syllabus.

Lab Code	Lab Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ITL404	Python Lab (SBL)	--	04	--	--	02	--	02

Lab Code	Lab Name	Examination Scheme						
		Theory Marks				Term Work	Pract. /Oral	Total
		Internal assessment			End Sem. Exam			
		Test1	Test 2	Avg.				
ITL404	Python Lab (SBL)	--	--	--	--	25	25	50

Lab Objectives:

Sr. No.	Lab Objectives
The Lab experiments aims:	
1	Basics of python including data types, operator, conditional statements, looping statements, input and output functions in Python
2	List, tuple, set, dictionary, string, array and functions
3	Object Oriented Programming concepts in python
4	Concepts of modules, packages, multithreading and exception handling
5	File handling, GUI & database programming
6	Data visualization using Matplotlib, Data analysis using Pandas and Web programming using Flask

Lab Outcomes:

Sr. No.	Lab Outcomes	Cognitive levels of attainment as per Bloom's Taxonomy
On successful completion, of course, learner/student will be able to:		
1	Understand the structure, syntax, and semantics of the Python language.	L1, L2
2	Interpret advanced data types and functions in python	L1, L2
3	illustrate the concepts of object-oriented programming as used in Python	L2
4	Create Python applications using modules, packages, multithreading and exception handling.	L6
5	Gain proficiency in writing File Handling programs ,also create GUI applications and evaluate database operations in python.	L1, L2
6	Design and Develop cost-effective robust applications using the latest Python trends and technologies	L6

Prerequisite: Structured Programming Approach & Java Programming Lab

Hardware & Software Requirements:

Hardware Requirements	Software Requirements	Other Requirements
PC With following Configuration 1. Intel Dual core Processor or higher 2. Minimum 2 GB RAM 3. Minimum 40 GB Hard disk 4. Network interface card	1. Windows or Linux Desktop OS 2. Python 3.6 or higher 3. Notepad ++ 4.Python IDEs like IDLE, Pycharm, Pydev, Netbeans or Eclipse 5. Mysql	1. Internet Connection for installing additional packages if required

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours	LO Mapping
0	**Prerequisite**	Python IDE installation and environment setup.	**02**	
I	**Basics of Python**	Introduction, Features, Python building blocks – Identifiers, Keywords, Indention, Variables and Comments, Basic data types (Numeric, Boolean, Compound) Operators: Arithmetic, comparison, relational, assignment, logical, bitwise, membership, identity operators, operator precedence Control flow statements: Conditional statements (if, if…else, nested if) Looping in Python (while loop, for loop, nested loops) Loop manipulation using continue, pass, break. Input/output Functions, Decorators, Iterators and Generators.	**08**	LO 1
II	**Advanced data types & Functions**	Lists: a) Defining lists, accessing values in list, deleting values in list, updating lists b) Basic list operations c) Built-in list functions Tuples: a) Accessing values in Tuples, deleting values in Tuples, and updating Tuples b) Basic Tuple operations c) Built-in Tuple functions Dictionaries: a) Accessing values in Dictionary, deleting values in Dictionary, and updating Dictionary b) Basic Dictionary operations c) Built-in Dictionary functions Sets: a) Accessing values in Set, deleting values in Set, updating Sets b) Basic Set operations, c) Built-in Set functions Strings: a) String initialization, Indexing, Slicing, Concatenation, Membership & Immutability b) Built-in String functions Arrays: a) Working with Single dimensional Arrays: Creating, importing, Indexing, Slicing, copying and processing array arrays. b) Working with Multi-dimensional Arrays using Numpy:	**09**	LO 1 LO 2

		Mathematical operations, Matrix operations, aggregate and other Built-in functions Functions: a) Built-in functions in python b) Defining function, calling function, returning values, passing parameters c) Nested and Recursive functions d) Anonymous Functions (Lambda, Map, Reduce, Filter)		
III	**Object Oriented Programming**	Overview of Object-oriented programming, Creating Classes and Objects, Self-Variable, Constructors, Inner class, Static method, Namespaces. Inheritance: Types of Inheritance (Single, Multiple, Multi-level, Hierarchical), Super() method, Constructors in inheritance, operator overloading, Method overloading, Method overriding, Abstract class, Abstract method, Interfaces in Python.	**08**	LO 1 LO 3
IV	**Exploring concept of modules, packages, multithreading and exception handling**	Modules: Writing modules, importing objects from modules, Python built-in modules (e.g. Numeric and Mathematical module, Functional Programming module, Regular Expression module), Namespace and Scoping. Packages: creating user defined packages and importing packages. Multi-threading: process vs thread, use of threads, types of threads, creating threads in python, thread synchronization, deadlock of threads. Exception handling: Compile time errors, Runtime errors, exceptions, types of exception, try statement, except block, raise statement, Assert statement, User-Defined Exceptions.	**06**	LO 1 LO 4
V	**File handling, GUI & database programming**	File Handling: Opening file in different modes, closing a file, writing to a file, accessing file contents using standard library functions, reading from a file – read (), readline (), readlines (), Renaming and Deleting a file, File Exceptions, Pickle in Python. Graphical user interface (GUI): different GUI tools in python (Tkinter, PyQt, Kivy etc.), Working with containers, Canvas, Frame, Widgets (Button, Label, Text, Scrollbar, Check button, Radio button, Entry, Spinbox, Message etc.) Connecting GUI with databases to perform CRUD operations. (on supported databases like SQLite, MySQL, Oracle, PostgreSQL etc.).	**09**	LO 1 LO 5
VI	**Data visualization, analysis and web programming using python**	Visualization using Matplotlib: Matplotlib with Numpy, working with plots (line plot, bar graph, histogram, scatter plot, area plot, pie chart etc.), working with multiple figures. Data manipulation and analysis using Pandas: Introduction to Pandas, importing data into Python, series, data frames, indexing data frames, basic operations with data frame, filtering, combining and merging data frames, Removing Duplicates. SciPy: Linear algebra functions using Numpy and Scipy. Web programming: Introduction to Flask, Creating a Basic Flask Application, Build a Simple REST API using Flask	**10**	LO 1 LO 6

List of Experiments/Mini-Project.

1)	Write python programs to understand a) Basic data types, Operators, expressions and Input Output Statements b) Control flow statements: Conditional statements (if, if…else, nested if) c) Looping in Python (while loop, for loop, nested loops) d) Decorators, Iterators and Generators.
2)	Write python programs to understand a) Different List and Tuple operations using Built-in functions b) Built-in Set and String functions c) Basic Array operations on 1-D and Multidimensional arrays using Numpy d) Implementing User defined and Anonymous Functions
3)	Write python programs to understand a) Classes, Objects, Constructors, Inner class and Static method b) Different types of Inheritance c) Polymorphism using Operator overloading, Method overloading, Method overriding, Abstract class, Abstract method and Interfaces in Python.
4)	Write python programs to understand a) Creating User-defined modules/packages and import them in a program b) Creating user defined multithreaded application with thread synchronization and deadlocks c) Creating a menu driven application which should cover all the built-in exceptions in python
5)	Write python programs to understand a) Different File Handling operations in Python b) Designing Graphical user interface (GUI) using built-in tools in python (Tkinter, PyQt, Kivy etc.). c) GUI database connectivity to perform CRUD operations in python (Use any one database like SQLite, MySQL, Oracle, PostgreSQL etc.)
6)	Write python programs to implement a) Different types of plots using Numpy and Matplotlob b) Basic operations using pandas like series, data frames, indexing, filtering, combining and merging data frames. c) Different Linear algebra functions using Scipy. d) A Basic Flask Application to build a Simple REST API.

❖ **Mini Project**

Mini-project have to be developed in a group of three students which should cover all above topics.
Suggested Mini-Project Topics:

1. Railway reservation system	27 IT Team Workspace	52. Business Directory	78. Practice Test Management.
2. Inventory Management system.	29 Job Requisition and Interview Management	53. Education Directory	79. Asset Management System
3 Classroom Management	28 Knowledge Base	54. Dental Clinic Management	80. Travel Agency System.
4 Clinical Trial Initiation and Management	29 Lending Library	55. Fund Raising Management	81. Placement Management System.
5 Competitive Analysis Web Site	30 Physical Asset Tracking and Management	56. Clinic/ Health Management	82. Polls Management
6 Discussion Forum website	31 Project Tracking Workspace	57. Cable Management System	83. Customer Management
7 Disputed Invoice Management	32. Shopping Cart .	58. Survey Creation and Analytics	84. Project Management System.
8 Employee Training Scheduling and Materials	33 Knowledge Base	59. Museum Management System	85. Network Marketing System
9 Equity Research Management	34 Lending Library	60. Multi-Level Marketing System	86. Yoga Health Care Management
10 Integrated Marketing Campaign Tracking	35 Physical Asset Tracking and Management	61. Learning Management System	87. Personal Finance Management System
11 Manufacturing Process Managements	36 Project Tracking Workspace	62. Knowledge Management System	88. Real Estate Management System
12 Product and Marketing Requirements Planning	37 Room and Equipment Reservations	63. Missing Person Site	89. Stock Mutual Funds Management
13 Request for Proposal Software	38 Sales Lead Pipeline	64. Disaster Management Site	90. Careers and Employment Management System
14 Sports League Management	39. Yellow Pages & Business Directory	65. Job Management Site	91. Music Albums Management System
15 Absence Request and Vacation Schedule Management	40. Time & Billing	66. Financial Portfolio Management	92. Classified Ads Managements
16 Budgeting and Tracking Multiple Projects	41. Class Room Management	67. Market Research Management	93. Property Management System
17 Bug Database Management	42. Expense Report Database	68. Order Management System	94. Sales & Retail Management
18 Call Center Management Software	43. Sales Contact Management Database	69. Point of Sale	95. Dating Site
19 Change Request Management	44. Inventory Management Database	70. Advertisement /Banner Management and Analytics	96. Hotel Management System
20 Compliance Process Support Site	45. Issue Database	71. Export Management System	97. Search Engine
21 Contacts Management Software	46. Event Management Database	72. Invoice Management	98. Online News Paper Site
22 Document Library and Review	47. Service Call Management Database	73. Recruitment Management System	99. Image Gallery
23 Event Planning and Management	48. Accounting Ledger Database	74. Articles / Blog / Wiki Web site	100. Staffing and Human Capital Management
24 Expense Reimbursement	49. Asset Tracking	75. Online Planner	101. Development of a

and Approval	Database		feature-rich, practical Online Survey Tool (OST)
25 Help Desk and Ticket Management	50. Cycle Factory Works Management	76. Mock Tests and Examination Management	102 Development of a Web/Email based Search Engine
26 Inventory Tracking	51. Sales Corporation Management	77. Examination System	103. Development of a web-based Recruitment Process System for the HR group for a company

Text Books:

1. Dr. R. Nageswara Rao," Core Python Programming" , Dreamtech Press, Wiley Publication
2. M. T. Savaliya , R. K. Maurya, "Programming through Python", StarEdu Solutions.
3. E Balagurusamy, "Introduction to computing and problem-solving using python", McGraw Hill Publication.

References:

1. Zed A. Shaw, "Learn Python 3 the Hard Way", Zed Shaw's Hard Way Series.
2. Martin C. Brown," Python: The Complete Reference", McGraw-Hill Publication.
3. Paul Barry," Head First Python", 2nd Edition, O'Reilly Media, Inc.

Online resources:

1) https://docs.scipy.org/doc/numpy/user/quickstart.html
2) https://matplotlib.org/tutorials/
3) https://pandas.pydata.org/docs/getting_started/
4) https://www.geeksforgeeks.org/python-build-a-rest-api-using-flask/

Term Work:

The Term work shall consist of at least 15 practical based on the above list. The term work Journal must include at least 2 Programming assignments. The Programming assignments should be based on real world applications which cover concepts from more than one modules of syllabus**.**

Term Work Marks: 25 Marks (Total marks) = 15 Marks (Experiment) + 5 Marks (Assignments/tutorial/write up) + 5 Marks (Attendance)

Practical & Oral Exam: An Oral & Practical exam will be held based on the above syllabus.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ITM401	Mini Project – 1 B for Python based automation projects	--	04	--	--	02	--	02

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Pract. /Oral	Total
		Internal assessment			End Sem. Exam			
		Test1	Test 2	Avg.				
ITM401	Mini Project – 1 B for Python based automation projects	--	--	--	--	25	25	50

Course Objectives

1. To acquaint with the process of identifying the needs and converting it into the problem.
2. To familiarize the process of solving the problem in a group.
3. To acquaint with the process of applying basic engineering fundamentalsto attempt solutions to the problems.
4. To inculcate the process of self-learning and research.

Course Outcome: Learner will be able to…

1. Identify problems based on societal /research needs.
2. Apply Knowledge and skill to solve societal problems in a group.
3. Develop interpersonal skills to work as member of a group or leader.
4. Draw the proper inferences from available results through theoretical/ experimental/simulations.
5. Analyse the impact of solutions in societal and environmental context for sustainable development.
6. Use standard norms of engineering practices
7. Excel in written and oral communication.
8. Demonstrate capabilities of self-learning in a group, which leads to life long learning.
9. Demonstrate project management principles during project work.

Guidelines for Mini Project

- Students shall form a group of 3 to 4 students, while forming a group shall not be allowed less than three or more than four students, as it is a group activity.
- Students should do survey and identify needs, which shall be converted into problem statement for mini project in consultation with faculty supervisor/head of department/internal committee of faculties.
- Students hall submit implementation plan in the form of Gantt/PERT/CPM chart, which will cover weekly activity of mini project.
- A log book to be prepared by each group, wherein group can record weekly work progress, guide/supervisor can verify and record notes/comments.
- Faculty supervisor may give inputs to students during mini project activity;however, focus shall be on self-learning.

- Students in a group shall understand problem effectively, propose multiple solution and select best possible solution in consultation with guide/ supervisor.
- Students shall convert the best solution into working model using various components of their domain areas and demonstrate.
- The solution to be validated with proper justification and report to be compiled in standard format of University of Mumbai.
- With the focus on the self-learning, innovation, addressing societal problems and entrepreneurship quality development within the students through the Mini Projects, it is preferable that a single project of appropriate level and quality to be carried out in two semesters by all the groups of the students. i.e. Mini Project 1 in semester III and IV. Similarly, Mini Project 2 in semesters V and VI.
- However, based on the individual students or group capability, with the mentor's recommendations, if the proposed Mini Project adhering to the qualitative aspects mentioned above gets completed in odd semester, then that group can be allowed to work on the extension of the Mini Project with suitable improvements/modifications or a completely new project idea in even semester. This policy can be adopted on case by case basis.

Guidelines for Assessment of Mini Project:

Term Work

- The review/ progress monitoring committee shall be constituted by head of departments of each institute. The progress of mini project to be evaluated on continuous basis, minimum two reviews in each semester.
- In continuous assessment focus shall also be on each individual student, assessment based on individual's contribution in group activity, their understanding and response to questions.
- Distribution of Term work marks for both semesters shall be as below;
    - Marks awarded by guide/supervisor based on log book : 10
    - Marks awarded by review committee : 10
    - Quality of Project report : 05

Review/progress monitoring committee may consider following points for assessment based on either one year or half year project as mentioned in general guidelines.

One-year project:

- In first semester entire theoretical solution shall be ready, including components/system selection and cost analysis. Two reviews will be conducted based on presentation given by students group.
    - First shall be for finalisation of problem
    - Second shall be on finalisation of proposed solution of problem.
- In second semester expected work shall be procurement of component's/systems, building of working prototype, testing and validation of results based on work completed in an earlier semester.
    - First review is based on readiness of building working prototype to be conducted.
    - Second review shall be based on poster presentation cum demonstration of working model in last month of the said semester.

Half-year project:

- In this case in one semester students' group shall complete project in all aspects including,
    - Identification of need/problem
    - Proposed final solution
    - Procurement of components/systems
    - Building prototype and testing
- Two reviews will be conducted for continuous assessment,
    - First shall be for finalisation of problem and proposed solution
    - Second shall be for implementation and testing of solution.

Assessment criteria of Mini Project.

Mini Project shall be assessed based on following criteria;

1. Quality of survey/ need identification
2. Clarity of Problem definition based on need.
3. Innovativeness in solutions
4. Feasibility of proposed problem solutions and selection of best solution
5. Cost effectiveness
6. Societal impact
7. Innovativeness
8. Cost effectiveness and Societal impact
9. Full functioning of working model as per stated requirements
10. Effective use of skill sets
11. Effective use of standard engineering norms
12. Contribution of an individual's as member or leader
13. Clarity in written and oral communication

- In **one year, project**, first semester evaluation may be based on first six criteria's and remaining may be used for second semester evaluation of performance of students in mini project.
- In case of **half year project** all criteria's in generic may be considered for evaluation of performance of students in mini project.

Guidelines for Assessment of Mini Project Practical/Oral Examination:

- Report should be prepared as per the guidelines issued by the University of Mumbai.
- Mini Project shall be assessed through a presentation and demonstration of working model by the student project group to a panel of Internal and External Examiners preferably from industry or research organisations having experience of more than five years approved by head of Institution.
- Students shall be motivated to publish a paper based on the work in Conferences/students competitions.

Mini Project shall be assessed based on following points;

1. Quality of problem and Clarity
2. Innovativeness in solutions
3. Cost effectiveness and Societal impact
4. Full functioning of working model as per stated requirements
5. Effective use of skill sets
6. Effective use of standard engineering norms
7. Contribution of an individual's as member or leader
8. Clarity in written and oral communication

UNIVERSITY OF MUMBAI

Bachelor of Engineering

in

Information Technology

Third Year with Effect from AY 2021-22

(REV- 2019 'C' Scheme) from Academic Year 2019 – 20

Under

FACULTY OF SCIENCE & TECHNOLOGY

(As per AICTE guidelines with effect from the academic year 2019–2020)

Preamble

To meet the challenge of ensuring excellence in engineering education, the issue of quality needs to be addressed, debated and taken forward in a systematic manner. Accreditation is the principal means of quality assurance in higher education. The major emphasis of accreditation process is to measure the outcomes of the program that is being accredited. In line with this Faculty of Science and Technology (in particular Engineering)of University of Mumbai has taken a lead in incorporating philosophy of outcome based education in the process of curriculum development.

Faculty resolved that course objectives and course outcomes are to be clearly defined for each course, so that all faculty members in affiliated institutes understand the depth and approach of course to be taught, which will enhance learner's learning process. Choice based Credit and grading system enables a much-required shift in focus from teacher-centric to learner-centric education since the workload estimated is based on the investment of time in learning and not in teaching. It also focuses on continuous evaluation which will enhance the quality of education. Credit assignment for courses is based on 15 weeks teaching learning process, however content of courses is to be taught in 13 weeks and remaining 2 weeks to be utilized for revision, guest lectures, coverage of content beyond syllabus etc.

There was a concern that the earlier revised curriculum more focused on providing information and knowledge across various domains of the said program, which led to heavily loading of students in terms of direct contact hours. In this regard, faculty of science and technology resolved that to minimize the burden of contact hours, total credits of entire program will be of 170, wherein focus is not only on providing knowledge but also on building skills, attitude and self learning. Therefore in the present curriculum skill based laboratories and mini projects are made mandatory across all disciplines of engineering in second and third year of programs, which will definitely facilitate self learning of students. The overall credits and approach of curriculum proposed in the present revision is in line with AICTE model curriculum.

The present curriculum will be implemented for Second Year of Engineering from the academic year 2020-21. Subsequently this will be carried forward for Third Year and Final Year Engineering in the academic years 2021-22, 2022-23, respectively.

Dr. S. K. Ukarande
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Dr. Anuradha Muzumdar
Dean
Faculty of Science and Technology
University of Mumbai

Incorporation and Implementation of Online Contents from NPTEL/ Swayam Platform

The curriculum revision is mainly focused on knowledge component, skill based activities and project based activities. Self learning opportunities are provided to learners. In the revision process this time in particular Revised syllabus of 'C ' scheme wherever possible additional resource links of platforms such as NPTEL, Swayam are appropriately provided. In an earlier revision of curriculum in the year 2012 and 2016 in Revised scheme 'A' and 'B' respectively, efforts were made to use online contents more appropriately as additional learning materials to enhance learning of students.

In the current revision based on the recommendation of AICTE model curriculum overall credits are reduced to 171, to provide opportunity of self learning to learner. Learners are now getting sufficient time for self learning either through online courses or additional projects for enhancing their knowledge and skill sets.

The Principals/ HoD's/ Faculties of all the institute are required to motivate and encourage learners to use additional online resources available on platforms such as NPTEL/ Swayam. Learners can be advised to take up online courses, on successful completion they are required to submit certification for the same. This will definitely help learners to facilitate their enhanced learning based on their interest.

Dr. S. K. Ukarande
Associate Dean
Faculty of Science and Technology
University of Mumbai

Dr Anuradha Muzumdar
Dean
Faculty of Science and Technology
University of Mumbai

Preface By Board of Studies Team

It is our honor and a privilege to present the Rev-2019 'C' scheme syllabus of Bachelor of Engineering in Information Technology (effective from year 2019-20) with inclusion of cutting edge technology. Information Technology is comparatively a young branch among other engineering disciplines in the University of Mumbai. It is evident from the placement statistics of various colleges affiliated to the University of Mumbai that IT branch has taken the lead in the placement.

The branch also provides multi-faceted scope like better placement and promotion of entrepreneurship culture among students, and increased Industry Institute Interactions. Industries views are considered as stakeholders will design of the syllabus of Information Technology. As per Industries views only 16 % graduates are directly employable. One of the reasons is a syllabus which is not in line with the latest technologies. Our team of faculties has tried to include all the latest technologies in the syllabus. Also first time we are giving skill-based labs and Mini-project to students from third semester onwards which will help students to work on latest IT technologies. Also the first time we are giving the choice of elective from fifth semester such that students will be master in one of the IT domain. The syllabus is peer reviewed by experts from reputed industries and as per their suggestions it covers future trends in IT technology and research opportunities available due to these trends.

We would like to thank senior faculties of IT department of all colleges affiliated to University of Mumbai for significant contribution in framing the syllabus. Also on behalf of all faculties we thank all the industry experts for their valuable feedback and suggestions. We sincerely hope that the revised syllabus will help all graduate engineers to face the future challenges in the field of information and technology

Program Specific Outcome for graduate Program in Information Technology

1. Apply Core Information Technology knowledge to develop stable and secure IT system.
2. Design, IT infrastructures for an enterprise using concepts of best practices in information Technology and security domain.
3. Ability to work in multidisciplinary projects and make it IT enabled.
4. Ability to adapt latest trends and technologies like **A**nalytics, **B**lockchain, **C**loud, **D**ata science.

Board of Studies in Information Technology - Team
Dr. Deven Shah (Chairman)
Dr. Lata Ragha (Member)
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Dr. Sharvari Govilkar (Member)
Dr. Sunil B. Wankhade (Member)
Dr. Anil Kale (Member)
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Dr. GV Choudhary (Member)

Ad-hoc Board Information Technology
University of Mumbai

Program Structure for Third Year Information Technology

Semester V & VI

UNIVERSITY OF MUMBAI

(With Effect from 2021-2022)

Semester V

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		
		Theory	**Pract.**	**Theory**	**Pract.**	**Total**
ITC501	Internet Programming	3	--	3	--	3
ITC502	Computer Network Security	3	--	3		3
ITC503	Entrepreneurship and E-business	3	--	3	--	3
ITC504	Software Engineering	3	--	3	--	3
ITDO501X	**Department Optional Course – 1**	**3**	**--**	**3**	**--**	**3**
ITL501	IP Lab	--	2	--	1	1
ITL502	Security Lab	--	2	--	1	1
ITL503	DevOPs Lab	--	2	--	1	1
ITL504	Advance DevOPs Lab	--	2	--	1	1
ITL505	Professional Communication & Ethics-II (PCE-II)	--	2*+2	--	2	2
ITM501	Mini Project – 2 A Web Based Business Model	--	4[$]	--	2	2
Total		**15**	**16**	**15**	**08**	**23**

Course Code	Course Name	Examination Scheme							
		Theory					**Term Work**	**Prac /oral**	**Total**
		Internal Assessment			**End Sem Exam**	**Exam. Duration (in Hrs)**			
		Test1	**Test2**	**Avg**					
ITC501	Internet Programming	20	20	20	80	3	--	--	100
ITC502	Computer Network Security	20	20	20	80	3	--	--	100
ITC503	Entrepreneurship and E-business	20	20	20	80	3	--	--	100
ITC504	Software Engineering	20	20	20	80	3	--	--	100
ITDO501X	**Department Optional Course – 1**	**20**	**20**	**20**	**80**	**3**	**--**	**--**	**100**
ITL501	IP Lab	--	--	--	--	--	25	25	50
ITL502	Security Lab	--	--	--	--	--	25	25	50
ITL503	DevOPs Lab	--	--	--	--	--	25	25	50

ITL504	Advance DevOPs Lab	--	--	--	--	--	25	25	50
ITL505	Professional Communication & Ethics-II (PCE-II)	--	--	--	--	--	50	--	50
ITM501	Mini Project – 2 A Web Based Business Model	--	--	--	--	--	25	25	50
Total		**--**	**--**	**100**	**400**	--	**175**	**125**	**800**

* Theory class to be conducted for full class

$ indicates work load of Learner (Not Faculty), for Mini-Project. Students can form groups with minimum 2(Two) and not more than 4(Four). Faculty Load: 1hour per week per four groups.

ITDO501X	**Department Optional Course – 1**
ITDO5011	Microcontroller Embedded Programming
ITDO5012	Advance Data Management Technologies
ITDO5013	Computer Graphics & Multimedia System
ITDO5014	Advanced Data structure and Analysis

Program Structure for Third Year Information Technology

Semester V & VI

UNIVERSITY OF MUMBAI

(With Effect from 2021-2022)

Semester VI

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		
		Theory	Pract. Tut.	Theory	Pract.	Total
ITC601	Data Mining & Business Intelligence	3	--	3	--	3
ITC602	Web X.0	3	--	3		3
ITC603	Wireless Technology	3	--	3	--	3
ITC604	AI and DS – 1	3	--	3	--	3
ITDO601X	**Department Optional Course – 2**	**3**	**--**	**3**	**--**	**3**
ITL601	BI Lab	--	2	--	1	1
ITL602	Web Lab	--	2	--	1	1
ITL603	Sensor Lab	--	2	--	1	1
ITL604	MAD & PWA Lab	--	2	--	1	1
ITL605	DS using Python Skill based Lab	--	2	--	1	1
ITM601	Mini Project – 2 B Based on ML	--	4[$]	--	2	2
Total		**15**	**14**	**15**	**07**	**22**

Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Prac /oral	Total
		Internal Assessment			End Sem Exam	Exam. Duration (in Hrs)			
		Test1	Test2	Avg					
ITC601	Data Mining & Business Intelligence	20	20	20	80	3	--	--	100
ITC602	Web X.0	20	20	20	80	3	--	--	100
ITC603	Wireless Technology	20	20	20	80	3	--	--	100
ITC604	AI and DS – 1	20	20	20	80	3	--	--	100
ITDO601X	**Department Optional Course – 2**	**20**	**20**	**20**	**80**	**3**	**--**	**--**	**100**
ITL601	BI Lab	--	--	--	--	--	25	25	50
ITL602	Web Lab	--	--	--	--	--	25	25	50
ITL603	Sensor Lab	--	--	--	--	--	25	25	50
ITL604	MAD & PWA Lab	--	--	--	--	--	25	25	50
ITL605	DS using Python Lab (SBL)	--	--	--	--	--	25	25	50

ITM601	Mini Project – 2 B Based on ML	--	--	--	--	--	25	25	50
Total		**--**	**--**	**100**	**400**	**--**	**150**	**150**	**800**

$ indicates work load of Learner (Not Faculty), for Mini-Project. Students can form groups with minimum 2(Two) and not more than 4(Four). Faculty Load: 1hour per week per four groups.

ITDO601X	**Department Optional Course – 2**
ITDO6011	Software Architecture
ITDO6012	Image Processing
ITDO6013	Green IT
ITDO6014	Ethical Hacking and Forensic

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		
		Theory	Practical	Theory	Practical	Total
ITC501	Internet Programming	03	--	03	--	03

Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Pract / Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (in Hrs)			
		Test1	Test2	Avg.					
ITC501	Internet Programming	20	20	20	80	03	--	--	100

Course Objectives:

Sr. No.	Course Objectives
The course aims:	
1	To orient students to Web Programming fundamental.
2	To expose students to JavaScript to develop interactive web page development
3	To orient students to Basics of REACT along with installation
4	To expose students to Advanced concepts in REACT
5	To orient students to Fundamentals of node.js
6	To expose students to node.js applications using express framework.

Course Outcomes:

Sr. No.	Course Outcomes	Cognitive levels of attainment as per Bloom's Taxonomy
On successful completion, of course, learner/student will be able to:		
1	Select protocols or technologies required for various web applications.	L1,L2,L3,L4
2	Apply JavaScript to add functionality to web pages.	L1, L2, L3
3	Design front end application using basic React.	L1,L2,L3,L4,L5,L6
4	Design front end applications using functional components of React.	L1,L2,L3,L4,L5,L6
5	Design back-end applications using Node.js.	L1,L2,L3,L4,L5,L6
6	Construct web based Node.js applications using Express.	L1,L2,L3,L4,L5,L6

Prerequisite: Knowledge of basic programming, network fundamentals and operating systems.

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours	CO Mapping
0	Prerequisite	Introduction and basics of HTML, CSS	**02**	-
I	Web programming fundamentals	Working of web browser, HTTP protocol, HTTPS, DNS, TLS, XML introduction, Json introduction, DOM, URL, URI, REST API. **Self-learning Topics:** : Nginx server	**03**	CO1
II	Java script:	Introduction to ES6, Difference between ES5 and ES6. Variables, Condition, Loops, Functions, Events, Arrow functions, Setting CSS Styles using JavaScript, DOM manipulation, Classes and Inheritance. Iterators and Generators, Promise, Client-server communication, Fetch **Self-learning Topics:** Asynchronous JavaScript, JSON	**06**	CO2
III	React fundamentals	Installation, Installing libraries, Folder and file structure, Components, Component lifecycle, State and Props, React Router and Single page applications, UI design, Forms, Events, Animations, Best practices. **Self-learning Topics**: React vs Angular vs Vue	**07**	CO3
IV	Advanced React:	Functional components- Refs, Use effects, Hooks, Flow architecture, Model-View-Controller framework, Flux, Bundling the application. Web pack. **Self-learning Topics:** React Native	**07**	CO4
V	Node.js:	Environment setup, First app, Asynchronous programming, Callback concept, Event loops, REPL, Event emitter, Networking module, Buffers, Streams, File system, Web module. **Self-learning Topics:** Node.js with Mongodb.	**07**	CO5
VI	Express:	Introduction, Express router, REST API, Generator, Authentication, sessions, Integrating with React. **Self-learning Topics:** Commercial deployment.	**07**	CO6

Text Books:

1. Rediscovering JavaScript, Master ES6, ES7, and ES8, By Venkat Subramaniam · 2018
2. Learning React Functional Web Development with React and Redux, Alex Banks and Eve Porcello, O'Reilly
3. Learning Redux, Daniel Bugl, Packt Publication
4. Learning Node.js Development, Andrew Mead, Packt Publishing
5. RESTful Web API Design with Node.js 10, Valentin Bojinov, Packt Publication

References:

1. Web Development with Node and Express, Ethan Brown, O'Reilly

Online Resources:

2. https://reactjs.org/tutorial/tutorial.html
3. https://react-redux.js.org/introduction/quick-start
4. https://webpack.js.org/
5. https://www.youtube.com/watch?v=-27HAh8c0YU

Assessment:

Internal Assessment (IA) for 20 marks:

- IA will consist of Two Compulsory Internal Assessment Tests. Approximately 40% to 50% of syllabus content must be covered in First IA Test and remaining 40% to 50% of syllabus content must be covered in Second IA Test

➢ **Question paper format**

- Question Paper will comprise of a total of **six questions each carrying 20 marksQ.1** will be **compulsory** and should **cover maximum contents of the syllabus**
- **Remaining questions** will be **mixed in nature** (part (a) and part (b) of each question must be from different modules. For example, if Q.2 has part (a) from Module 3 then part (b) must be from any other Module randomly selected from all the modules)
- A total of **four questions** need to be answered

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		
		Theory	Practical	Theory	Practical	Total
ITC502	Computer Network Security	03	--	03	--	03

Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Pract / Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (in Hrs)			
		Test1	Test2	Avg.					
ITC502	Computer Network Security	20	20	20	80	03	--	--	100

Course Objectives:

Sr. No.	Course Objectives
The course aims:	
1	The basic concepts of computer and Network Security
2	Various cryptographic algorithms including secret key management and different authentication techniques.
3	Different types of malicious Software and its effect on the security.
4	Various secure communication standards including IPsec, SSL/TLS and email.
5	The Network management Security and Network Access Control techniques in Computer Security.
6	Different attacks on networks and infer the use of firewalls and security protocols.

Course Outcomes:

Sr. No.	Course Outcomes	Cognitive levels of attainment as per Bloom's Taxonomy
On successful completion, of course, learner/student will be able to:		
1	Explain the fundamentals concepts of computer security and network security.	L1, L2
2	Identify the basic cryptographic techniques using classical and block encryption methods.	L1
3	Study and describe the system security malicious software.	L1, L2
4	Describe the Network layer security, Transport layer security and application layer security.	L1, L2
5	Explain the need of network management security and illustrate the need for NAC.	L1, L2
6	Identify the function of an IDS and firewall for the system security.	L1,L2, L3

Prerequisite: Basic concepts of Computer Networks & Network Design, Operating System

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours	CO Mapping
0	Prerequisite	Basic concepts of Computer Networks & Network Design, Operating System	**02**	--
I	Introduction to Network Security & cryptography	Computer security and Network Security(Definition), CIA, Services, Mechanisms and attacks, The OSI security architecture, Network security model. Classical Encryption techniques (mono-alphabetic and poly-alphabetic substitution techniques: Vigenere cipher, playfair cipher, transposition techniques: keyed and keyless transposition ciphers). Introduction to steganography. **Self-learning Topics:** Study some more classical encryption techniques and solve more problems on all techniques. Homomorphic encryption in cloud computing	**07**	CO1
II	Cryptography: Key management, distribution and user authentication	Block cipher modes of operation,Data Encryption Standard, Advanced Encryption Standard (AES). RC5 algorithm. Public key cryptography: RSA algorithm. Hashing Techniques: SHA256, SHA-512, HMAC and CMAC, Digital Signature Schemes – RSA, DSS. Remote user Authentication Protocols, Kerberos, Digital Certificate: X.509, PKI **Self-learning Topics:** Study working of elliptical curve digital signature and its benefits over RSA digital signature.	**09**	CO2
III	Malicious Software	SPAM, Trojan horse, Viruses, Worms, System Corruption, Attack Agents, Information Theft, Trapdoor, Keyloggers, Phishing, Backdoors, Rootkits, Denial of Service Attacks, Zombie **Self-learning Topics:** Study the recent malicious software's and their effects.	**04**	CO3
IV	IP Security, Transport level security and Email Security	IP level Security: Introduction to IPSec, IPSec Architecture, Protection Mechanism (AH and ESP), Transport level security: VPN. Need Web Security considerations, Secure Sockets Layer (SSL)Architecture, Transport Layer Security (TLS), HTTPS, Secure Shell (SSH) Protocol Stack. Email Security: Secure Email S/MIME Screen reader support enabled. **Self-learning Topics:** Study Gmail security and privacy from Gmail help	**07**	CO4
V	Network Management Security and Network Access Control	Network Management Security:SNMPv3, NAC:Principle elements of NAC,Principle NAC enforcement methods, How to implement NAC Solutions, Use cases for network access control **Self-learning Topics:** Explore any open source network management security tool	**06**	CO5

VI	System Security	IDS, Firewall Design Principles, Characteristics of Firewalls, Types of Firewalls **Self-learning Topics:** Study firewall rules table	**04**	CO6

Textbooks:

1 William Stallings, Cryptography and Network Security, Principles and Practice, 6th Edition, Pearson Education, March 2013.
2 Behrouz A. Ferouzan, "Cryptography & Network Security", Tata Mc Graw Hill.
3 Mark Stamp's Information Security Principles and Practice, Wiley
4 Bernard Menezes, "Cryptography & Network Security", Cengage Learning.

References:

1 Applied Cryptography, Protocols, Algorithms and Source Code in C, Bruce Schneier, Wiley.
2 Cryptography and Network Security, Atul Kahate, Tata Mc Graw Hill.
3 www.rsa.com

Online References:

Sr. No.	Website Name
1.	https://swayam.gov.in/
2.	https://nptel.ac.in/
3.	https://www.coursera.org/

Assessment:
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- **Remaining questions** will be **mixed in nature** (part (a) and part (b) of each question must be from different modules. For example, if Q.2 has part (a) from Module 3 then part (b) must be from any other Module randomly selected from all the modules)
- A total of **four questions** need to be answered

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		
		Theory	Practical	Theory	Practical	Total
ITC503	Entrepreneurship and E-business	03	--	03	--	03

Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Pract / Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (in Hrs)			
		Test1	Test2	Avg.					
ITC503	Entrepreneurship and E-business	20	20	20	80	03	--	--	100

Course Objectives:

Sr. No.	Course Objectives
The course aims:	
1	Distinguish Entrepreneur and Entrepreneurship starting and feasibility study.
2	Realize the skills required to be an entrepreneur
3	Acquaint the students with challenges of starting new ventures
4	Identify the right sources of fund for starting a new business
5	Be familiarized with concept of E-business Models.
6	Understand various E-business Strategies.

Course Outcomes:

Sr. No.	Course Outcomes	Cognitive levels of attainment as per Bloom's Taxonomy
On successful completion, of course, learner/student will be able to:		
1	Understand the concept of entrepreneurship and its close relationship with enterprise and owner-management.	L1,L2
2	Understand the nature of business development in the context of existing organizations and of new business start-ups.	L1,L2
3	Comprehended important factors for starting a new venture and business development.	L1,L2,L3
4	Know issues and decisions involved in financing and resourcing a business start-up	L1,L2,L3,L4
5	Describe various E-business Models	L1,L2,L3,L4
6	Discuss various E-business Strategies.	L1,L2,L3,L4

Prerequisite: None

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours	CO Mapping
0	Prerequisite	**None**	--	--
I	Introduction	Concept, meaning and definition of Entrepreneur and Entrepreneurship. Evolution of Entrepreneurship, Role of Entrepreneurship in economic Development; Managerial vs entrepreneurial approach; Classification and types of Entrepreneurs. Characteristics and qualities of successful Entrepreneurs; Women Entrepreneurs; Corporate & Social entrepreneurship. **Self-learning Topics:** Factors impacting emergence of entrepreneurship.	**04**	CO1
II	Entrepreneurship Development and Leadership	Entrepreneurial Motivation: motivating factors, Types of startups; Characteristics of entrepreneurial leadership, Components of Entrepreneurial Leadership; Factors influencing entrepreneurial development and motivation, Entrepreneurial Opportunities and challenges, Entrepreneurship process. Types of Enterprises and Ownership Structure: small scale, medium scale and large-scale enterprises: Meaning and definition (evolution), role of small enterprises in economic development; proprietorship, Policies governing SMEs, partnership, Ltd. companies and co-operatives: their formation, capital structure and source of finance. **Self-learning Topics:** study the white paper https://www.ncert.nic.in/ncerts/l/lebs213.pdf	**06**	CO2
III	New Venture Planning	Methods to Initiate Ventures; Acquisition-Advantages of acquiring an ongoing venture and examination of key issues; Developing a Marketing plan-customer analysis, sales analysis and competition analysis, Business Plan-benefits of drivers, perspectives in business plan preparation, elements of a business plan; Business plan failures. **Self-learning Topics:** Refer following URL to study various case studies https://www.entrepreneurindia.co/case-studies	**07**	CO3
IV	Financing & Managing Venture	Financing Stages; Sources of Finance; Venture Capital; Criteria for evaluating new-venture proposals & Capital-process. Management of venture: objectives and functions of management, scientific management, general and strategic management; introduction to human resource management: planning, job analysis, training, recruitment and selection **Self-learning Topics:** visit website	**06**	CO4

		https://www.startupindia.gov.in		
V	Overview of E – business	Concept of E-business, Business Success through adoption of technology, information management for business Initiatives, Performance improvement through e-business. Introduction to various collaborative partnerships, E-commerce: Sectors of e-commerce, B to C, B to B and C to C ecommerce, E-commerce success factors, clicks and Bricks in ecommerce, collaborative commerce. E-Marketplace, M-commerce, E-Government; Various E-business Models, Challenges of the E-Business Models, Globalization of E-business. **Self-learning Topics:** Social media applications for E-Business, Social media analytics.	**08**	CO5
VI	Strategic Initiatives for Technology	**Customer Relationship Management:** The evolution of CRM, functional areas of CRM, contemporary trends - SRM, PRM AND ERM, Future Trends of CRM **Enterprise Resource Planning**: Core and Extended ERP; components of ERP system; Benefits and Risks of ERP implementation **Supply Chain Management**: Meaning, definition, importance, and characteristics of SCM, Elements of SCM, Push & Pull supply chain model, Use of e-business to restructure supply chain, Supply chain management implementation **Procurement**: Meaning and advantages of e –procurement, Types& Drivers of e- procurement, Components of e-procurement systems, Implementation of e-procurement **Self-learning Topics:** SEM and SEO E-CRM	**08**	CO6

Textbooks:

1. Entrepreneurship; Robert Hisrich, Michael Peters; Tata McGraw Hill Publication
2. Entrepreneurship: New venture creation by David Holt, Prentice Hall of India Pvt. Ltd.
3. E- Business & E– Commerce Management: Strategy, Implementation, Practice – Dave Chaffey, Pearson Education
4. E-commerce – A Managerial Perspective- P. T. Joseph, Prentice Hall India Publications. Content

References:

1. Entrepreneurship and Innovations in E-business An Integrative Perspective by Fang Zhao, Idea Group Publications.
2. Business Driven Technology –Haag/Baltzan/Philips –Tata McGraw Hill Publication
3. Digital Business and E-commerce Management by Dave Chaffey, David Edmundson-Bird, Tanya Hemphill, Pearson Education
4. E-Business 2.0 Roadmap for Success by Dr. Ravi Kalakota, Marcia Robinson, Pearson Education
5. Case Studies in International Entrepreneurship: Managing and Financing Ventures in the Global Economy. By Walter Kuemmerle, Walter Kuemmerle. McGraw-Hill/Irwin, 2004.

ISBN: 0072977841.

Note: - It is advisable that faculty should discuss case studies in the classroom

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- A total of **four questions** need to be answered

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		
		Theory	Practical	Theory	Practical	Total
ITC504	Software Engineering	03	--	03	--	03

Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Pract/ Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (in Hrs)			
		Test1	Test 2	Avg.					
ITC504	Software Engineering	20	20	20	80	03	--	--	100

Course Objectives:

Sr. No.	Course Objectives
The course aims:	
1	To provide the knowledge of software engineering discipline.
2	To understand Requirements and analyze it
3	To do planning and apply scheduling
4	To apply analysis, and develop software solutions
5	To demonstrate and evaluate real time projects with respect to software engineering principles
6	Apply testing and assure quality in software solution.

Course Outcomes:

Sr. No.	Course Outcomes	Cognitive levels of attainment as per Bloom's Taxonomy
On successful completion, of course, learner/student will be able to:		
1	Understand and use basic knowledge in software engineering.	L1, L2
2	Identify requirements, analyze and prepare models.	L1, L2, L3
3	Plan, schedule and track the progress of the projects.	L1, L2, L3
4	Design & develop the software solutions for the growth of society	L1, L2, L3
5	To demonstrate and evaluate real time projects with respect to software engineering principles	L1, L2, L3, L4
6	Apply testing and assure quality in software solution	L1, L2, L3, L4

Prerequisite: Basic programming of knowledge.

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours	CO Mapping
0	Prerequisite	None	--	--
I	Introduction to Software Engineering	Nature of Software, Software Engineering, Software Process, Capability Maturity Model (CMM) Generic Process Model, Prescriptive Process Models: The Waterfall Model, V-model, Incremental Process Models, Evolutionary Process Models, Concurrent Models, Agile process, Agility Principles, Extreme Programming (XP), Scrum, Kanban model **Self-learning Topics:** Personal and Team Process Models	**06**	CO1,CO2
II	Requirement Analysis	Software Requirements: Functional & non-functional – user-system requirement engineering process – feasibility studies – elicitation – validation & management – software prototyping – S/W documentation – Analysis and modelling Requirement Elicitation, Software requirement specification (SRS), **Self-learning Topics:** prioritizing requirements (Kano diagram) - real life application case study.	**07**	CO1,CO2
III	Software Estimation and Scheduling	Management Spectrum, 3Ps (people, product and process) Process and Project metrics Software Project Estimation: LOC, FP, Empirical Estimation Models - COCOMO II Model, Specialized Estimation Techniques, Object based estimation, use-case based estimation Project scheduling: Defining a Task Set for the Software Project, Timeline charts, Tracking the Schedule, Earned Value Analysis **Self-learning Topics:** Cost Estimation Tools and Techniques, Typical Problems with IT Cost Estimates.	**06**	CO3
IV	Design Engineering	Design Process & quality, Design Concepts, The design Model, Pattern-based Software Design. 4.2 Architectural Design :Design Decisions, Views, Patterns, Application Architectures, Modeling Component level Design: component, Designing class based components, conducting component-level design, User Interface Design: The golden rules, Interface Design	**07**	CO3, CO4

		steps & Analysis, Design Evaluation **Self-learning Topics:** Refinement, Aspects, Refactoring		
V	Software Risk, Configuration Management	Risk Identification, Risk Assessment, Risk Projection, RMMM Software Configuration management, SCM repositories, SCM process Software Quality Assurance Task and Plan, Metrics, Software Reliability, Formal Technical Review (FTR), Walkthrough **Self-learning Topics:**: Configuration management for WebApps	**07**	CO5
VI	Software Testing and Maintenance	Testing: Software Quality, Testing: Strategic Approach, Strategic Issues- Testing: Strategies for Conventional Software, Object oriented software, Web Apps- Validating Testing- System Testing- Art of Debugging. Maintenance : Software Maintenance-Software Supportability- Reengineering- Business Process Reengineering- Software Reengineering- Reverse Engineering- Restructuring- Forward Engineering **Self-learning Topics:** Test Strategies for WebApps	**06**	CO6

Text Books:

1 Roger S. Pressman, Software Engineering: A practitioner's approach, McGraw Hill
2 Rajib Mall, Fundamentals of Software Engineering, Prentice Hall India
3 PankajJalote, An integrated approach to Software Engineering, Springer/Narosa.
4 Ian Sommerville, Software Engineering, Addison-Wesley.

References:

1 https://nptel.ac.in/courses/106/101/106101061/
2 https://www.youtube.com/watch?v=wEr6mwquPLY
3 http://www.nptelvideos.com/video.php?id=911&c=9
4 https://onlinecourses.nptel.ac.in/noc19_cs70/unit?unit=25&lesson=66
5 https://onlinecourses.nptel.ac.in/noc19_cs70/unit?unit=25&lesson=67
6 https://onlinecourses.nptel.ac.in/noc19_cs70/unit?unit=25&lesson=65
7 https://onlinecourses.nptel.ac.in/noc19_cs70/unit?unit=25&lesson=64
8 https://onlinecourses.nptel.ac.in/noc19_cs70/unit?unit=25&lesson=63

Preferable: Case studies can be discussed on every unit as per requirement for better understanding, examples are given below.

Unit 1	An information system (mental health-care system), wilderness weather system.
Unit 2	Mental health care patient management system (MHC-PMS).
Unit 3	Software Tools for Estimation.

Unit 4	Risk management in Food delivery software.
Unit 5	Study design of Biometric Authentication software.
Unit 6	Selenium Testing with any online application.

Assessment:

Internal Assessment (IA) for 20 marks:

- IA will consist of Two Compulsory Internal Assessment Tests. Approximately 40% to 50% of syllabus content must be covered in First IA Test and remaining 40% to 50% of syllabus content must be covered in Second IA Test.

- **Question paper format**

  - Question Paper will comprise of a total of **six questions each carrying 20 marksQ.1** will be **compulsory** and should **cover maximum contents of the syllabus**

  - **Remaining questions** will be **mixed in nature** (part (a) and part (b) of each question must be from different modules. For example, if Q.2 has part (a) from Module 3 then part (b) must be from any other Module randomly selected from all the modules)

  - A total of **four questions** need to be answered.

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		
		Theory	Practical	Theory	Practical	Total
ITL501	IP Lab	--	02	--	01	01

Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Pract / Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (in Hrs)			
		Test1	Test 2	Avg.					
ITL501	IP Lab	--	--	--	--	--	25	25	50

Lab Objectives:

Sr. No.	Lab Objectives
The Lab aims:	
1	To orient students to HTML for making webpages
2	To expose students to CSS for formatting web pages
3	To expose students to developing responsive layout
4	To expose students to JavaScript to make web pages interactive
5	To orient students to React for developing front end applications
6	To orient students to Node.js for developing backend applications

Lab Outcomes:

Sr. No.	Course Outcomes	Cognitive levels of attainment as per Bloom's Taxonomy
On successful completion, of course, learner/student will be able to:		
1	Identify and apply the appropriate HTML tags to develop a webpage.	L1, L2,L3,L4
2	Identify and apply the appropriate CSS tags to format data on webpage	L1, L2,L3,L4
3	Construct responsive websites using Bootstrap	L1, L2,L3,L4,L5,L6
4	Use JavaScript to develop interactive web pages.	L1, L2,L3,L4,L5,L6
5	Construct front end applications using React	L1, L2,L3,L4,L5,L6
6	Construct back end applications using Node.js/Express	L1, L2,L3,L4,L5,L6

Prerequisite: Knowledge of Java programming and object-oriented programming.

Hardware & Software Requirements:

Hardware Requirement:	Software requirement:
PC i3 processor and above	Google Chrome Browser (latest), Java 8 or above, NodeJS, React. Internet Connection

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours	LO Mapping
I	HTML5	Elements, Attributes, Head, Body, Hyperlink, Formatting, Images, Tables, List, Frames, Forms, Multimedia	**02**	LO1
II	CSS3	Syntax, Inclusion, Color, Background, Fonts, Tables, lists,CSS3 selectors, Pseudo classes, Pseudo elements	**02**	LO2
III	Bootstrap	Grid system, Forms, Button, Navbar, Breadcrumb, Jumbotron	**02**	LO3
IV	JavaScript	Variables, Operators, Conditions, Loops, Functions, Events, Classes and Objects, Error handling, Validations, Arrays, String, Date	**05**	LO4
V	React	Installation and Configuration, JSX, Components, Props, State, Forms, Events, Routers, Refs, Keys.	**08**	LO5
VI	Node.js	Installation and Configuration, Callbacks, Event loops, Creating express app.	**07**	LO6

Textbooks:

1. HTML 5 Black Book (Covers CSS3, JavaScript, XML, XHTML, AJAX, PHP, jQuery) 2Ed., DT Editorial Services
2. Learning React Functional Web Development with React and Redux, Alex Banks and Eve Porcello, O'Reilly
3. Learning Node.js Development, Andrew Mead, Packt Publishing

References:

1. https://www.tutorialspoint.com/
2. https://reactjs.org/tutorial/tutorial.html
3. https://nodejs.dev/learn
4. https://www.youtube.com/watch?v=-27HAh8c0YU

Term Work: Term Work shall consist of at least 12 to 15 practicals based on the above list. Also Term work Journal must include at least 2 assignments.

Term Work Marks: 25 Marks (Total marks) = 15 Marks (Experiment) + 5 Marks (Assignments) + 5 Marks (Attendance)

Practical & Oral Exam: An Practical & Oral exam will be held based on the above syllabus.

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		
		Theory	Practical	Theory	Practical	Total
ITL502	Security Lab	--	02	--	01	01

Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Pract / Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (in Hrs)			
		Test1	Test 2	Avg.					
ITL502	Security Lab	--	--	--	--	--	25	25	50

Lab Objectives:

Sr. No.	Lab Objectives
The Lab experiments aims:	
1	To apply the knowledge of symmetric cryptography to implement classical ciphers.
2	To analyze and implement public key encryption algorithms, hashing and digital signature algorithms.
3	To explore the different network reconnaissance tools to gather information about networks.
4	To explore the tools like sniffers, port scanners and other related tools for analyzing.
5	To Scan the network for vulnerabilities and simulate attacks.
6	To set up intrusion detection systems using open-source technologies and to explore email security.

Lab Outcomes:

Sr. No.	Lab Outcomes	Cognitive levels of attainment as per Bloom's Taxonomy
On successful completion, of course, learner/student will be able to:		
1	Illustrate symmetric cryptography by implementing classical ciphers.	L1,L2
2	Demonstrate Key management, distribution and user authentication.	L1,L2
3	Explore the different network reconnaissance tools to gather information about networks	L1,L2, L3
4	Use tools like sniffers, port scanners and other related tools for analyzing packets in a network.	L1,L2,L3
5	Use open-source tools to scan the network for vulnerabilities and simulate attacks.	L1,L2,L3
6	Demonstrate the network security system using open source tools.	L1,L2

Prerequisite: Basic concepts of Computer Networks & Network Design, Operating System

Hardware & Software Requirements:

Hardware Requirement: PC With following Configuration 1. Intel Core i3/i5/i7 Processor 2. 4 GB RAM 3. 500 GB Harddisk	Software requirement: 1. Windows or Linux Desktop OS 2. wireshark 3. ARPWATCH 4. Kismet, NetStumbler 5. NESSU

DETAILED SYLLABUS:

Sr. No.	Detailed Content	Hours	LO Mapping
I	Classical Encryption techniques (mono-alphabetic and poly-alphabetic substitution techniques: Vigenere cipher, playfair cipher)	**04**	LO1
II	1)Block cipher modes of operation using a)Data Encryption Standard b)Advanced Encryption Standard (AES). 2)Public key cryptography: RSA algorithm. 3)Hashing Techniques: HMAC using SHA 4)Digital Signature Schemes – RSA, DSS.	**06**	LO2
III	1) Study the use of network reconnaissance tools like WHOIS, dig, traceroute, nslookup to gather information about networks and domain registrars. 2) Study of packet sniffer tools Wireshark, :- a. Observer performance in promiscuous as well as non-promiscuous mode. b. Show the packets can be traced based on different filters.	**04**	LO3
IV	1) Download and install nmap. 2) Use it with different options to scan open ports, perform OS fingerprinting, ping scan, tcp port scan, udp port scan, etc.	**04**	LO4
V	a) Keylogger attack using a keylogger tool. b) Simulate DOS attack using Hping or other tools c) Use the NESSUS/ISO Kali Linux tool to scan the network for vulnerabilities.	**04**	LO5
VI	1) Set up IPSec under Linux. 2) Set up Snort and study the logs. 3) Explore the GPG tool to implement email security	**04**	LO6

Text Books

1 Build your own Security Lab, Michael Gregg, Wiley India.
2 CCNA Security, Study Guide, TIm Boyles, Sybex.
3 Hands-On Information Security Lab Manual, 4th edition, Andrew Green, Michael Whitman,

Herbert Mattord.
4 The Network Security Test Lab: A Step-by-Step Guide Kindle Edition, Michael Gregg.

References:

1 Network Security Bible, Eric Cole, Wiley India.
2 Network Defense and Countermeasures, William (Chuck) Easttom.
3 Principles of Information Security + Hands-on Information Security Lab Manual, 4th Ed. , Michael E. Whitman , Herbert J. Mattord.
4 IITB virtual Lab: http://cse29-iiith.vlabs.ac.in/
5 https://www.dcode.fr/en

Sr.No	Experiment Title
1.	Breaking the Mono-alphabetic Substitution Cipher using Frequency analysis method.
2.	Design and Implement a product cipher using Substitution ciphers.
3.	Cryptanalysis or decoding Playfair, vigenere cipher.
4.	Encrypt long messages using various modes of operation using AES or DES.
5.	Cryptographic Hash Functions and Applications (HMAC): to understand the need, design and applications of collision resistant hash functions.
6.	Implementation and analysis of RSA cryptosystem and Digital signature scheme using RSA.
7.	Study the use of network reconnaissance tools like WHOIS, dig, traceroute, nslookup to gather information about networks and domain registrars.
8.	Study of packet sniffer tools wireshark: - a. Observer performance in promiscuous as well as non-promiscuous mode. b. Show the packets can be traced based on different filters.
9.	Download, install nmap and use it with different options to scan open ports, perform OS fingerprinting, ping scan, tcp port scan, udp port scan, etc.
10.	Study of malicious software using different tools: a) Keylogger attack using a keylogger tool. b) Simulate DOS attack using Hping or other tools c) Use the NESSUS/ISO Kali Linux tool to scan the network for vulnerabilities.
11.	Study of Network security by a) Set up IPSec under Linux. b) Set up Snort and study the logs. c) Explore the GPG tool to implement email security

Term Work: Term Work shall consist of at least 12 to 15 practicals based on the above list. Also Term work Journal must include at least 2 assignments.

Term Work Marks: 25 Marks (Total marks) = 15 Marks (Experiment) + 5 Marks (Assignments) + 5 Marks (Attendance)

Practical & Oral Exam: An Practical & Oral exam will be held based on the above syllabus.

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		
		Theory	Practical	Theory	Practical	Total
ITL503	DevOPs Lab	--	02	--	01	01

Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Pract / Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (in Hrs)			
		Test1	Test 2	Avg.					
ITL503	DevOPs Lab	--	--	--	--	--	25	25	50

Lab Objectives:

Sr. No.	Lab Objectives
The Lab experiments aims:	
1	To understand DevOps practices which aims to simplify Software Development Life Cycle
2	To be aware of different Version Control tools like GIT, CVS or Mercurial
3	To Integrate and deploy tools like Jenkins and Maven, which is used to build, test and deploy applications in DevOps environment
4	To be familiarized with selenium tool, which is used for continuous testing of applications deployed.
5	To use Docker to Build, ship and manage applications using containerization
6	To understand the concept of Infrastructure as a code and install and configure Ansible tool.

Lab Outcomes:

Sr. No.	Lab Outcomes	Cognitive levels of attainment as per Bloom's Taxonomy
On successful completion, of course, learner/student will be able to:		
1	To understand the fundamentals of DevOps engineering and be fully proficient with DevOps terminologies, concepts, benefits, and deployment options to meet your business requirements	L1,L2
2	To obtain complete knowledge of the "version control system" to effectively track changes augmented with Git and GitHub	L1,L2
3	To understand the importance of Jenkins to Build and deploy Software Applications on server environment	L1,L2
4	Understand the importance of Selenium and Jenkins to test Software Applications	L1,L2

5	To understand concept of containerization and Analyze the Containerization of OS images and deployment of applications over Docker	L1,L2,L3
6	To Synthesize software configuration and provisioning using Ansible.	L1,L2,L3

Prerequisite: Operating System, Linux Administration, Java /Web Application Programming, and Software Engineering.

Hardware & Software Requirements:

Hardware Requirements	Software Requirements	Other Requirements
PC With following Configuration 1. Intel i3 core or above 2. 4 GB RAM or above 3. 500 GB HDD 4. Network interface card	1. Linux / Windows Operating system 2. VIRTUAL BOX/ VMWARE	1. Internet Connection for installing additional packages 2. GitHub account 3. Docker hub account

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours	LO Mapping
0	Prerequisite	Knowledge of Linux Operating system, installation and configuration of services and command line basics, Basics of Computer Networks and Software Development Life cycle.	**00**	LO1
I	Introduction to Devops	Understanding of the process to be followed during the development of an application, from the inception of an idea to its final deployment. Learn about the concept of DevOps and the practices and principles followed to implement it in any company's software development life cycle. Learn about the phases of Software Lifecycle. Get familiar with the concept of Minimum Viable Product (MVP) & Cross-functional Teams. Understand why DevOps evolved as a prominent culture in most of the modern-day startups to achieve agility in the software development process **Self-Learning Topics: Scrum, Kanban, Agile**	**04**	LO1
II	Version Control	In this module you will learn: • GIT Installation, Version Control, Working with remote repository • GIT Cheat sheet • Create and fork repositories in GitHub • Apply branching, merging and rebasing concepts. • Implement different Git workflow strategies in real-time scenarios • Understand Git operations in IDE **Self-Learning Topics: AWS Codecommit, Mercurial, Subversion, Bitbucket, CVS**	**04**	LO1 & LO2
III	Continuous Integration using Jenkins	In this module, you will know how to perform Continuous Integration using Jenkins by building and automating test cases using Maven / Gradle / Ant. • Introduction to Jenkins (With Architecture) • Introduction to Maven / Gradle / Ant.	**04**	LO1 & LO3

		• Jenkins Management Adding a slave node to Jenkins • Build the pipeline of jobs using Maven / Gradle / Ant in Jenkins, create a pipeline script to deploy an application over the tomcat server **Self-Learning Topics: Travis CI, Bamboo, GitLab, AWS CodePipeline**		
IV	Continuous Testing with Selenium	In this module, you will learn about selenium and how to automate your test cases for testing web elements. You will also get introduced to X-Path, TestNG and integrate Selenium with Jenkins and Maven. • Introduction to Selenium • Installing Selenium • Creating Test Cases in Selenium WebDriver • Run Selenium Tests in Jenkins Using Maven **Self-Learning Topics: Junit, Cucumber**	**04**	LO1 , LO3 & LO4
V	Continuous Deployment: Containerizatio n with Docker	In this module, you will be introduced to the core concepts and technology behind Docker. Learn in detail about container and various operations performed on it. • Introduction to Docker Architecture and Container Life Cycle • Understanding images and containers • Create and Implement docker images using Dockerfile. • Container Lifecycle and working with containers. • To Build, deploy and manage web or software application on Docker Engine. • Publishing image on Docker Hub. **Self-Learning Topics: Docker Compose, Docker Swarm.**	**05**	LO1 & LO5
VI	Continuous Deployment: Configuration Management with Puppet	In this module, you will learn to Build and operate a scalable automation system. • Puppet Architecture • Puppet Master Slave Communication • Puppet Blocks • Installation and Configuring Puppet Master and Agent on Linux machines • Use exported resources and forge modules to set up Puppet modules • Create efficient manifests to streamline your deployments **Self-Learning Topics: Ansible, Saltstack**	**05**	LO1 & LO6

Text books

1. DevOps Bootcamp, Sybgen Learning
2. Karl Matthias & Sean P. Kane, Docker: Up and Running, O'Reilly Publication.
3. Len Bass,Ingo Weber,Liming Zhu,"DevOps, A Software Architects Perspective", AddisonWesley-Pearson Publication.
4. John Ferguson Smart," Jenkins, The Definitive Guide", O'Reilly Publication.
5. Mastering Puppet 5: Optimize enterprise-grade environment performance with Puppet, by Ryan Russell-

Yates Packt Publishing (September 29, 2018)

References:

1. Sanjeev Sharma and Bernie Coyne," DevOps for Dummies", Wiley Publication
2. Httermann, Michael, "DevOps for Developers", Apress Publication.
3. Joakim Verona, "Practical DevOps", Pack publication
4. Puppet 5 Essentials - Third Edition: A fast-paced guide to automating your infrastructure by Martin Alfke Packt Publishing; 3rd Revised edition (September 13, 2017)

List of Experiments:

Sr.No	Experiment Title
1.	To understand DevOps: Principles, Practices, and DevOps Engineer Role and Responsibilities.
2.	To understand Version Control System / Source Code Management, install git and create a GitHub account.
3.	To Perform various GIT operations on local and Remote repositories using GIT Cheat-Sheet
4.	To understand Continuous Integration, install and configure Jenkins with Maven/Ant/Gradle to setup a build Job.
5.	To Build the pipeline of jobs using Maven / Gradle / Ant in Jenkins, create a pipeline script to Test and deploy an application over the tomcat server.
6.	To understand Jenkins Master-Slave Architecture and scale your Jenkins standalone implementation by implementing slave nodes.
7.	To Setup and Run Selenium Tests in Jenkins Using Maven.
8.	To understand Docker Architecture and Container Life Cycle, install Docker and execute docker commands to manage images and interact with containers.
9.	To learn Dockerfile instructions, build an image for a sample web application using Dockerfile.
10.	To install and Configure Pull based Software Configuration Management and provisioning tools using Puppet.
11.	To learn Software Configuration Management and provisioning using Puppet Blocks(Manifest, Modules, Classes, Function)
12	To provision a LAMP/MEAN Stack using Puppet Manifest.

Term Work: Term Work shall consist of at least 12 to 15 practicals based on the above list. Also Term work Journal must include at least 2 assignments, one of which must include a Case study on DevOps Implementation in real world and the other one can be based on the self-learning topics mentioned in syllabus.

Term Work Marks: 25 Marks (Total marks) = 15 Marks (Experiment) + 5 Marks (Assignments) + 5 Marks (Attendance)

Practical & Oral Exam: An Practical & Oral exam will be held based on the above syllabus.

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Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		
		Theory	Practical	Theory	Practical	Total
ITL504	Advance DevOps Lab	--	02	--	01	01

Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Pract / Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (in Hrs)			
		Test1	Test 2	Avg.					
ITL504	Advance DevOps Lab	--	--	--	--	--	25	25	50

Lab Objectives:

Sr. No.	Lab Objectives
The Lab experiments aims:	
1	To understand DevOps practices and cloud native environments to achieve continuous software delivery pipelines and automated operations that address the gap between IT resources and growing cloud complexity.
2	To Use Kubernetes services to structure N-tier applications.
3	To be familiarized with Infrastructure as code for provisioning, compliance, and management of any cloud infrastructure, and service.
4	To understand that security and speed in software development are not inversely-related objectives Internalizing the contribution of tools and automation in DevSecOps
5	To understand various troubleshooting techniques by monitoring your entire infrastructure and business processes
6	To understand how software and software-defined hardware are provisioned dynamically.

Lab Outcomes:

Sr. No.	Lab Outcomes	Cognitive levels of attainment as per Bloom's Taxonomy
On successful completion, of course, learner/student will be able to:		
1	To understand the fundamentals of Cloud Computing and be fully proficient with Cloud based DevOps solution deployment options to meet your business requirements	L1,L2
2	To deploy single and multiple container applications and manage application deployments with rollouts in Kubernetes	L1,L2,L3
3	To apply best practices for managing infrastructure as code environments and use terraform to define and deploy cloud	L1,L2,L3

	infrastructure.	
4	To identify and remediate application vulnerabilities earlier and help integrate security in the development process using SAST Techniques.	L1,L2,L3
5	To use Continuous Monitoring Tools to resolve any system errors (low memory, unreachable server etc.) before they have any negative impact on the business productivity	L1,L2,L3
6	To engineer a composition of nano services using AWS Lambda and Step Functions with the Serverless Framework	L1,L2,L3

Prerequisite: Operating System, Linux Administration, Java /Web Application Programming, Software Engineering, Cloud Computing and DevOps Ecosystem.

Hardware & Software Requirements:

Hardware Requirements	Software Requirements	Other Requirements
PC With following Configuration 1. Intel i3 core or above 2. 4 GB RAM or above 3. 500 GB HDD 4. Network interface card	1. Linux / Windows Operating system 2. VIRTUAL BOX/ VMWARE	1. Internet Connection for installing additional packages 2. GitHub account 3. AWS free tier account

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours	LO Mapping
0	Prerequisite	Knowledge of Linux Operating system, installation and configuration of services and command line basics, Basics of Computer Networks, Software Development Life cycle, Cloud Computing and DevOps Ecosystem.	**02**	--
I	Introduction to Devops on Cloud	Learn about various cloud services and service providers, also get the brief idea of how to implement DevOps over Cloud Platforms. • Introduction to high availability architecture and auto-scaling • Set up the DevOps infrastructure on the cloud • Work and set up IDE on Cloud9 • Deploy projects on AWS using Code Build, CodeDeploy, and CodePipeline **Self-Learning Topics:** AWS Codestar	**04**	LO1
II	Container Orchestration using Kubernetes	In this module, you will learn how Kubernetes automates many of the manual processes involved in deploying, managing, and scaling containerized applications. Install and configure Kubernetes Spin Up a Kubernetes Cluster Check the Nodes of Your Kubernetes Cluster	**04**	LO1, LO2

		Installing kubectl to manage cluster and deploy Your First Kubernetes Application **Self-Learning Topics:** • Using Services and Ingresses to Expose Deployments • Perform logging, monitoring, services, and volumes in Kubernetes.		
III	Infrastructure Automation with Terraform	In this module you will learn, Infrastructure as code for provisioning, compliance, and management of any cloud infrastructure, and service. • Introduction to Infrastructure as Code with Terraform • Install, Build, change and Destroy Infrastructure using Terraform. **Self-Learning Topics:** Terraform • Create Resource Dependencies • Provision Infrastructure • Define Input Variables, Query Data with output and store remote state	**04**	LO1, LO3
IV	DevSecOps: Static Application Security Testing (SAST)	In this module, you will learn to identify and remediate application vulnerabilities earlier and help integrate security in the development process using tools like SonarQube / Gitlab / • Perform static analysis on application source code and binaries. • Spot potential vulnerabilities before deployment • Analysis of java / web-based project • Jenkins SonarQube / Gitlab Integration **Self-Learning Topics:** Snyk, OWASP ZAP, Analysis Core Plugin	**04**	LO1, LO4
V	DevSecOps: Continuous Monitoring	In this module, you will learn to detect, report, respond to the attacks and issues which occur within the infrastructure. • Introduction to Continuous Monitoring • Introduction to Nagios • Installing Nagios • Nagios Plugins (NRPE) and Objects Nagios Commands and Notification • Monitoring of different servers using Nagios	**04**	LO1, LO5

		Self-Learning Topics: Splunk, Snort, Tenable		
VI	NoOps: Serverless Computing	In this module, you will learn serverless computing platform like AWS Lambda, which allows you to build your code and deploy it without ever needing to configure or manage underlying servers. • AWS Lambda - Overview and Environment Setup • Building and Configuring the Lambda function (NODEJS/PYTHON/JAVA) • Creating & Deploying using AWS Console/CLI • Creating & Deploying using Serverless Framework **Self-Learning Topics:** AWS Lambda • Create a REST API with the Serverless Framework	**04**	LO1, LO6

Textbooks:

1. AWS Certified SysOps Administrator Official Study Guide: Associate Exam by Stephen Cole (Author), Gareth Digby (Author), Chris Fitch (Author), Steve Friedberg (Author), Shaun Qual
2. AWS Certified Solutions Architect Official Study Guide: Associate Exam by Joe Baron
3. Terraform: Up & Running - Writing Infrastructure as Code, Second Edition by Yevgeniy Brikman , O'Reilly
4. Kubernetes: Up and Running - Dive into the Future of Infrastructure, Second Editionby Brendan Burns,O'Reilly
5. Going Serverless with AWS Lambda: Leveraging the latest services from the AWS cloud by Ajay Pherwani , Shroff/X-Team;
6. Learning Nagios, Packt Publishing.

References:

1. Learning Aws - Second Edition: Design, build, and deploy responsive applications using AWS by Amit Shah Aurobindo Sarkar
2. Mastering Aws Lambda by Yohan Wadia Udita Gupta

List of Experiments:

Sr. No	Experiment Title
1	To understand the benefits of Cloud Infrastructure and Setup AWS Cloud9 IDE, Launch AWS Cloud9 IDE and Perform Collaboration Demonstration.
2	To Build Your Application using AWS CodeBuild and Deploy on S3 / SEBS using AWS CodePipeline, deploy Sample Application on EC2 instance using AWS CodeDeploy.
3	To understand the Kubernetes Cluster Architecture, install and Spin Up a Kubernetes Cluster on Linux Machines/Cloud Platforms.
4	To install Kubectl and execute Kubectl commands to manage the Kubernetes cluster and deploy Your First Kubernetes Application.

5	To understand terraform lifecycle, core concepts/terminologies and install it on a Linux Machine.
6	To Build, change, and destroy AWS / GCP /Microsoft Azure/ DigitalOcean infrastructure Using Terraform.
7	To understand Static Analysis SAST process and learn to integrate Jenkins SAST to SonarQube/GitLab.
8	Create a Jenkins CICD Pipeline with SonarQube / GitLab Integration to perform a static analysis of the code to detect bugs, code smells, and security vulnerabilities on a sample Web / Java / Python application.
9	To Understand Continuous monitoring and Installation and configuration of Nagios Core, Nagios Plugins and NRPE (Nagios Remote Plugin Executor) on Linux Machine.
10	To perform Port, Service monitoring, Windows/Linux server monitoring using Nagios.
11	To understand AWS Lambda, its workflow, various functions and create your first Lambda functions using Python / Java / Nodejs.
12	To create a Lambda function which will log "An Image has been added" once you add an object to a specific bucket in S3.

Term Work: Term Work shall consist of at least 12 to 15 practicals based on the above list. Also Term work Journal must include at least 2 assignments based on the self-learning topics mentioned in syllabus.

Term Work Marks: 25 Marks (Total marks) = 15 Marks (Experiment) + 5 Marks (Assignments) + 5 Marks (Attendance)

Practical & Oral Exam: An Practical & Oral exam will be held based on the above syllabus.

Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ITL505	Professional Communication & Ethics-II (PCE-II)	--	2*+ 2 Hours (Batch-wise)	--	--	02	--	02

***Theory class to be conducted for full class.**

Course Code	Course Name	Examination Scheme									
		Theory					Term work	Pract	Oral	Internal Oral	Total
		Internal Assessment			End sem	Duration (hrs)					
		Test 1	Test 2	Avg.							
ITL505	Professional Communication & Ethics-II (PCE-II)	--	--	--	--	--	25	--	--	25	50

Course Code	Course Name	Credits
ITL505	Professional Communication & Ethics-II (PCE-II)	02
Course Rationale	This curriculum is designed to build up a professional and ethical approach, effective oral and written communication with enhanced soft skills. Through practical sessions, it augments student's interactive competence and confidence to respond appropriately and creatively to the implied challenges of the global Industrial and Corporate requirements. It further inculcates the social responsibility of engineers as technical citizens.	
Course Objectives	• To discern and develop an effective style of writing important technical/business documents. • To investigate possible resources and plan a successful job campaign. • To understand the dynamics of professional communication in the form of group discussions, meetings, etc. required for career enhancement. • To develop creative and impactful presentation skills. • To analyze personal traits, interests, values, aptitudes and skills. • To understand the importance of integrity and develop a personal code of ethics.	
Course Outcomes	**Learner will be able to…** • plan and prepare effective business/ technical documents which will in turn provide solid foundation for their future managerial roles. • strategize their personal and professional skills to build a professional image and meet the demands of the industry. • emerge successful in group discussions, meetings and result-oriented agreeable solutions in group communication situations. • deliver persuasive and professional presentations. • develop creative thinking and interpersonal skills required for effective professional communication. • apply codes of ethical conduct, personal integrity and norms of organizational behaviour.	

Module	Contents	Hours
1	**ADVANCED TECHNICAL WRITING :PROJECT/PROBLEM BASED LEARNING (PBL)** **1.1 Purpose and Classification of Reports:** **Classification on the basis of:** • Subject Matter (Technology, Accounting, Finance, Marketing, etc.) • Time Interval (Periodic, One-time, Special) • Function (Informational, Analytical, etc.) • Physical Factors (Memorandum, Letter, Short & Long) **1.2. Parts of a Long Formal Report:** • Prefatory Parts (Front Matter) • Report Proper (Main Body) • Appended Parts (Back Matter) **1.3. Language and Style of Reports** • Tense, Person & Voice of Reports • Numbering Style of Chapters, Sections, Figures, Tables and Equations • Referencing Styles in APA & MLA Format • Proofreading through Plagiarism Checkers **1.4. Definition, Purpose & Types of Proposals** • Solicited (in conformance with RFP) & Unsolicited Proposals • Types (Short and Long proposals) **1.5. Parts of a Proposal** • Elements • Scope and Limitations • Conclusion **1.6. Technical Paper Writing** • Parts of a Technical Paper (Abstract, Introduction, Research Methods, Findings and Analysis, Discussion, Limitations, Future Scope and References) • Language and Formatting • Referencing in IEEE Format	**06**
2	**EMPLOYMENT SKILLS** **2.1. Cover Letter & Resume** • Parts and Content of a Cover Letter • Difference between Bio-data, Resume & CV • Essential Parts of a Resume • Types of Resume (Chronological, Functional & Combination) **2.2 Statement of Purpose** • Importance of SOP • Tips for Writing an Effective SOP **2.3 Verbal Aptitude Test** • Modelled on CAT, GRE, GMAT exams **2.4. Group Discussions** • Purpose of a GD • Parameters of Evaluating a GD • Types of GDs (Normal, Case-based & Role Plays)	**06**

	• GD Etiquettes **2.5. Personal Interviews** • Planning and Preparation • Types of Questions • Types of Interviews (Structured, Stress, Behavioural, Problem Solving & Case-based) • Modes of Interviews: Face-to-face (One-to one and Panel) Telephonic, Virtual	
3	**BUSINESS MEETINGS** **1.1. Conducting Business Meetings** • Types of Meetings • Roles and Responsibilities of Chairperson, Secretary and Members • Meeting Etiquette **3.2. Documentation** • Notice • Agenda • Minutes	**02**
4	**TECHNICAL/ BUSINESS PRESENTATIONS** **1.1 Effective Presentation Strategies** • Defining Purpose • Analyzing Audience, Location and Event • Gathering, Selecting &Arranging Material • Structuring a Presentation • Making Effective Slides • Types of Presentations Aids • Closing a Presentation • Platform skills **1.2 Group Presentations** • Sharing Responsibility in a Team • Building the contents and visuals together • Transition Phases	**02**
5	**INTERPERSONAL SKILLS** **1.1. Interpersonal Skills** • Emotional Intelligence • Leadership & Motivation • Conflict Management & Negotiation • Time Management • Assertiveness • Decision Making **5.2 Start-up Skills** • Financial Literacy • Risk Assessment • Data Analysis (e.g. Consumer Behaviour, Market Trends, etc.)	**08**
6	**CORPORATE ETHICS** **6.1Intellectual Property Rights** • Copyrights • Trademarks • Patents • Industrial Designs	**02**

	• Geographical Indications • Integrated Circuits • Trade Secrets (Undisclosed Information) **6.2 Case Studies** • Cases related to Business/ Corporate Ethics	

List of assignments:

(In the form of Short Notes, Questionnaire/ MCQ Test, Role Play, Case Study, Quiz, etc.)

1. Cover Letter and Resume
2. Short Proposal
3. Meeting Documentation
4. Writing a Technical Paper/ Analyzing a Published Technical Paper
5. Writing a SOP
6. IPR
7. Interpersonal Skills
8. Aptitude test (Verbal Ability)

Note:

1. The Main Body of the project/book report should contain minimum 25 pages (excluding Front and Back matter).
2. The group size for the final report presentation should not be less than 5 students or exceed 7 students.
3. There will be an end–semester presentation based on the book report.

Assessment:

Term Work:

Term work shall consist of minimum 8 experiments.

The distribution of marks for term work shall be as follows:

Assignment : 10 Marks

Attendance : 5 Marks

Presentation slides : 5 Marks

Book Report (hard copy) : 5 Marks

The final certification and acceptance of term work ensures the satisfactory performance of laboratory work and minimum passing in the term work.

Internal oral:

Oral Examination will be based on a GD & the Project/Book Report presentation.

Group Discussion : 10 marks

Project Presentation : 10 Marks

Group Dynamics : 5 Marks

Books Recommended:

Textbooks and Reference books:

1. Arms, V. M. (2005). *Humanities for the engineering curriculum: With selected chapters from Olsen/Huckin: Technical writing and professional communication, second edition*. Boston, MA: McGraw-Hill.
2. Bovée, C. L., &Thill, J. V. (2021). *Business communication today*. Upper Saddle River, NJ: Pearson.
3. Butterfield, J. (2017). *Verbal communication: Soft skills for a digital workplace*. Boston, MA: Cengage Learning.
4. Masters, L. A., Wallace, H. R., & Harwood, L. (2011).*Personal development for life and work*. Mason: South-Western Cengage Learning.
5. Robbins, S. P., Judge, T. A., & Campbell, T. T. (2017). *Organizational behaviour*. Harlow, England:

Pearson.
6. Meenakshi Raman, Sangeeta Sharma (2004) Technical Communication, Principles and Practice. Oxford University Press
7. Archana Ram (2018) Place Mentor, Tests of Aptitude For Placement Readiness. Oxford University Press
Sanjay Kumar &PushpLata (2018). Communication Skills a workbook, New Delhi: Oxford University Press.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ITM501	Mini Project – 2 A Web Based Business Model	--	04	--	--	02	--	02

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Pract. /Oral	Total
		Internal assessment			End Sem. Exam			
		Test1	Test 2	Avg.				
ITM501	Mini Project – 2 A Web Based Business Model	--	--	--	--	25	25	50

Course Objectives

1. To acquaint with the process of identifying the needs and converting it into the problem.
2. To familiarize the process of solving the problem in a group.
3. To acquaint with the process of applying basic engineering fundamentals to attempt solutions to the problems.
4. To inculcate the process of self-learning and research.

Course Outcome: Learner will be able to…

1. Identify problems based on societal /research needs.
2. Apply Knowledge and skill to solve societal problems in a group.
3. Develop interpersonal skills to work as member of a group or leader.
4. Draw the proper inferences from available results through theoretical/ experimental/simulations.
5. Analyse the impact of solutions in societal and environmental context for sustainable development.
6. Use standard norms of engineering practices
7. Excel in written and oral communication.
8. Demonstrate capabilities of self-learning in a group, which leads to life long learning.
9. Demonstrate project management principles during project work.

Guidelines for Mini Project

- Students shall form a group of 3 to 4 students, while forming a group shall not be allowed less than three or more than four students, as it is a group activity.
- Students should do survey and identify needs, which shall be converted into problem statement for mini project in consultation with faculty supervisor/head of department/internal committee of faculties.
- Students hall submit implementation plan in the form of Gantt/PERT/CPM chart, which will cover weekly activity of mini project.
- A log book to be prepared by each group, wherein group can record weekly work progress, guide/supervisor can verify and record notes/comments.
- Faculty supervisor may give inputs to students during mini project activity;however, focus shall be on self-learning.

- Students in a group shall understand problem effectively, propose multiple solution and select best possible solution in consultation with guide/ supervisor.
- Students shall convert the best solution into working model using various components of their domain areas and demonstrate.
- The solution to be validated with proper justification and report to be compiled in standard format of University of Mumbai.
- With the focus on the self-learning, innovation, addressing societal problems and entrepreneurship quality development within the students through the Mini Projects, it is preferable that a single project of appropriate level and quality to be carried out in two semesters by all the groups of the students. i.e. Mini Project 1 in semester III and IV. Similarly, Mini Project 2 in semesters V and VI.
- However, based on the individual students or group capability, with the mentor's recommendations, if the proposed Mini Project adhering to the qualitative aspects mentioned above gets completed in odd semester, then that group can be allowed to work on the extension of the Mini Project with suitable improvements/modifications or a completely new project idea in even semester. This policy can be adopted on case by case basis.

Guidelines for Assessment of Mini Project:

Term Work

- The review/ progress monitoring committee shall be constituted by head of departments of each institute. The progress of mini project to be evaluated on continuous basis, minimum two reviews in each semester.
- In continuous assessment focus shall also be on each individual student, assessment based on individual's contribution in group activity, their understanding and response to questions.
- Distribution of Term work marks for both semesters shall be as below;
    - Marks awarded by guide/supervisor based on log book : 10
    - Marks awarded by review committee : 10
    - Quality of Project report : 05

Review/progress monitoring committee may consider following points for assessment based on either one year or half year project as mentioned in general guidelines.

One-year project:

- In first semester entire theoretical solution shall be ready, including components/system selection and cost analysis. Two reviews will be conducted based on presentation given by students group.
    - First shall be for finalisation of problem
    - Second shall be on finalisation of proposed solution of problem.
- In second semester expected work shall be procurement of component's/systems, building of working prototype, testing and validation of results based on work completed in an earlier semester.
    - First review is based on readiness of building working prototype to be conducted.
    - Second review shall be based on poster presentation cum demonstration of working model in last month of the said semester.

Half-year project:

- In this case in one semester students' group shall complete project in all aspects including,
    - Identification of need/problem
    - Proposed final solution
    - Procurement of components/systems
    - Building prototype and testing
- Two reviews will be conducted for continuous assessment,
    - First shall be for finalisation of problem and proposed solution
    - Second shall be for implementation and testing of solution.

Assessment criteria of Mini Project.

Mini Project shall be assessed based on following criteria;

1. Quality of survey/ need identification
2. Clarity of Problem definition based on need.
3. Innovativeness in solutions
4. Feasibility of proposed problem solutions and selection of best solution
5. Cost effectiveness
6. Societal impact
7. Innovativeness
8. Cost effectiveness and Societal impact
9. Full functioning of working model as per stated requirements
10. Effective use of skill sets
11. Effective use of standard engineering norms
12. Contribution of an individual's as member or leader
13. Clarity in written and oral communication

- In **one year, project**, first semester evaluation may be based on first six criteria's and remaining may be used for second semester evaluation of performance of students in mini project.
- In case of **half year project** all criteria's in generic may be considered for evaluation of performance of students in mini project.

Guidelines for Assessment of Mini Project Practical/Oral Examination:

- Report should be prepared as per the guidelines issued by the University of Mumbai.
- Mini Project shall be assessed through a presentation and demonstration of working model by the student project group to a panel of Internal and External Examiners preferably from industry or research organisations having experience of more than five years approved by head of Institution.
- Students shall be motivated to publish a paper based on the work in Conferences/students competitions.

Mini Project shall be assessed based on following points;

1. Quality of problem and Clarity
2. Innovativeness in solutions
3. Cost effectiveness and Societal impact
4. Full functioning of working model as per stated requirements
5. Effective use of skill sets
6. Effective use of standard engineering norms
7. Contribution of an individual's as member or leader
8. Clarity in written and oral communication

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		
		Theory	Practical	Theory	Practical	Total
ITDO5011	Microcontroller Embedded Programming	03	--	03	--	03

Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Pract/ Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (in Hrs)			
		Test1	Test 2	Avg.					
ITDO5011	Microcontroller Embedded Programming	20	20	20	80	3	--	--	100

Course Objectives:

Sr. No.	Course Objectives
The course aims:	
1	Conceptualize the architecture of embedded systems.
2	Study the basics of microcontroller 8051.
3	Elaborate on the concepts of microcontroller interfacing.
4	Understand the concepts of ARM architecture
5	Study the concepts of real-time operating system
6	Learn about various embedded platforms and their programming

Course Outcomes:

Sr. No.	Course Outcomes	Cognitive levels of attainment as per Bloom's Taxonomy
On successful completion, of course, learner/student will be able to:		
1	Introduce and discuss the embedded system concepts, architecture of embedded systems and understand the embedded development environments	L1, L2
2	Describe the architecture of 8051 microcontroller and write embedded programs for 8051Microcontroller	L2, L3
3	Illustrate the interfacing of peripherals with 8051 microcontroller and write programs	L2, L3
4	Understand and apply the concepts of ARM architecture	L2, L3
5	Explain and Demonstrate the open source RTOS	L3
6	**Select** the embedded platform and program it for real time application	L3, L4

Prerequisite: Computer Organization and Architecture, Operating System.

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours	CO Mapping
0	Prerequisite	Revision of microcomputer system terminologies, High level, difference between microprocessor and microcontroller, basics of operating System.	**02**	--
I	Introduction to Embedded systems	Overview of Embedded System Architecture, Application areas, Categories of embedded systems, specialties of embedded systems. Recent trends in embedded systems. Brief introduction to embedded microcontroller cores CISC, RISC, ARM, DSP and SoC. Introduction to Embedded System Integrated Development Environments (IDEs) with examples. **Self-learning Topics:** Comparison of CISC & RISC, Case studies of Real Time Embedded Systems.	**04**	CO1
II	The Microcontroller Architecture and Programming of 8051	Introduction to 8051 Microcontroller, Architecture, Pin configuration, Memory Organization, Input /Output Ports, Counter and Timers, Serial communication, Interrupts. Addressing modes, Instruction set 8051 developing tools, Programming based on Arithmetic & Logical Operations, I/O parallel and serial ports, Timers & Counters, and ISR. **Self-learning Topics:** Writing 8051 programming in Embedded C	**10**	CO2
III	Interfacing with 8051Microcontroller	Interfacing 8051 with peripherals: ADC, DAC, stepper motor. Interfacing 8051 with LED, LCD, keyboard, Temp sensor, etc. using assembly language. **Self-learning Topics:** Study of 8051 based GSM, Bluetooth and RS232 communication	**04**	CO3
IV	ARM 7 Architecture	Architectural inheritance, Detailed study of Programmer's model, ARM Development tools, Addressing modes, Instruction set: Data processing, Data Transfer, Control flow. Pipelining, Writing simple assembly language programs.	**07**	CO4

		Brief introduction to exceptions and interrupts handling. **Self-learning Topics:** Writing ARM programs in Embedded C and Python for sensor application		
V	Open source RTOS Real Time system concept with embedded OS	Basics of RTOS: Real-time concepts, Hard Real time and Soft Real-time, differences between general purpose OS & RTOS, Basic architecture of an RTOS, scheduling systems, Inter-process-communication using pipes and mailboxes, performance matrix in scheduling models, interrupt management in RTOS environment, RTOS comparative study. ucos2 for real time embedded system demonstrate one case study: Case study of automobile RTOS issues in multitasking –selecting a Real Time Operating System **Self-learning Topics:** Inter-process-communication using semaphore, and Mutex, RTOS simple programming using ucos2	**07**	CO5
VI	Introduction to Embedded Platforms	Overview of various Embedded hardware Platforms: Architecture of Arduino,. Basic Arduino programming using Arduino IDE and Arduino libraries for interfacing of LCD and sensors such as Temperature (DHT11), Pressure, Humidity. RaspberryPi (RPi-Functional Block diagram and its operation, GPIO pins, Features of RaspbianOS) Programming Arduino using python (pyserial or pyfirmata): blink.py Programming RaspberryPi GPIO using python: blink.py **Self-learning Topics:** Study of Arduino/ RaspberryPi using Thingspeak cloud platform and Blink app using Mobile.	**05**	CO6

Textbooks:

1 M. A. Mazidi, J. G. Mazidi, R. D., McKinlay," The 8051 microcontroller & Embedded systems Using Assembly and C", Pearson, 3rd edition

2 Embedded / real – time systems: concepts, design & programming, Black Book, Dr. K. V. K. K. Prasad, Dreamtech press, Reprint edition 2013

3 Shibu K. V., "Introduction to embedded systems", McGraw Hill

References:

1 Steve Furber, “ARM System on chip Architecture”, Pearson, edition second
2 Laya B. Das, “Embedded systems an integrated approach”, Pearson, Third impression, 2013
3 Embedded Systems, Architecture, program and Design by Rajkamal
4 Simon Monk,” Raspberry Pi Cookbook”, O’reilly
5 Massimo Banzi, “Getting Started with Arduino: The Open Source Electronics Prototyping Platform (Make)”, O'Reilly Media.
6 https://nptel.ac.in/courses/117/104/117104072/
7 https://www.coursera.org/learn/raspberry-pi-platform

Assessment:
Internal Assessment (IA) for 20 marks:

- IA will consist of Two Compulsory Internal Assessment Tests. Approximately 40% to 50% of syllabus content must be covered in First IA Test and remaining 40% to 50% of syllabus content must be covered in Second IA Test

➢ **Question paper format**

- Question Paper will comprise of a total of **six questions each carrying 20 marksQ.1** will be **compulsory** and should **cover maximum contents of the syllabus**
- **Remaining questions** will be **mixed in nature** (part (a) and part (b) of each question must be from different modules. For example, if Q.2 has part (a) from Module 3 then part (b) must be from any other Module randomly selected from all the modules)
- A total of **four questions** need to be answered.

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		
		Theory	Practical	Theory	Practical	Total
ITDO5012	Advance Data Management Technologies	03	--	03	--	03

Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Pract / Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (in Hrs)			
		Test1	Test 2	Avg.					
ITDO5012	Advance Data Management Technologies	20	20	20	80	3	--	--	100

Course Objectives:

Sr. No.	Course Objectives
The course aims:	
1	To impart knowledge related to query processing and query optimization phases of a database management system.
2	To learn advanced techniques for data management and to overview emerging data models like Temporal, Mobile, and Spatial database.
3	To introduce advanced database models like distributed databases.
4	To create awareness of how enterprise can organize and analyze large amounts of data by creating a Data Warehouse.
5	To understand the process of data extraction, transformation and loading.
6	To understand the concept of Big data and NoSQL databases..

Course Outcomes:

Sr. No.	Course Outcomes:	Cognitive levels of attainment as per bloom's Taxonomy
1	Measure query costs and design alternate efficient paths for query execution.	L1,L2
2	Apply sophisticated access protocols to control access to the database.	L1,L2,L3
3	Implement Distributed databases.	L1,L2,L3

4	Organize strategic data in an enterprise and build a data Warehouse.	L1,L2,L3
5	Analyse data using OLAP operations so as to take strategic decisions.	L1,L2,L3,L4
6	Design modern applications using NoSQL databases**.** databases**.**	L1,L2,L3,L4

Prerequisite: Course on Database Management System

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours	CO Mapping
0	Prerequisite	Reviewing basic concepts of a Relational database, SQL concepts	**02**	----
I	Query Processing and Optimization	Overview: Introduction, Query processing in DBMS, Steps of Query Processing, Measures of Query Cost Selection Operation, Sorting, Join Operation, Evaluation of Expressions. Query Optimization Overview, Goals of Query Optimization, Approaches of Query Optimization, Transformations of Relational Expression, Estimating Statistics of Expression Results Choice of Evaluation Plans. **Self-learning Topics:** Solve problems on query optimization.	**06**	CO1
II	Advanced Data Management Techniques	**Advanced Database Access protocols:** Discretionary Access Control Based on Granting and Revoking Privileges. Mandatory Access Control and Role-Based Access Control, Remote Database access protocol. Overview of Advanced Database Models like Mobile databases, Temporal databases, Spatial databases. **Self-learning Topics**: Learn Data Security concepts like Authentication, Authorization and encryption.	**06**	CO2
III	Distributed Databases	Introduction: Distributed Data Processing, Distributed Database System: Architecture, Types, Design Issues. Data Fragmentation, Allocation in distributed databases. **Self-learning Topics**: Query Optimization in Distributed Databases	**04**	CO3
IV	Data Warehousing, Dimensional Modelling and OLAP	The Need for Data Warehousing; Data Warehouse Defined; Is data warehouse still relevant in the age of big data, Features of a Data Warehouse; Data Warehouse Architecture-Enterprise or centralized, federated and multi tired architectures; Data Warehouse and Data Marts; Data Warehousing Design Strategies, Data modeling-Dimensional Model; The Star Schema; How Does a Query Execute? The Snowflake Schema; Fact Tables and Dimension Tables; Factless Fact Table;, Updates To Dimension Tables, Primary Keys, Surrogate Keys & Foreign Keys. What is business intelligence, use of BI, Tools used in BI, Need for Online Analytical Processing; OLAP Operations	**09**	CO4

		in a cube: Roll-up, Drill-down, Slice, Dice, Pivot; OLAP Architectures: MOLAP, ROLAP, DOLAP and HOLAP. **Self-learning Topics:** Explore life cycle of data warehouse development		
V	ETL Process	Challenges in ETL Functions; Data Extraction; Identification of Data Sources; Immediate Data Extraction, Deferred Data Extraction; Data Transformation: Tasks Involved in Data Transformation, Techniques of Data Loading **Self-learning Topics:** Find out various ETL tools for enterprise data management.	**05**	CO5
VI	Big data and NoSQL	Big data and NoSQL : Introduction, types and characteristics of big data, What is NoSQL, CAP theorem, BASE property, NoSQL data architecture patterns: Key-value stores, Graph stores, Column family stores, Document stores. **Self-learning Topics:** Google's Bigtable, Cassandra, MongoDB, Neo4j	**07**	CO6

Textbooks:

1 Korth, Slberchatz,Sudarshan, :"Database System Concepts", 6th Edition, McGraw – Hill
2 Elmasri and Navathe, "Fundamentals of Database Systems", 6th Edition, PEARSON Education.
3 Theraja Reema, "Data Warehousing", Oxford University Press.
4 Raghu Ramakrishnan and Johannes Gehrke, "Database Management Systems" 3rd Edition - McGraw Hill

References:

1 Paulraj Ponniah, "Data Warehousing: Fundamentals for IT Professionals", Wiley India.
2 Ralph Kimball, Margy Ross, "The Data Warehouse Toolkit: The Definitive Guide to Dimensional Modeling", 3rd Edition. Wiley India.
3 Han, Kamber, "Data Mining Concepts and Techniques", Morgan Kaufmann 3nd Edition.
4 Peter Rob and Carlos Coronel, "Database Systems Design, Implementation and Management", Thomson Learning, 9th Edition.

Assessment:

Internal Assessment (IA) for 20 marks:

- IA will consist of Two Compulsory Internal Assessment Tests. Approximately 40% to 50% of syllabus content must be covered in First IA Test and remaining 40% to 50% of syllabus content must be covered in Second IA Test

- **Question paper format**

  - Question Paper will comprise of a total of **six questions each carrying 20 marksQ.1** will be **compulsory** and should **cover maximum contents of the syllabus**

  - **Remaining questions** will be **mixed in nature** (part (a) and part (b) of each question must be from different modules. For example, if Q.2 has part (a) from Module 3 then part (b) must be from any other Module randomly selected from all the modules)

  - A total of **four questions** need to be answered

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		
		Theory	Practical	Theory	Practical	Total
ITDO5013	Computer Graphics & Multimedia System	03	--	03	--	03

Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Pract / Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (in Hrs)			
		Test1	Test 2	Avg.					
ITDO5013	Computer Graphics & Multimedia System	20	20	20	80	3	--	--	100

Course Objectives:

Sr. No.	Course Objectives
The course aims:	
1	To equip student with the fundamental knowledge and basic technical competence in the field of Computer Graphics.
2	To emphasize on understanding of Computer Graphics Algorithms.
3	To prepare the student for advanced areas in the field of Computer Graphics.
4	To introduce student for professional avenues in the field of Computer Graphics
5	To introduce students about basic fundamentals and key aspects of Multimedia system.
6	To equip the students for various techniques of Multimedia.

Course Outcomes:

Sr. No.	Course Outcomes	Cognitive levels of attainment as per Bloom's Taxonomy
On successful completion, of course, learner/student will be able to:		
1	Describe the basic concepts of Computer Graphics.	L1,L2
2	Demonstrate various algorithms for basic graphics primitives.	L1,L2
3	Apply 2-D geometric transformations on graphical objects. Use various Clipping algorithms on graphical objects	L1,L2,L3
4	Explore 3-D geometric transformations and curve representation techniques.	L1,L2,L3
5	Describe the basics of Multimedia System	L1,L2
6	Explore the Digital images audio & video and their related concepts.	L1,L2,L3

Prerequisite: Basic knowledge of mathematics.

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours	CO Mapping
0	Prerequisite	**Basic** knowledge of mathematics	--	---
I	Introduction	Definition and Representative uses of computer graphics, Overview of coordinate system, Definition of scan conversion, Raster scan & random scan displays, Architecture of raster graphicssystem with display processor, Architecture of random scan systems. **Self-learning Topics:-** study the working of some Raster scan display devices	**02**	CO1
II	Output Primitives	Scan conversions of point, line and circle: DDA algorithm and Brenham algorithm for line drawing, Midpoint algorithm for circle, Aliasing, Antialiasing techniques like Pre filtering and post filtering, super sampling, and pixel phasing. Filled Area Primitive: Scan line Polygon Fill algorithm, inside outside tests, Boundary Fill and Flood fill algorithm. **Self-learning Topics:-**Implementation of DDA and Bresenhams line algorithm for dotted line, dashed line, Dash-dot line etc.	**08**	CO2
III	Two Dimensional Transformations and Clipping	Basic 2D transformations:- Translation, Scaling, Rotation, Reflection. Matrix representation and Homogeneous Coordinates. Composite transformation. Viewing transformation pipeline and Window to Viewport coordinate transformation. Clipping operations: Point clipping, Line Clipping. Line clipping algorithms: Cohen- Sutherland, Liang-Barsky, Polygon Clipping Algorithms: Sutherland- Hodgeman, Weiler-Atherton. **Self-learning Topics:-**Implementation of 2D transformations like translation, rotation and scaling. Implementation of clipping algorithm.	**09**	CO3
IV	3D Transformation, curves and fractals	3D Transformations: Translation, Rotation, Scaling. Reflection , Composite transformations: Rotation about an arbitrary axis. Bezier Curve, B-Spline Curve.	**06**	CO4

		Fractal-Geometry: Fractal Dimension, Hilbert's curve, Koch Curve. **Self-learning Topics:-**Implementation of 3D transformations, Bezier curve , Koch curve.		
V	**Introduction to Multimedia**	Overview, Objects and Elements of Multimedia, Applications of Multimedia, Multimedia Systems Architecture – IMA, Workstation, Network, Types of Medium (Perception, Representation-..), Interaction Techniques **Self-learning Topics:-**Study the objects and elements of multimedia	**04**	CO5
VI	Digital Image, audio & video	Digital Image Representation (2D format, resolution) Types of Images (monochrome, gray, color), File formats: JPG. Compression Techniques: fundamentals (coding, inter pixel and psychovisual redundancies). Types – lossless and lossy Compression, Lossless Compression Algorithms– Shannon-Fano, Lossy Compression Algorithm – JPEG **Digital Audio** Basic Sound Concepts: computer representation of sound File Formats – WAV **Digital Video** Digitization of Video, types of video signals (component, composite and S- video). File Formats: MPEG Video **Self-learning Topics:-**Implementation of compression algorithms. Analysis of Digital audio and digital video file formats.	**10**	CO6

Text Books:

1 Hearn & Baker, "Computer Graphics C version", 2nd Edition, Pearson Publication

2 James D. Foley, Andries van Dam, Steven K Feiner, John F. Hughes, "Computer Graphics Principles and Practice in C", 2nd Edition, Pearson Publication

3 Rajesh K. Maurya, "Computer Graphics", Wiley India Publication.

4 Multimedia System Design, Prabhat K. Andleigh& Kiran Thakrar, PHI

5 Fundamentals of Multimedia, Ze-Nian Li & Mark S. Drew, PHI.

References:

1 D. Rogers, "Procedural Elements for Computer Graphics", Tata McGraw-Hill Publications.
2 Samit Bhattacharya, "Computer Graphics", Oxford Publication
3 Multimedia Communication Systems: Techniques, Standards & Networks, K. R. Rao, Zoran S. Bojkovic & Dragorad A. Milovanovic, TMH.
4 Multimedia Systems, K. Buford, PHI.

Sr.No	Online Resources
1	https://nptel.ac.in/courses/106/106/106106090/
2	https://nptel.ac.in/courses/106/103/106103224/
3	https://nptel.ac.in/courses/106/102/106102065/
4	https://onlinecourses.swayam2.ac.in/nou21_cs04/preview
5	https://nptel.ac.in/courses/117/105/117105083/

Assessment:
Internal Assessment (IA)for 20 marks:

- IA will consist of Two Compulsory Internal Assessment Tests. Approximately 40% to 50% of syllabus content must be covered in First IA Test and remaining 40% to 50% of syllabus content must be covered in Second IA Test

➢ **Question paper format**

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- **Remaining questions** will be **mixed in nature** (part (a) and part (b) of each question must be from different modules. For example, if Q.2 has part (a) from Module 3 then part (b) must be from any other Module randomly selected from all the modules)
- A total of **four questions** need to be answered

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		
		Theory	Practical	Theory	Practical	Total
ITDO5014	Advanced Data structure and Analysis	03	--	03	--	03

Course Code	Course Name	Examination Scheme							
		Theory							
		Internal Assessment			End Sem Exam	Exam Duration (in Hrs)	Term Work	Pract / Oral	Total
		Test1	Test 2	Avg.					
ITDO5014	Advanced Data structure and Analysis	20	20	20	80	3	--	--	100

Course Objectives:

Sr. No.	Course Objectives
The course aims:	
1	To learn mathematical background for analysis of algorithm
2	To learn various advanced data structures.
3	To understand the different design approaches of algorithm.
4	To learn dynamic programming methods.
5	To understand the concept of pattern matching
6	To learn advanced algorithms.

Course Outcomes:

Sr. No.	Course Outcomes	Cognitive levels of attainment as per Bloom's Taxonomy
On successful completion, of course, learner/student will be able to:		
1	Understand the different methods for analysis of algorithms.	L1,L2
2	Choose an appropriate advanced data structure to solve a specific problem.	L1,L2
3	Apply an appropriate algorithmic design approach for a given problem.	L1,L2,L3
4	Apply the dynamic programming technique to solve a given problem.	L1,L2,L3
5	Select an appropriate pattern matching algorithm for a given application.	L1,L2,L3
6	Understand the concepts of Optimization, Approximation and Parallel computing algorithms.	L1,L2

Prerequisite: Data structures and Analysis, Knowledge of Any Programming Language

DETAILED SYLLABUS:

Sr. No	Module	Detailed Content	Hours	CO Mapping
0	Prerequisite	Basic of Data structures and analysis and programming language.	**02**	-
I	Introduction	Fundamentals of the analysis of algorithms: Time and Space complexity, Asymptotic analysis and notation, average and worst-case analysis, Recurrences: The substitution method, Recursive tree method, Masters method. **Self-learning Topics:** Analysis of Time and space complexity of iterative and recursive algorithms	**04**	CO1
II	Advanced Data Structures	B/B+ tree, Red-Black Trees, Heap operations, Implementation of priority queue using heap, Topological Sort. **Self-learning Topics:** Implementation of Red-Black Tree and Heaps.	**05**	CO2
III	Divide and Conquer AND Greedy algorithms	Introduction to Divide and conquer, Analysis of Binary Search, Merge sort and Quick sort, Finding minimum and maximum algorithm. Introduction to Greedy Algorithms: Knapsack Problem, Job sequencing using deadlines, Optimal storage on tape, Optimal Merge Pattern, Analysis of all these algorithms and problem solving. **Self-learning Topics:** Implementation of minimum and maximum algorithm, Knapsack problem, Job sequencing using deadlines.	**08**	CO3
IV	Dynamic algorithms	Introduction to Dynamic Algorithms, all pair shortest path, 0/1 knapsack, travelling salesman problem, Matrix Chain Multiplication, Optimal binary search tree, Analysis of All algorithms and problem solving. **Self-learning Topics:** Implementation of All pair shortest path, 0/1 Knapsack and OBST.	**06**	CO4
V	String Matching	Introduction, the naïve string matching algorithm, Rabin Karp algorithm, Boyer Moore algorithm, Knuth-Morris-Pratt algorithm, Longest Common Subsequence (LCS), Analysis of All algorithms and problem solving. **Self-learning Topics:** Implementation of Robin Karp algorithm, KMP algorithm and LCS.	**07**	CO5

VI	Advanced Algorithms and NP problems	**Optimization Algorithms:** Genetic algorithm(GA), **Approximation Algorithms:** Vertex-cover problem, **Parallel Computing Algorithms:** Fast Fourier Transform, **Introduction to NP-Hard and NP-Complete Problems** **Self-learning Topics:** Implementation of Genetic algorithm and Vertex-cover problem	**07**	CO6

Textbooks:

1 Introduction to Algorithms, Cormen, Leiserson, Rivest, Stein, PHI.
2 Algorithms: Design and Analysis, Harsh Bhasin, OXFORD.
3 Fundamentals of Computer Algorithms, Horowitz, Sahani, Rajsekaran, Universities Press.
4 C and Data structures, Deshpande, Kakde, Dreamtech Press.

References:

1 Data Structures and Algorithms in C++, Goodritch, Tamassia, Mount, WILEY.
2 Data Structures using C, Reema Thareja , OXFORD.
3 Data Structures and Algorithm Analysis in C, Mark A. Weiss, Pearson.
4 Optimization Algorithms and Applications, By Rajesh Kumar Arora by Chapman and Hall

Online Resources

Sr.No	Website Links
1	https://nptel.ac.in/courses/106/106/106106131/
2	https://swayam.gov.in/nd1_noc19_cs47/preview
3	https://www.coursera.org/specializations/algorithms
4	https://www.mooc-list.com/tags/algorithms

Assessment:
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- IA will consist of Two Compulsory Internal Assessment Tests. Approximately 40% to 50% of syllabus content must be covered in First IA Test and remaining 40% to 50% of syllabus content must be covered in Second IA Test

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- **Remaining questions** will be **mixed in nature** (part (a) and part (b) of each question must be from different modules. For example, if Q.2 has part (a) from Module 3 then part (b) must be from any other Module randomly selected from all the modules)
- A total of **four questions** need to be answered.

Program Structure for Third Year Information Technology

Semester V & VI

UNIVERSITY OF MUMBAI

(With Effect from 2021-2022)

Semester VI

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		
		Theory	Pract. Tut.	Theory	Pract.	Total
ITC601	Data Mining & Business Intelligence	3	--	3	--	3
ITC602	Web X.0	3	--	3	--	3
ITC603	Wireless Technology	3	--	3	--	3
ITC604	AI and DS – 1	3	--	3	--	3
ITDO601X	**Department Optional Course – 2**	**3**	**--**	**3**	**--**	**3**
ITL601	BI Lab	--	2	--	1	1
ITL602	Web Lab	--	2	--	1	1
ITL603	Sensor Lab	--	2	--	1	1
ITL604	MAD & PWA Lab	--	2	--	1	1
ITL605	DS using Python Skill based Lab	--	2	--	1	1
ITM601	Mini Project – 2 B Based on ML	--	4[$]	--	2	2
Total		**15**	**14**	**15**	**07**	**22**

Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Prac /oral	Total
		Internal Assessment			End Sem Exam	Exam. Duration (in Hrs)			
		Test1	Test2	Avg					
ITC601	Data Mining & Business Intelligence	20	20	20	80	3	--	--	100
ITC602	Web X.0	20	20	20	80	3	--	--	100
ITC603	Wireless Technology	20	20	20	80	3	--	--	100
ITC604	AI and DS – 1	20	20	20	80	3	--	--	100
ITDO601X	**Department Optional Course – 2**	**20**	**20**	**20**	**80**	**3**	**--**	**--**	**100**
ITL601	BI Lab	--	--	--	--	--	25	25	50
ITL602	Web Lab	--	--	--	--	--	25	25	50
ITL603	Sensor Lab	--	--	--	--	--	25	25	50
ITL604	MAD & PWA Lab	--	--	--	--	--	25	25	50

ITL605	DS using Python Lab (SBL)	--	--	--	--	--	25	25	50
ITM601	Mini Project – 2 B Based on ML	--	--	--	--	--	25	25	50
Total		**--**	**--**	**100**	**400**	**--**	**150**	**150**	**800**

$ indicates work load of Learner (Not Faculty), for Mini-Project. Students can form groups with minimum 2(Two) and not more than 4(Four). Faculty Load: 1hour per week per four groups.

ITDO601X	**Department Optional Course – 2**
ITDO6011	Software Architecture
ITDO6012	Image Processing
ITDO6013	Green IT
ITDO6014	Ethical Hacking and Forensic

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical/ Oral	Tutorial	Total
ITC601	Data Mining & Business Intelligence	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Pract / Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (in Hrs)			
		Test1	Test 2	Avg.					
ITC601	Data Mining & Business Intelligence	20	20	20	80	3	--	--	100

Course Objectives:

Sr. No.	Course Objectives
The course aims:	
1	To introduce the concept of data warehouse data Mining as an important tool for enterprise data management and as a cutting-edge technology for building competitive advantage.
2	To enable students to effectively identify sources of data and process it for data mining.
3	To make students well versed in all data mining algorithms, methods of evaluation.
4	To impart knowledge of tools used for data mining
5	To provide knowledge on how to gather and analyze large sets of data to gain useful business understanding.
6	To impart skills that can enable students to approach business problems analytically identifying opportunities to derive business value from data.

Course Outcomes:

Sr. No.	Course Outcomes	Cognitive levels of attainment as per Bloom's Taxonomy
On successful completion, of course, learner/student will be able to:		
1	Demonstrate an understanding of the importance of data warehousing and data mining and the principles of business intelligence.	L1
2	Organize and prepare the data needed for data mining using pre preprocessing techniques.	L1,L2,L3
3	Perform exploratory analysis of the data to be used for mining.	L1,L2,L3,L4
4	Implement the appropriate data mining methods like classification, clustering or Frequent Pattern mining on large data sets.	L1,L2,L3,L4,L5
5	Define and apply metrics to measure the performance of various data mining	L1,L2,L3

	algorithms.	
6	Apply BI to solve practical problems: Analyze the problem domain, use the data collected in enterprise apply the appropriate data mining technique, interpret and visualize the results and provide decision support.	L1,L2,L3

Prerequisite: Database Management System

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours	CO Mapping
0	Prerequisite	Basic Knowledge of databases	**01**	-
I	Data Warehouse (DWH) Fundamentals with Introduction to Data Mining	DWH characteristics, Dimensional modeling: Star, Snowflakes, OLAP operation, OLTP vs OLAP Data Mining as a step in KDD, Kind of patterns to be mined, Technologies used, Data Mining applications. **Self-learning Topics:** Data Marts, Major issues in Data Mining.	**04**	CO1
II	Data Exploration and Data Preprocessing	Types of Attributes, Statistical Description of Data, Measuring Data Similarity and Dissimilarity. Why Preprocessing? Data Cleaning, Data Integration, Data Reduction: Attribute Subset Selection, Histograms, Clustering, Sampling, Data Cube aggregation, Data transformation and Data Discretization: Normalization, Binning, Histogram Analysis **Self-learning Topics** Data Visualization, Concept hierarchy generation	**06**	CO2, CO3
III	Classification	Basic Concepts; Classification methods: 1. Decision Tree Induction: Attribute Selection Measures, Tree pruning. 2. Bayesian Classification: Naïve Bayes Classifier. Prediction: Structure of regression models; Simple linear regression, Accuracy and Error measures, Precision, Recall, Holdout, Random Sampling, Cross Validation, Bootstrap, Introduction of Ensemble methods, Bagging, Boosting, AdaBoost and Random forest. **Self-learning Topics:** Multiple linear regression, logistic regression, Random forest, nearest neighbour classifier, SVM	**08**	CO4, CO5
IV	Clustering and Outlier Detection	Cluster Analysis: Basic Concepts; Partitioning Methods: K-Means, K Medoids; Hierarchical Methods: Agglomerative, Divisive, BIRCH; Density-Based Methods: DBSCAN. What are outliers? Types, Challenges; Outlier Detection Methods: Supervised, Semi Supervised,	**08**	CO4

		Unsupervised, Proximity based, Clustering Based. **Self-learning Topics** Hierarchical methods : Chameleon, Density based methods: OPTICS, Grid based methods: STING, CLIQUE		
V	Frequent Pattern Mining	**Basic Concepts**: Market Basket Analysis, Frequent Itemset, Closed Itemset, and Association Rules; Frequent Itemset. Mining Methods: The Apriori Algorithm: Finding Frequent Itemset Using Candidate Generation, Generating Association Rules from Frequent Itemset, Improving the Efficiency of Apriori, A pattern growth approach for mining Frequent Itemset, Mining Frequent Itemset using vertical data formats; Introduction to Advance Pattern Mining: Mining Multilevel Association Rules and Multidimensional Association Rules. **Self-learning Topics:** Association Mining to Correlation Analysis, lift, Introduction to Constraint-Based Association Mining	**08**	CO4, CO5
VI	Business Intelligence	What is BI? Business intelligence architectures; Definition of decision support system; Development of a business intelligence system using Data Mining for business Applications like Fraud Detection, Recommendation System **Self-learning Topics:** Clickstream Mining, Market Segmentation, Retail industry, Telecommunications industry, Banking & finance CRM, Epidemic prediction, Fake News Detection, Cyberbullying, Sentiment Analysis etc.	**04**	CO6

Text Books:

1. Han, Kamber, "Data Mining Concepts and Techniques", Morgan Kaufmann 3nd Edition.
2. P. N. Tan, M. Steinbach, Vipin Kumar, “Introduction to Data Mining”, Pearson Education.
3. Paulraj Ponniah “Data Warehousing Fundamentals: A Comprehensive Guide for IT Professionals” Wiley Publications
4. Business Intelligence: Data Mining and Optimization for Decision Making by Carlo Vercellis, Wiley India Publications.
5. G. Shmueli, N.R. Patel, P.C. Bruce, “Data Mining for Business Intelligence: Concepts, Techniques, and Applications in Microsoft Office Excel with XLMiner”, 2nd Edition, Wiley India.

References:

1. Michael Berry and Gordon Linoff “Data Mining Techniques”, 2nd Edition Wiley Publications.
2. Michael Berry and Gordon Linoff “Mastering Data Mining- Art & science of CRM”, Wiley Student Edition.
3. Vikram Pudi & Radha Krishna, “Data Mining”, Oxford Higher Education.
4. Data Mining https://onlinecourses.nptel.ac.in/noc21_cs06/preview

Assessment:

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Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical/ Oral	Tutorial	Total
ITC602	Web X.0	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Pract / Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (in Hrs)			
		Test1	Test 2	Avg.					
ITC602	Web X.0	20	20	20	80	3	--	--	100

Course Objectives:

Sr. No.	Course Objectives
The course aims:	
1	To understand the digital evolution of web technology.
2	To learn Type Script and understand how to use it in web application.
3	To empower the use of AngularJS to create web applications that depend on the Model-View-Controller Architecture.
4	To gain expertise in a leading document-oriented NoSQL database, designed for speed, scalability, and developer agility using MongoDB.
5	To build web applications quickly and with less code using Flask framework.
6	To gain knowledge of Rich Internet Application Technologies.

Course Outcomes:

Sr. No.	Course Outcomes	Cognitive levels of attainment as per Bloom's Taxonomy
On successful completion, of course, learner/student will be able to:		
1	Understand the basic concepts related to web analytics and semantic web.	L1, L2
2	Understand how TypeScript can help you eliminate bugs in your code and enable you to scale your code.	L1, L2
3	Understand AngularJS framework and build dynamic, responsive single-page web applications.	L2, L3
4	Apply MongoDB for frontend and backend connectivity using REST API.	L1, L2, L3
5	Apply Flask web development framework to build web applications with less code.	L1, L2, L3

6	Develop Rich Internet Application using proper choice of Framework.	L1, L2, L3, L4

Prerequisite: Object Oriented Programming, Python Programming, HTML and CSS.

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours	CO Mapping
0	Prerequisite	HTML/HTML5 (Tags, Attributes and their properties), CSS/CSS3 (Types and Properties), Basics of Java Script, Python Programming	**02**	--
I	Introduction to WebX.0	**Evolution of WebX.0**; **Web Analytics 2.0**: Introduction to Web Analytics, Web Analytics 2.0, Clickstream Analysis, Strategy to choose your web analytics tool, Measuring the success of a website; **Web3.0 and Semantic Web**: Characteristics of Semantic Web, Components of Semantic Web, Semantic Web Stack, N-Triples and Turtle, Ontology, RDF and SPARQL **Self-learning Topics**: Semantic Web Vs AI, SPARQL Vs SQL.	**04**	CO1
II	Type Script	Overview, TypeScript Internal Architecture, TypeScript Environment Setup, TypeScript Types, variables and operators, Decision Making and loops, TypeScript Functions, TypeScript Classes and Objects, TypeScript Modules **Self-learning Topics**: Javascript Vs TypeScript	**06**	CO2
III	Introduction to AngularJS	Overview of AngularJS, Need of AngularJS in real web sites, AngularJS modules, AngularJS built-in directives, AngularJS custom directives, AngularJS expressions, Angular JS Data Binding, AngularJS filters, AngularJS controllers, AngularJS scope, AngularJS dependency injection, Angular JS Services, Form Validation, Routing using ng-Route, ng-Repeat, ng-style, ng-view, Built-in Helper Functions, Using Angular JS with Typescript **Self-learning Topics**: MVC model, DOM model, Javascript functions and Error Handling	**08**	CO3
IV	MongoDB and Building REST API using MongoDB	**MongoDB**: Understanding MongoDB, MongoDB Data Types, Administering User Accounts, Configuring Access Control, Adding the MongoDB Driver to Node.js, Connecting to MongoDB from Node.js, Accessing and Manipulating Databases, Manipulating MongoDB Documents from Node.js, Accessing MongoDB from Node.js, Using Mongoose for Structured Schema and Validation. **REST API**: Examining the rules of REST APIs, Evaluating API patterns, Handling typical CRUD functions (create, read, update, delete), Using Express and Mongoose to interact with MongoDB, Testing API endpoints **Self-learning Topics**: MongoDB vs SQL DB	**08**	CO4
V	Flask	Introduction, Flask Environment Setup, App Routing, URL Building, Flask HTTP Methods, Flask Request Object, Flask cookies, File Uploading in Flask	**06**	CO5

		Self-learning Topics: Flask Vs Django		
VI	Rich Internet Application	**AJAX:** Introduction and Working **Developing RIA using AJAX Techniques**: CSS, HTML, DOM, XML HTTP Request, JavaScript, PHP, AJAX as REST Client **Introduction to Open Source Frameworks and CMS for RIA**: Django, Drupal, Joomla **Self-learning Topics**: Applications of AJAX in Blogs, Wikis and RSS Feeds	**05**	CO6

Text Books:

1. Boris Cherny, "Programming TypeScript- Making Your Javascript Application Scale", O'Reilly Media Inc.
2. Adam Bretz and Colin J. Ihrig, "Full Stack JavaScript Development with MEAN", SitePoint Pty. Ltd.
3. Simon Holmes Clive Harber, "Getting MEAN with Mongo, Express, Angular, and Node", Manning Publications.
4. Miguel Grinberg, "Flask Web Development: Developing Web Applications with Python", O'Reilly.
5. Dr. Deven Shah, "Advanced Internet Programming", StarEdu Solutions.

References:

1. Yakov Fain and Anton Moiseev, "TypeScript Quickly", Manning Publications.
2. Steve Fenton, "Pro TypeScript: Application - Scale Javascript Development", Apress
3. Brad Dayley, Brendan Dayley, Caleb Dayley, "Node.js, MongoDB and Angular Web Development: The definitive guide to using the MEAN stack to build web applications", 2nd Edition, Addison-Wesley Professional

Online References:

Sr. No.	Website Links
1.	https://www.nptel.ac.in
2.	https://swayam.gov.in
3.	https://www.coursera.org
4.	https://udemy.com

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Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical/ Oral	Tutorial	Total
ITC603	Wireless Technology	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Pract / Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (in Hrs)			
		Test1	Test 2	Avg.					
ITC603	Wireless Technology	20	20	20	80	3	--	--	100

Course Objectives:

Sr. No.	Course Objectives
The course aims:	
1	Discuss the Fundamentals of Wireless Communication.
2	Comprehend the Fundamental Principles of Wide Area Wireless Networking Technologies and their Applications.
3	Explain Wireless Metropolitan and Local Area Networks.
4	Describe Wireless Personal Area Networks and Ad hoc Networks
5	Learn and Analyze Wireless Network Security Standards.
6	Study the Design Considerations for Wireless Networks.

Course Outcomes:

Sr. No.	Course Outcomes	Cognitive levels of attainment as per Bloom's Taxonomy
On successful completion, of course, learner/student will be able to:		
1	Describe the basic concepts of Wireless Network and Wireless Generations.	L1,L2
2	Demonstrate and Evaluate the various Wide Area Wireless Technologies.	L1,L2,L3, L4, L5
3	Analyze the prevalent IEEE standards used for implementation of WLAN and WMAN Technologies	L1,L2,L3,L4
4	Appraise the importance of WPAN, WSN and Ad-hoc Networks.	L1,L2,L3,L4,L5
5	Analyze various Wireless Network Security Standards.	L1,L2,L3,L4
6	Review the design considerations for deploying the Wireless Network Infrastructure.	L1,L2

Prerequisite: Principle of Communication, Computer Network and Network Design, Computer Network Security.

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours	CO Mapping
0	Prerequisite	Digital Modulation Techniques – ASK, FSK, BPSK, QPSK; Electromagnetic Spectrum; Multiplexing Techniques – FDM, TDM, OFDM; OSI and TCP/IP Model; Need for Security, Types of Security Threats and Attacks.	**02**	--
I	Fundamentals of Wireless Communication	Introduction to Wireless Communication - Advantages, Disadvantages and Applications; Multiple Access Techniques - FDMA, TDMA, CDMA, OFDMA; Spread Spectrum Techniques – DSSS, FHSS; Evolution of wireless generations – 1G to 5G (Based on technological differences and advancements); 5G – Key requirements and drivers of 5G systems, Use cases, Massive MIMO. **Self-learning Topics:** Modulation Techniques - QAM, MSK, GMSK	**07**	CO1
II	Wide Area Wireless Networks	Principle of Cellular Communication – Frequency Reuse concept, cluster size and system capacity, co-channel interference and signal quality; GSM – System Architecture, GSM Radio Subsystem, Frame Structure; GPRS and EDGE – System Architecture; UMTS – Network Architecture; CDMA 2000 – Network Architecture; LTE – Network Architecture; Overview of LoRa & LoRaWAN. **Self-learning Topics:-** IS-95	**09**	CO2
III	Wireless Metropolitan and Local Area Networks	IEEE 802.16 (WiMax) – Mesh mode, Physical and MAC layer; IEEE 802.11(Wi-Fi) – Architecture, Protocol Stack, Enhancements and Applications. **Self-learning Topics:-** WLL(Wireless Local Loop).	**06**	CO3
IV	Wireless Personal Area Networks and Ad hoc Networks	IEEE 802.15.1 (Bluetooth) – Piconet, Scatter net, Protocol Stack; IEEE 802.15.4 (ZigBee) – LR-WPAN Device Architecture, Protocol Stack; Wireless Sensor Network – Design Considerations, Issues and Challenges, WSN Architecture, Applications; Introduction of Ad hoc Networks – MANET and VANET – Characteristics, Applications, Advantages and Limitations; Over view of E-VANET(Electrical Vehicular AdHoc Networks). **Self-learning Topics**:- HR–WPAN (UWB)	**08**	CO4
V	Wireless Network Security	Security in GSM; UMTS Security; Bluetooth Security; WEP; WPA2. **Self-learning Topics :-** Study of Wireless Security Tools.	**04**	CO5

VI	Wireless Network Design Considerations	Cisco Unified Wireless Network; Designing Wireless Networks with Lightweight Access Points and Wireless LAN Controllers. **Self-learning Topics:-** Cisco Unified Wireless Network Mobility Services.	**03**	CO6

Text Books:

1. Wireless Communications, T.L. Singal, McGraw Hill Education.
2. Wireless Communications and Networking, Vijay Garg, Morgan Kaufmann Publishers.
3. Wireless Mobile Internet Security, 2nd Edition, Man Young Rhee, A John Wiley & Sons, Ltd., Publication.
4. 5G Outlook–Innovations and Applications,Ramjee Prasad,River Publishers Series in Communications.
5. Designing for Cisco Internetwork Solutions, 2nd Edition, CCDA, Diane Teare, Cisco Press.

Reference Books:

1. Cellular Communications: A Comprehensive and Practical Guide, Nishith Tripathi, Jeffery H Reed, Wiley.
2. Wireless Communications- Principles & Practice,Theodore S. Rappaport, Prentice Hall Series.
3. Wireless Communications and Networks", William Stallings, Pearson / Prentice Hall.
4. Adhoc & Sensor Networks Theory and Applications, Carlos de Morais Cordeiro,Dharma Prakash Agrawal, World Scientific,2nd Edition.
5. Wireless Networks, Nicopolitidia, M S Obaidat, GI Papadimitriou, Wiley India (Student Edition, 2010).

Online References:

Sr. No.	Website/Reference link
1.	www.swayam.gov.in
2.	www.coursera.org
3.	https://doi.org/10.1007/978-3-642-17878-8_63
4.	https://doi.org/10.1007/978-3-642-54525-2_44
5.	https://lora-alliance.org/resource_hub/what-is-lorawan/
6.	https://doi.org/10.1007/s42835-021-00687-8

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  - A total of **four questions** need to be answered

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical/ Oral	Tutorial	Total
ITC604	AI and DS - 1	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Pract / Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (in Hrs)			
		Test1	Test 2	Avg.					
ITC604	AI and DS - 1	20	20	20	80	3	--	--	100

Course Objectives:

Sr. No.	Course Objectives
The course aims:	
1	To introduce the students' with different issues involved in trying to define and simulate intelligence.
2	To familiarize the students' with specific, well known Artificial Intelligence methods, algorithms and knowledge representation schemes.
3	To introduce students' different techniques which will help them build simple intelligent systems based on AI/IA concepts.
4	To introduce students to data science and problem solving with data science and statistics.
5	To enable students to choose appropriately from a wider range of exploratory and inferential methods for analyzing data, and interpret the results contextually.
6	To enable students to apply types of machine learning methods for real world problems.

Course Outcomes:

Sr. No.	Course Outcomes	Cognitive levels of attainment as per Bloom's Taxonomy
On successful completion, of course, learner/student will be able to:		
1	Develop a basic understanding of the building blocks of AI as presented in terms of intelligent agents.	L1
2	Apply an appropriate problem-solving method and knowledge-representation scheme.	L1,L2,L3
3	Develop an ability to analyze and formalize the problem (as a state space, graph, etc.). They will be able to evaluate and select the appropriate search method.	L1,L2,L3,L4
4	Apply problem solving concepts with data science and will be able to tackle them from a statistical perspective.	L1,L2,L3

5	Choose and apply appropriately from a wider range of exploratory and inferential methods for analyzing data and will be able to evaluate and interpret the results contextually.	L1,L2,L3
6	Understand and apply types of machine learning methods for real world problems.	L1,L2, L3

Prerequisite:

1. Engineering Mathematics III (ITC301)
2. Data Structures and Analysis (ITC302)
3. Engineering Mathematics IV (ITC401)

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours	CO Mapping
0	Prerequisite	**Nil**	--	--
I	Introduction to AI	**Introduction:** Introduction to AI, AI techniques, Problem Formulation. **Intelligent Agents:** Structure of Intelligent agents, Types of Agents, Agent Environments PEAS representation for an Agent. **Self-Learning Topics :** Identify application areas of AI	**04**	CO1
II	Search Techniques	Uninformed Search Techniques: Uniform cost search, Depth Limited Search, Iterative Deepening, Bidirectional search. Informed Search Methods: Heuristic functions, Best First Search, A*, Hill Climbing, Simulated Annealing. Constraint Satisfaction Problem Solving: Crypto-Arithmetic Problem, Water Jug, Graph Coloring. Adversarial Search: Game Playing, Min-Max Search, Alpha Beta Pruning. Comparing Different Techniques. **Self-Learning Topics :** IDA*, SMA*	**09**	CO2
III	Knowledge Representation using First Order Logic	**Knowledge and Reasoning:** A Knowledge Based Agent, WUMPUS WORLD Environment, Propositional Logic, First Order Predicate Logic, Forward and Backward Chaining, Resolution. Planning as an application of a knowledge based agent. Concepts of Partial Order planning, Hierarchical Planning and Conditional Planning. **Self-Learning Topics:** Representing real world problems as planning problems.	**06**	CO3
IV	Introduction to DS	Introduction and Evolution of Data Science, Data Science Vs. Business Analytics Vs. Big Data, Data Analytics, Lifecycle, Roles in Data Science Projects. **Self-Learning Topics :** Applications and Case Studies of Data Science in various Industries	**04**	CO4
V	Exploratory Data Analysis	Introduction to exploratory data analysis, Typical data formats. Types of EDA, Graphical/Non graphical Methods, Univariate/multivariate methods Correlation and covariance, Degree of freedom	**08**	CO5

		Statistical Methods for Evaluation including ANOVA. **Self-Learning Topics:** Implementation of graphical EDA methods.		
VI	Introduction to ML	Introduction to Machine Learning, Types of Machine Learning: Supervised **(**Logistic Regression, Decision Tree, Support Vector Machine) and Unsupervised (K Means Clustering, Hierarchical Clustering, Association Rules) Issues in Machine learning, Application of Machine Learning Steps in developing a Machine Learning Application. **Self-Learning Topics :** Real world case studies on machine learning	**08**	CO6

Text Books:

1. Stuart Russell and Peter Norvig, Artificial Intelligence: A Modern Approach, 2nd Edition, Pearson Education.
2. Elaine Rich, Kevin Knight, Shivshankar B Nair, Artificial Intelligence, McGraw Hill, 3rd Edition.
3. Howard J. Seltman, Experimental Design and Analysis, Carnegie Mellon University, 2012/1.
4. Ethem Alpaydın, "Introduction to Machine Learning", MIT Press

References:

1. Deepak Khemani, A First Course in Artificial Intelligence, McGraw Hill Publication
2. George Lugar, AI-Structures and Strategies for Complex Problem Solving., 4/e, 2002, Pearson Education.
3. Data Science & Big Data Analytics, 1st Edition, 2015, EMC Education Services, Wiley. ISBN: 978-1118876138
4. Tom M.Mitchell "Machine Learning" McGraw Hill
5. Richard I. Levin, David S. Rubin "Statistics for Management" Pearson
6. Vivek Belhekar, "Statistics for Psychology using R" SAGE

Online References:

Sr. No.	Website/Reference link
1.	https://nptel.ac.in/noc/courses/noc19/SEM2/noc19-cs83/
2.	https://nptel.ac.in/courses/106/105/106105077/
3.	https://www.coursera.org/specializations/jhu-data-science
4.	https://www.coursera.org/learn/machine-learning
5.	https://www.udemy.com/course/statistics-for-data-science-and-business-analysis/

Assessment:

Internal Assessment (IA) for 20 marks:

- IA will consist of Two Compulsory Internal Assessment Tests. Approximately 40% to 50% of syllabus content must be covered in First IA Test and remaining 40% to 50% of syllabus content must be covered in Second IA Test

➢ **Question paper format**

- Question Paper will comprise of a total of **six questions each carrying 20 marksQ.1** will be **compulsory** and should **cover maximum contents of the syllabus**

- **Remaining questions** will be **mixed in nature** (part (a) and part (b) of each question must be from different modules. For example, if Q.2 has part (a) from Module 3 then part (b) must be from any other Module randomly selected from all the modules)

- A total of **four questions** need to be answered

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		
		Theory	Practical	Theory	Practical	Total
ITL601	Business Intelligence Lab	--	02	--	01	01

Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Pract / Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (in Hrs)			
		Test1	Test 2	Avg.					
ITL601	Business Intelligence Lab	--	--	--	--	--	25	25	50

Lab Objectives:

Sr. No.	Lab Objectives
The Lab experiments aims:	
1	To introduce the concept of data Mining as an important tool for enterprise data management and as a cutting-edge technology for building competitive advantage
2	To enable students to effectively identify sources of data and process it for data mining
3	To make students well versed in all data mining algorithms, methods, and tools.
4	To learn how to gather and analyze large sets of data to gain useful business understanding.
5	To impart skills that can enable students to approach business problems analytically by identifying opportunities to derive business value from data.
6	To identify and compare the performance of business.

Lab Outcomes:

Sr. No.	Lab Outcomes	Cognitive levels of attainment as per Bloom's Taxonomy
On successful completion, of course, learner/student will be able to:		
1	Identify sources of Data for mining and perform data exploration	L2
2	Organize and prepare the data needed for data mining algorithms in terms of attributes and class inputs, training, validating, and testing files	L2
3	Implement the appropriate data mining methods like classification, clustering or association mining on large data sets using open-source tools like WEKA	L3

4	Implement various data mining algorithms from scratch using languages like Python/ Java etc.	L3
5	Evaluate and compare performance of some available BI packages	L3, L4
6	Apply BI to solve practical problems: Analyze the problem domain, use the data collected in enterprise apply the appropriate data mining technique, interpret and visualize the results and provide decision support	L3, L4

Prerequisite: Object oriented Concept, Java programming language, Python.

Hardware & Software Requirements:

Hardware Requirements	**Software Requirements**
PC i3 processor and above	Open source data mining and BI tools like WEKA, Rapid Miner, Pentaho

DETAILED SYLLABUS:

Sr. No.	**Module**	**Detailed Content**	**Hours**	**LO Mapping**
0	Prerequisite	--	----	--
I	I	Tutorial on a) Design Star and Snowflake Schema	**02**	LO 1
II	II	Implement using tools or languages like JAVA/ python/R a) Data Exploration b) Data preprocessing	**04**	LO 2
III	III	Implement and evaluate using languages like JAVA/ python/R a) Classification Algorithms b) Clustering Algorithms c) Frequent Pattern Mining Algorithms	**06**	LO4
IV	IV	Perform and evaluate using any open-source tools a) Classification Algorithms b) Clustering Algorithms c) Frequent Pattern Mining Algorithms	**04**	LO3
V	V	Detailed case study of any one BI tool such as Pentaho, Tableau and QlikView	**04**	LO5
VI	VI	Business Intelligence Mini Project: Each group assigned one new case study for this A BI report must be prepared outlining the following steps: a) Problem definition, identifying which data mining task is needed b) Identify and use a standard data mining dataset available for the problem. Some links for data mining datasets are: WEKA, Kaggle, KDD cup, Data Mining Cup, UCI Machine Learning Repository etc. c) Implement appropriate data mining algorithm d) Interpret and visualize the results	**06**	LO6

		e) Provide clearly the BI decision that is to be taken as a result of mining		

Text Books:

1. Han, Kamber, "Data Mining Concepts and Techniques", Morgan Kaufmann 3nd Edition.
2. G. Shmueli, N.R. Patel, P.C. Bruce, “Data Mining for Business Intelligence: Concepts, Techniques, and Applications in Microsoft Office Excel with XLMiner”, 1st Edition, Wiley India.
3. Paulraj Ponniah “Data Warehousing Fundamentals: A Comprehensive Guide for IT Professionals” Wiley Publications

References:

1. P. N. Tan, M. Steinbach, Vipin Kumar, “Introduction to Data Mining”, Pearson Education
2. WEKA, RapidMiner Pentaho resources from the Web.
3. https://www.kaggle.com/learn/overview
4. Python for Data Science https://onlinecourses.nptel.ac.in/noc21_cs33/preview

Term Work: Term Work shall consist of at least 10 racticals based on the above list. Also Term work Journal must include at least 2 assignments.

Term Work Marks: 25 Marks (Total marks) = 10 Marks (Experiment) + 10 Marks (Mini Project) + 5 Marks (Attendance)

Oral Exam: An Oral exam will be held based on the above syllabus.

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		
		Theory	Practical	Theory	Practical	Total
ITL602	Web Lab	--	02	--	01	01

Course Code	Course Name	Examination Scheme							
		Theory							
		Internal Assessment			End Sem Exam	Exam Duration (in Hrs)	Term Work	Pract / Oral	Total
		Test1	Test 2	Avg.					
ITL602	Web Lab	--	--	--	--	--	25	25	50

Lab Objectives:

Sr. No.	Lab Objectives
The Lab experiments aims:	
1	Open Source Tools for Web Analytics and Semantic Web.
2	Programming in TypeScript for designing Web Applications.
3	AngularJS Framework for Single Page Web Applications.
4	AJAX for Rich Internet Applications.
5	REST API and MongoDB for Frontend and Backend Connectivity.
6	Flask Framework for building web applications.

Lab Outcomes:

Sr. No.	Lab Outcomes	Cognitive Levels of Attainment as per Bloom's Taxanomy
On successful completion, of course, learner/student will be able to:		
1	Understand open source tools for web analytics and semantic web apps development and deployment.	L1, L2
2	Understand the basic concepts of TypeScript for designing web applications.	L1, L2, L3
3	Implement Single Page Applications using AngularJS Framework.	L1, L2, L3

4	Develop Rich Internet Applications using AJAX.	L1, L2, L3
5	Create REST Web services using MongoDB.	L1, L2, L3, L4
6	Design web applications using Flask.	L1, L2, L3, L4

Prerequisite: HTML/HTML5, CSS/CSS3, JavaScript, Python

Hardware & Software requirements:

Hardware Specifications	**Software Specifications**
PC with following Configuration 1. Intel Core i3/i5/i7 2. 4 GB RAM 3. 500 GB Hard disk	Angular IDE, Visual Studio Code, Notepad++, Python Editors, MySQL, XAMPP, MongoDB, JDK

DETAILED SYLLABUS:

Sr. No.	**Module**	**Detailed Content**	**Hours**	**LO Mapping**
I	Web Analytics & Semantic Web	Study **Any 1** tool in each 1. Study web analytics using open source tools like Matomo, Open Web Analytics, AWStats, Countly, Plausible. 2. Study Semantic Web Open Source Tools like Apache TinkerPop, RDFLib, Apache Jena, Protégé, Sesame.	**02**	LO1
II	TypeScript	Perform **Any 3** from the following 1. Small code snippets for programs like Hello World, Calculator using TypeScript. 2. Inheritance example using TypeScript 3. Access Modifiers example using TypeScript 4. Building a Simple Website with TypeScript	**04**	LO2
III	AngularJS	Perform **Any 2** from the following 1. Create a simple HTML "Hello World" Project using AngularJS Framework and apply ng-controller, ng-model and expressions. 2. Events and Validations in AngularJS. (Create functions and add events, adding HTML validators, using $valid property of Angular, etc.) 3. Create an application for like Students Record using AngularJS	**06**	LO3
IV	Rich Internet Application using AJAX	Perform **Any 3** from the following 1. Write a JavaScript program for a AJAX. 2. Write a program to use AJAX for user validation using and to show the result on the same page below the submit button.	**06**	LO4

		3. Design and develop small web application using AJAX, HTML and JSP.		
V	MongoDB and Building REST API using MongoDB	Perform **Any 1** from the following 1. Build a RESTful API using MongoDB. 2. Build a TypeScript REST API using MongoDB.	**04**	LO5
VI	Flask	Perform **Any 3** from the following 1. Design Feedback Form using Flask. 2. Design Weather App using Flask. 3. Design Portfolio Website using Flask. 4. Create a complete Machine learning web application using React and Flask.	**04**	LO6

Text Books:

1. John Hebeler, Matthew Fisher, Ryan Blace, Andrew Perez-Lopez, "Semantic Web Programming", Wiley Publishing, Inc, 1st Edition, 2009.
2. Boris Cherny, "Programming TypeScript- Making Your Javascript Application Scale", O'Reilly Media Inc., 2019 Edition.
3. Adam Bretz and Colin J. Ihrig, "Full Stack JavaScript Development with MEAN", SitePoint Pty. Ltd., 2015 Edition.
4. Simon Holmes Clive Harber, "Getting MEAN with Mongo, Express, Angular, and Node", Manning Publications, 2019 Edition.
5. Dr. Deven Shah, "Advanced Internet Programming", StarEdu Solutions, 2019 Edition.
6. Miguel Grinberg, "Flask Web Development: Developing Web Applications with Python", O'Reilly, 2018 Edition.

References:

1. John Davies, Rudi Studer and Paul Warren, "Semantic Web Technologies Trends and Research in Ontology-based Systems", Wiley, 2006 Edition.
2. Yakov Fain and Anton Moiseev, "TypeScript Quickly", Manning Publications, 2020 Edition.
3. Steve Fenton, "Pro TypeScript: Application - Scale Javascript Development", Apress, 2014 Edition.
4. Brad Dayley, Brendan Dayley, Caleb Dayley, "Node.js, MongoDB and Angular Web Development: The definitive guide to using the MEAN stack to build web applications", 2nd Edition, Addison-Wesley Professional, 2018 Edition.

Term Work:
Term Work shall consist of at least 10 to 12 practical's based on the above list. Also Term Work Journal must include at least 2 assignments.
Term Work Marks:
25 Marks (Total marks) = 15 Marks (Experiment) + 5 Marks (Assignments) + 5 Marks (Attendance)
Oral Exam: An Oral exam will be held based on the above syllabus.

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		
		Theory	Practical	Theory	Practical	Total
ITL603	Sensor Lab	--	02	--	01	01

Course Code	Course Name	Examination Scheme							
		Theory							
		Internal Assessment			End Sem Exam	Exam Duration (in Hrs)	Term Work	Pract / Oral	Total
		Test1	Test 2	Avg.					
ITL603	Sensor Lab	--	--	--	--	--	25	25	50

Lab Objectives:

Sr. No.	Lab Objectives
The Lab experiments aims:	
1	Learn various communication technologies, Microcontroller boards and sensors.
2	Design the problem solution as per the requirement analysis done using sensors and technologies.
3	Study the basic concepts of programming/sensors/ emulators.
4	Design and implement the mini project intended solution for project based earning.
5	Build, test and report the mini project successfully.
6	Improve the team building, communication and management skills of the students.

Lab Outcomes:

Sr. No.	Lab Outcomes	Cognitive Levels of Attainment as per Bloom's Taxanomy
On successful completion, of course, learner/student will be able to:		
1	Differentiate between various wireless communication technologies based on the range of communication, cost, propagation delay, power and throughput.	L1,L2

2	Conduct a literature survey of sensors used in real world wireless applications.	L1,L2
3	Demonstrate the simulation of WSN using the Network Simulators (Contiki/ Tinker CAD/ Cup carbon etc).	L1,L2,L3
4	Demonstrate and build the project successfully by hardware/sensor requirements, coding, emulating and testing	L1,L2,L3
5	Report and present the findings of the study conducted in the preferred domain.	L1,L2,L3
6	Demonstrate the ability to work in teams and manage the conduct of the research study.	L1,L2,L3

Prerequisite: Computer Networks, Microprocessor Lab.

Hardware & Software requirements:

Hardware Specifications:	**Software Specifications:**
1.Laptop/ PC with minimum 2GB RAM and 500 GB Hard disk drive. 2. Sensors –DHT11/22, PIR, MQ2/MQ3, HC-SR04, Moisture sensor , Arduino Uno/Mega board, RPi Board 3. Wireless Radio Modules- Zigbee RF module, Bluetooth Module (HC-05), Mobile Phone with Bluetooth antenna 4. Others-Breadboard, wires, power supplies, USB cables, buzzers, LEDs, LCDs.	1. Windows or Linux Desktop OS Arduino IDE 2.XCTU configuration and test utility software 3. CupCarbon IOT simulator 4. Tinkercad Simulation Software 5. Contiki/Cooja 6. Internet connection

Guidelines

A. **Students should perform the following experiments:**

DETAILED SYLLABUS:

Sr. No.	**Module**	**Detailed Content**	**Hours**	**LO Mapping**
0	Prerequisite	Introduction to 8086, 8051 and Python programming	**02**	--
I	Review of Wireless Communication Technologies	Study of various wireless communication technologies like IEEE 802.15.1, IEEE 802.15.4 and IEEE 802.11. Mini Project: Allocation of the groups	**02**	LO1
II	Sensors and their Interfacing	Study of various types of sensors and display devices (eg. DHT-11/22, HC-SR04, MFRC 522, PIR Sensor) and demonstration of their interfacing using Arduino/ Raspberry pi. Mini Project: Topic selection	**02**	LO2
III	Wireless Communication tools	Installation and testing the simulation tools (eg. TinkerCad/Cupcarbon/ContikiCooja). Mini Project: Topic validation and finalizing software and Hardware requirement.	**02**	LO3
IV	Implementation of Wireless Technologies	Study of interfacing of Arduino/ Raspberry pi with Wireless Technologies (eg. HC-05, XBee S2C by	**02**	LO4

		Digi, ESP controller). Mini Project: Hardware procurement		
V	Remote Access	Study of interface using Mobile/Web to publish or remotely access the data on the Internet. Mini Project: Study of remote access technologies with respect to the selected project.	**02**	LO4
VI	Mini Project	Implementation of the Mini Project: 1. Design, configure, testing the Mini Project. 2. Report submission as per the guidelines.	**14**	LO4,LO5 ,LO6

B. Mini project

1. Students should carry out hardware based mini-project in a group of three/four students with a subject In charge/ mini project mentor associated with each group.
2. The group should meet with the concerned faculty during laboratory hours and the progress of work discussed must be documented.
3. Each group should perform a detailed literature survey and formulate a problem statement.
4. Each group will identify the hardware and software requirement for their defined mini project problem statement.
5. Design, configure and test their own circuit board.
5. Interface using Mobile/Web to publish or remotely access the data on the Internet.
6. A detailed report is to be prepared as per guidelines.
7. Each group may present their work in various project competitions and paper presentations

C. Documentation of the Mini Project

The Mini Project Report can be made on following lines:
1. Abstract
2. Contents
3. List of figures and tables
4. Chapter-1 (Introduction, Literature survey, Problem definition, Objectives, Proposed Solution, Wireless Technology used)
5. Chapter-2 (System design/Block diagram, Flow chart, Circuit/Interfacing diagram, Hardware and Software requirements, cost estimation)
6. Chapter-3 (Implementation snapshots/figures with explanation, code, future directions)
7. Chapter-4 (Conclusion)
8. References

Text Books:

1. Fundamentals of Sensor Network Programming: Applications and Technology, S. Sitharama Iyengar, Nandan Parameshwaran, Vir V. Phoha, N. Balakrishnan, Chuka D. Okoye, Wiley Publications.
2. ContikiCooja User Guide.
3. Building Wireless Sensor Networks, Robert Faludi, O'Reilly Publications.

Reference Books:

1. Internet of Things (A Hands-on-Approach) , Vijay Madisetti , ArshdeepBahga.

2. A comparative review of wireless sensor network mote technologies, IEEE paper 2009.

3. Wireless Sensor Networks-Technology, Protocols and Applications, KazemSohraby, Daniel Minoli and TaiebZnati, Wiley Publications.

4. Adhoc& Sensor Networks Theory and Applications, Carlos de MoraisCordeiro,Dharma Prakash Agrawal, World Scientific,2nd Edition.

Online References:

Sr. No.	Website/Reference link
1.	https://www.digi.com/resources/documentation/digidocs/90001526/tasks/t_download_and_install_xctu.htm
2.	https://www.arduino.cc/en/software
3.	http://cupcarbon.com/

Term Work:

Term Work shall consist of Mini Project on above guidelines/syllabus. Also Term work must include at least 2 assignments and mini project report.

Term Work Marks: 25 Marks (Total marks) =15 Marks (Mini Project) + 5 Marks (Assignments) + 5 Marks (Attendance)

Oral Exam: An Oral exam will be held based on the Mini Project and Presentation.

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		
		Theory	Practical	Theory	Practical	Total
ITL604	MAD & PWA Lab	--	02	--	01	01

Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Pract / Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (in Hrs)			
		Test1	Test 2	Avg.					
ITL604	MAD & PWA Lab	--	--	--	--	--	25	25	50

Lab Objectives:

Sr. No.	Lab Objectives
The Lab experiments aims:	
1	Learn the basics of the Flutter framework.
2	Develop the App UI by incorporating widgets, layouts, gestures and animation
3	Create a production ready Flutter App by including files and firebase backend service.
4	Learn the Essential technologies, and Concepts of PWAs to get started as quickly and efficiently as possible
5	Develop responsive web applications by combining AJAX development techniques with the jQuery JavaScript library.
6	Understand how service workers operate and also learn to Test and Deploy PWA.

Lab Outcomes:

Sr. No.	Lab Outcomes	Cognitive levels of attainment as per Bloom's Taxonomy
On Completion of the course the learner/student should be able to:		
1	Understand cross platform mobile application development using Flutter framework	**L1, L2**
2	Design and Develop interactive Flutter App by using widgets, layouts, gestures and animation	**L3**
3	Analyze and Build production ready Flutter App by incorporating backend services and deploying on Android / iOS	**L3, L4**
4	Understand various PWA frameworks and their requirements	**L1, L2**
5	Design and Develop a responsive User Interface by applying PWA Design techniques	**L3**
6	Develop and Analyse PWA Features and deploy it over app hosting solutions	**L3, L4**

Prerequisite: HTML/HTML5, CSS3, Javascript

Hardware & Software Requirements:

Hardware Requirement:	**Software requirement:**
PC i3 processor and above	**JDK 8 and above, Android studio, Flutter SDK, AngularJs, React, Vue, PWA Builder, Google Chrome Browser, Github account.** **Internet Connection**

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours	LO Mapping
I	Basics of Flutter Programming	Introduction of Flutter, Understanding Widget Lifecycle Events,Dart Basics, Widget Tree and Element Tree, Basics of Flutter installation, Flutter Hello World App.	**02**	LO1
II	Developing Flutter UI:Widgets, Layouts, Gestures, Animation	**USING COMMON WIDGETS:** SafeArea, Appbar, Column, Row, Container, Buttons, Text , Richtext,Form ,Images and Icon. **BUILDING LAYOUTS** : high level view of layouts, Creating the layout, Types of layout widgets **APPLYING GESTURES**: Setting Up GestureDetector, Implementing the Draggable	**06**	LO2

		and Dragtarget Widgets,Using the GestureDetector for Moving and Scaling **ADDING ANIMATION TO AN APP** :Using Animated Container,Using Animated CrossFade,Using Animated Opacity,Using Animation Controller, Using Staggered Animation **CREATING AN APP'S NAVIGATION:** Using the Navigator,Using the Named Navigator Route,Using the Bottom NavigationBar,Using the TabBar and TabBarView		
III	Creating Production Ready Apps	**Working with files** : Including libraries in your Flutter app, Including a file with your app, Reading/Writing to files, Using JSON. **Using Firebase with Flutte**r: Adding the Firebase and Firestore Backend,Configuring the Firebase Project,Adding a Cloud Firestore Database and Implementing Security **Testing and Deploying of Flutter Application:** Widget testing, Deploying Flutter Apps on Android / iOS	**04**	LO3
IV	Introduction to Progressive Web App	**Introduction to Progressive Web App** ● Why Progressive Web App ● Characteristics of PWA ● PWAs and Hybrid Apps vs. Mobile Apps ● PWA Requirements: HTTPS, Service Workers, and Web App Manifest ● PWA framework tools ● Use cases	**02**	LO4
V	Creating Responsive UI	**Creating Responsive UI using JQuery Mobile / Material UI / Angular UI / React UI** ● Understanding the concept of responsive web design ● Comparing responsive, fluid, and adaptive web ● keys to great Progressive Web App UX ● Responsive Design – The Technicalities ● Flexible grid-based layout ● Flexible images and video ● Smart use of CSS splitting the website behavior (media queries)	06	LO5

VI	Web App Manifest & Service Workers	**Web App Manifest:** Understand the basic format and workings of the Web App Manifest file. ● Using an App Manifest to Make your App Installable ● Understanding App Manifest Properties ● Simulating the Web App on an Emulator ● Installing the Web App - Prerequisites ● Understanding manifest.json **Service Workers:** Making PWAs work offline with Service workers ● Introduction to Service Workers ● Service Workers Lifecycle (Registration, Installation and Activation) ● Implement Service Workers Features (Events) ● Handling cached content ● Enabling offline functionality ● Serving push notifications ● Loading cached content for new users ● Background synchronization ● Using IndexedDB in the Service Worker ● Geo-fencing **Deploy a PWA to GitHub Pages as a free SSL enabled static app hosting solution.** ● Initialising the PWA as a Git repo ● Testing with Lighthouse ● Deploying via GitHub Pages	06	LO6

Text Books:

1. Beginning Flutter a Hands-on Guide to App Development, Marco L. Napoli, Wiley, 2020.
2. Beginning App Development with Flutter: Create Cross-Platform Mobile Apps, By Rap Payne, 201**9**
3. Progressive Web Application Development by Example: Develop fast, reliable, and engaging user experiences for the web, Packt Publishing Limited ,2018
4. Building Progressive Web Apps,O'Reilly 2017
5. Progressive Web Apps with Angular: Create Responsive, Fast and Reliable PWAs Using Angular, Apress; 1st ed. edition (28 May 2019)

References:

1. Flutter in Action by Eric Windmill, MANING, 2019
2. Google Flutter Mobile Development Quick Start Guide.Packt,2019
3. Learning Progressive Web Apps: Building Modern Web Apps Using Service Workers ,Addison-Wesley Professional, 2020

Online References:

Sr. No.	Website/Reference link
1.	https://flutter.dev/docs/reference/tutorials
2.	**https://www.tutorialspoint.com/flutter/index.htm**

3.	**https://www.javatpoint.com/flutter**
4.	https://www.tutorialspoint.com/jquery_mobile/jqm_panel_responsive.htm
5.	https://www.w3schools.com/css/css_rwd_intro.asp
6	https://developers.google.com/web/updates/2015/12/getting-started-pwa
7	https://www.w3schools.com/react/
8	https://angular.io/docs
9	https://flaviocopes.com/service-workers/
10	https://blog.logrocket.com/how-to-build-a-progressive-web-app-pwa-with-node-js/

List of Experiments.

1. To install and configure Flutter Environment.
2. To design Flutter UI by including common widgets.
3. To create an interactive Form using form widget
4. To design a layout of Flutter App using layout widgets
5. To include icons, images, charts in Flutter app
6. To apply navigation, routing and gestures in Flutter App
7. To Connect Flutter UI with fireBase database
8. To test and deploy production ready Flutter App on Android platform
9. To create a responsive User Interface using jQuery Mobile/ Material UI/ Angular UI/ React UI for Ecommerce application.
10. To write meta data of your Ecommerce PWA in a Web app manifest file to enable "add to homescreen feature".
11. To code and register a service worker, and complete the install and activation process for a new service worker for the E-commerce PWA.
12. To implement Service worker events like fetch, sync and push for E-commerce PWA.
13. To study and implement deployment of Ecommerce PWA to GitHub Pages.
14. To use google Lighthouse PWA Analysis Tool to test the PWA functioning.
15. To deploy an Ecommerce PWA using SSL enabled static hosting solution.

Assignment 1: MAD (Any one)

1. To Study basics of Dart language and design basic Flutter App
2. To include Files and JSON data in App
3. To build interactive App by including Flutter Gestures and Animations

Assignment 2: PWA (Any one)

1. To study the requirement for progressive web application for Ecommerce using the concept of service worker, Webapp Manifest and framework tools
2. To Design a wireframe for simple PWA for E-commerce website
3. Case study for successful real life implementation of PWA.

Term Work:

Term Work shall consist of at least 10 to 12 practical's based on the above list. Also Term Work Journal must include at least 2 assignments as mentioned in above syllabus.

Term Work Marks: 25 Marks (Total marks) = 15 Marks (Experiment) + 5 Marks (Assignments) + 5 Marks (Attendance)

Practical & Oral Exam: An Practical & Oral exam will be held based on the above syllabus.

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		
		Theory	Practical	Theory	Practical	Total
ITL605	DS using Python Lab	--	02	--	01	01

Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Pract / Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (in Hrs)			
		Test1	Test 2	Avg.					
ITL605	DS using Python Lab	--	--	--	--	--	25	25	50

Lab Objectives:

Sr. No.	Lab Objectives
The Lab experiments aims:	
1	To know the fundamental concepts of data science and analytics
2	To learn data collection, preprocessing and visualization techniques for data science
3	To Understand and practice analytical methods for solving real life problems based on Statistical analysis
4	To learn various machine learning techniques to solve complex real-world problems
5	To learn streaming and batch data processing using Apache Spark
6	To map the elements of data science to perceive information

Lab Outcomes:

Sr. No.	Lab Outcomes	**Cognitive levels of attainment as per Bloom's Taxonomy**
On successful completion, of course, learner/student will be able to:		
1	Understand the concept of Data science process and associated terminologies to solve real-world problems	L1
2	Analyze the data using different statistical techniques and visualize the outcome using different types of plots.	L1, L2, L3, L4
3	Analyze and apply the supervised machine learning techniques like Classification, Regression or Support Vector Machine on data for building the models of data and solve the problems.	L1,L2, L3, L4
4	Apply the different unsupervised machine learning algorithms like Clustering, Decision Trees, Random Forests or Association to solve the problems.	L1, L2,L3
5	Design and Build an application that performs exploratory data analysis using Apache Spark	L1,L2,L3,L4,L5,L6
6	Design and develop a data science application that can have data acquisition, processing, visualization and statistical analysis methods with supported machine learning technique to solve the real-world problem	L1,L2,L3,L4,L5,L6

Prerequisite: Basics of Python programming and Database management system.

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours	LO Mapping
I	Introduction to Data Science and Data Processing using Pandas	i. Introduction, Benefits and uses of data science ii. Data Science tasks iii. Introduction to Pandas iv. Data preparation: Data cleansing, Data transformation, Combine/Merge /Join data, Data loading & preprocessing with pandas v. Data aggregation vi. Querying data in Pandas vii. Statistics with Pandas Data Frames viii. Working with categorical and text data ix. Data Indexing and Selection x. Handling Missing Data	**04**	LO1
II	Data Visualization and Statistics	i. Visualization with Matplotlib and Seaborn ii. Plotting Line Plots, Bar Plots, Histograms Density Plots, Paths, 3Dplot, Stream plot, Logarithmic plots, Pie chart, Scatter Plots and Image visualization using Matplotlib iii. Plotting scatter plot, box plot, Violin plot, swarm plot, Heatmap, Bar Plot using seaborn iv. Introduction to scikit-learn and SciPy v. Statistics using python: Linear algebra, Eigen value, Eigen Vector, Determinant, Singular Value Decomposition, Integration, Correlation, Central Tendency, Variability, Hypothesis testing, Anova, z-test, t-test and chi-square test.	**04**	LO2
III	Machine Learning	i. What is Machine Learning? ii. Applications of Machine Learning; iii. Introduction to Supervised Learning iv. Overview of Regression v. Support Vector Machine vi. Classification algorithms	**05**	LO3
IV	Unsupervised Learning	i. Introduction to Unsupervised Learning ii. Overview of Clustering iii. Decision Trees iv. Random Forests v. Association	**05**	LO4
V	Data analytics using Apache Spark	i. Introduction to Apache Spark ii. Architecture of Apache Spark iii. Modes and components iv. Basics of PySpark	**04**	LO5
VI	Case Studies	i. Understanding the different data science phases used in selected case study ii. Implementation of Machine learning algorithm for selected case study	**04**	LO1, LO6

Text Books:

1. Jake VanderPlas, “Python Data Science Handbook”, O’Reilly publication
2. Frank Kane, “Hands-On Data Science and Python Machine Learning”, packt publication

3. M.T. Savaliya, R.K. Maurya, G.M.Magar, "Programming with Python", 2nd Edition, Sybgen Learning.

References:

1. Armando Fandango, "Python Data Analysis", Second Edition, Packt publication.
2. Alberto Boschetti, Luca Massaron, "Python Data Science Essentials Second Edition", Packt Publishing
3. Davy Cielen, Arno D. B. Meysman, Mohamed Ali, "Introducing Data Science", Manning Publications.

Online References:

Sr. No.	Website/Reference link
1.	https://www.w3schools.com/python/pandas/default.asp
2.	https://matplotlib.org/stable/gallery/index.html
3.	. https://seaborn.pydata.org/examples/index.html
4.	. https://docs.scipy.org/doc/scipy/reference/linalg.html#module-scipy.linalg
5.	https://scikit-learn.org/stable/auto_examples/index.html
6	https://www.tutorialspoint.com/scipy/scipy_integrate.htm\
7	https://machinelearningmastery.com/statistical-hypothesis-tests-in-python-cheat-sheet/
8	https://data-flair.training/blogs/data-science-project-ideas/

Suggested List of Experiments

For the following Experiments, use any available data set or download it from Kaggle/UCI or other repositories and use Python to solve each problem.

1. Data preparation using NumPy and Pandas
    a. Derive an index field and add it to the data set.
    b. Find out the missing values.
    c. Obtain a listing of all records that are outliers according to the any field. Print out a listing of the 10 largest values for that field.
    d. Do the following for the any field.
        i. Standardize the variable.
        ii. Identify how many outliers there are and identify the most extreme outlier.
2. Data Visualization / Exploratory Data Analysis for the selected data set using Matplotlib and Seaborn
    a. Create a bar graph, contingency table using any 2 variables.
    b. Create normalized histogram.
    c. Describe what this graphs and tables indicates?
3. Data Modeling
    a. Partition the data set, for example 75% of the records are included in the training data set and 25% are included in the test data set. Use a bar graph to confirm your proportions.
    b. Identify the total number of records in the training data set.
    c. Validate your partition by performing a two-sample Z-test.
4. Implementation of Statistical Hypothesis Test using Scipy and Sci-kit learn [Any one]

    1. Normality Tests
        1. Shapiro-Wilk Test
        2. D'Agostino's K^2 Test
        3. Anderson-Darling Test
    2. Correlation Tests

1. Pearson's Correlation Coefficient
2. Spearman's Rank Correlation
3. Kendall's Rank Correlation
4. Chi-Squared Test

3. Stationary Tests
    1. Augmented Dickey-Fuller
    2. Kwiatkowski-Phillips-Schmidt-Shin
4. Parametric Statistical Hypothesis Tests
    1. Student's t-test
    2. Paired Student's t-test
    3. Analysis of Variance Test (ANOVA)
    4. Repeated Measures ANOVA Test
5. Nonparametric Statistical Hypothesis Tests
    1. Mann-Whitney U Test
    2. Wilcoxon Signed-Rank Test
    3. Kruskal-Wallis H Test
    4. Friedman Test

5. Regression Analysis
    a. Perform Logistic Regression to find out relation between variables.
    b. Apply regression Model techniques to predict the data on above dataset

6. Classification modelling
    a. Choose classifier for classification problem.
    b. Evaluate the performance of classifier.
7. Clustering
    a. Clustering algorithms for unsupervised classification.
    b. Plot the cluster data.
8. Using any machine learning techniques using available data set to develop a recommendation system.

9. Exploratory data analysis using Apache Spark and Pandas
10. Batch and Streamed Data Analysis using Spark
11. Implementation of Mini project based on following case study using Data science and Machine learning [Any one]

List of Case Studies		
Fake News Detection	Road Lane Line Detection	Sentiment Analysis
Detecting Parkinson's Disease	Brain Tumor Detection with Data Science	Leaf Disease Detection
Speech Emotion Recognition	Gender Detection and Age prediction	Diabetic Retinopathy
Uber Data Analysis	Driver Drowsiness detection	Chatbot Project
Credit Card Fraud Detection	Movie/ Web Show Recommendation System	Customer Segmentation
Cancer Classification	Traffic Signs Recognition	Exploratory Data Analysis for Housing price prediction
Coronavirus visualizations	Visualizing climate change	Predictive policing
Uber's pickup analysis	Earth Surface Temperature Visualization	Web traffic forecasting using time series

Pokemon Data Exploration	Impact of Climate Change on Global Food Supply	Used Car Price Estimator
Skin Cancer Image Detection	World University Rankings	and so on ….

Assignments:

1) Recent trends in Data science
2) Comparative analysis between Batch and Streamed data processing tools like Map-reduce, Apache spark, Apache Flink, Apache Samza, Apache Kafka and Apache Storm.

Term Work:

- Term work shall consist of at least 10 experiments and a case study.
- Journal must include 2 assignments.
- The final certification and acceptance of term work indicates that performance in laboratory work is satisfactory and minimum passing marks may be given in term work.
- The distribution of marks for term work shall be as follows:
- Laboratory work (Experiments) …… (15) Marks.
- Mini project (Implementation) …… . (05) Marks.
- Attendance……. (05) Marks

TOTAL:…….(25) Marks.

Oral examination will be based on Laboratory work, mini project and above syllabus.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ITM601	Mini Project – 2 B Web Based on ML	--	04	--	--	02	--	02

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Pract. /Oral	Total
		Internal assessment			End Sem. Exam			
		Test1	Test 2	Avg.				
ITM601	Mini Project – 2 B Based on ML	--	--	--	--	25	25	50

Course Objectives

5. To acquaint with the process of identifying the needs and converting it into the problem.
6. To familiarize the process of solving the problem in a group.
7. To acquaint with the process of applying basic engineering fundamentals to attempt solutions to the problems.
8. To inculcate the process of self-learning and research.

Course Outcome: Learner will be able to…

10. Identify problems based on societal /research needs.
11. Apply Knowledge and skill to solve societal problems in a group.
12. Develop interpersonal skills to work as member of a group or leader.
13. Draw the proper inferences from available results through theoretical/ experimental/simulations.
14. Analyse the impact of solutions in societal and environmental context for sustainable development.
15. Use standard norms of engineering practices
16. Excel in written and oral communication.
17. Demonstrate capabilities of self-learning in a group, which leads to life long learning.
18. Demonstrate project management principles during project work.

Guidelines for Mini Project

- Students shall form a group of 3 to 4 students, while forming a group shall not be allowed less than three or more than four students, as it is a group activity.
- Students should do survey and identify needs, which shall be converted into problem statement for mini project in consultation with faculty supervisor/head of department/internal committee of faculties.
- Students hall submit implementation plan in the form of Gantt/PERT/CPM chart, which will cover weekly activity of mini project.
- A log book to be prepared by each group, wherein group can record weekly work progress, guide/supervisor can verify and record notes/comments.
- Faculty supervisor may give inputs to students during mini project activity;however, focus shall be on self-learning.
- Students in a group shall understand problem effectively, propose multiple solution and select best possible solution in consultation with guide/ supervisor.
- Students shall convert the best solution into working model using various components of their domain areas and demonstrate.

- The solution to be validated with proper justification and report to be compiled in standard format of University of Mumbai.
- With the focus on the self-learning, innovation, addressing societal problems and entrepreneurship quality development within the students through the Mini Projects, it is preferable that a single project of appropriate level and quality to be carried out in two semesters by all the groups of the students. i.e. Mini Project 1 in semester III and IV. Similarly, Mini Project 2 in semesters V and VI.
- However, based on the individual students or group capability, with the mentor's recommendations, if the proposed Mini Project adhering to the qualitative aspects mentioned above gets completed in odd semester, then that group can be allowed to work on the extension of the Mini Project with suitable improvements/modifications or a completely new project idea in even semester. This policy can be adopted on case by case basis.

Guidelines for Assessment of Mini Project:
Term Work

- The review/ progress monitoring committee shall be constituted by head of departments of each institute. The progress of mini project to be evaluated on continuous basis, minimum two reviews in each semester.
- In continuous assessment focus shall also be on each individual student, assessment based on individual's contribution in group activity, their understanding and response to questions.
- Distribution of Term work marks for both semesters shall be as below;
    - Marks awarded by guide/supervisor based on log book : 10
    - Marks awarded by review committee : 10
    - Quality of Project report : 05

Review/progress monitoring committee may consider following points for assessment based on either one year or half year project as mentioned in general guidelines.

One-year project:

- In first semester entire theoretical solution shall be ready, including components/system selection and cost analysis. Two reviews will be conducted based on presentation given by students group.
    - First shall be for finalisation of problem
    - Second shall be on finalisation of proposed solution of problem.
- In second semester expected work shall be procurement of component's/systems, building of working prototype, testing and validation of results based on work completed in an earlier semester.
    - First review is based on readiness of building working prototype to be conducted.
    - Second review shall be based on poster presentation cum demonstration of working model in last month of the said semester.

Half-year project:

- In this case in one semester students' group shall complete project in all aspects including,
    - Identification of need/problem
    - Proposed final solution
    - Procurement of components/systems
    - Building prototype and testing
- Two reviews will be conducted for continuous assessment,
    - First shall be for finalisation of problem and proposed solution
    - Second shall be for implementation and testing of solution.

Assessment criteria of Mini Project.

Mini Project shall be assessed based on following criteria;

14. Quality of survey/ need identification
15. Clarity of Problem definition based on need.

16. Innovativeness in solutions
17. Feasibility of proposed problem solutions and selection of best solution
18. Cost effectiveness
19. Societal impact
20. Innovativeness
21. Cost effectiveness and Societal impact
22. Full functioning of working model as per stated requirements
23. Effective use of skill sets
24. Effective use of standard engineering norms
25. Contribution of an individual's as member or leader
26. Clarity in written and oral communication

- In **one year, project**, first semester evaluation may be based on first six criteria's and remaining may be used for second semester evaluation of performance of students in mini project.
- In case of **half year project** all criteria's in generic may be considered for evaluation of performance of students in mini project.

Guidelines for Assessment of Mini Project Practical/Oral Examination:

- Report should be prepared as per the guidelines issued by the University of Mumbai.
- Mini Project shall be assessed through a presentation and demonstration of working model by the student project group to a panel of Internal and External Examiners preferably from industry or research organisations having experience of more than five years approved by head of Institution.
- Students shall be motivated to publish a paper based on the work in Conferences/students competitions.

Mini Project shall be assessed based on following points;

9. Quality of problem and Clarity
10. Innovativeness in solutions
11. Cost effectiveness and Societal impact
12. Full functioning of working model as per stated requirements
13. Effective use of skill sets
14. Effective use of standard engineering norms
15. Contribution of an individual's as member or leader
16. Clarity in written and oral communication

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		
		Theory	Practical	Theory	Practical	Total
ITDO6011	Software Architecture	03	--	03	--	03

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Avg. of 2 Tests					
ITDO6011	Software Architecture	20	20	20	80	--	--	--	100

Course Objectives:

Sr. No.	Course Objectives
The course aims:	
1	To understand the importance of architecture in building effective, efficient, competitive software products.
2	To understand the need, design approaches for software architecture to bridge the dynamic requirements and implementation
3	To learn the design principles and to apply for large scale systems including distributed, network and heterogeneous systems
4	To understand principal design decisions governing the system.
5	To understand different notations used for capturing design decisions.
6	To understand different functional and non-functional properties of complex software systems.

Course Outcomes:

Sr. No.	Course Outcomes	Cognitive levels of attainment as per Bloom's Taxonomy
On successful completion, of course, learner/student will be able to:		
1	Understand the need of software architecture for sustainable dynamic systems.	L1
2	Have a sound knowledge on design principles and to apply for large scale systems.	L2
3	Apply functional and non-functional requirements	L1,L2,L3
4	Design architectures for distributed, network and heterogeneous systems	L1,L2,L3
5	Have good knowledge on service oriented and model driven architectures and the aspect-oriented architecture.	L1,L2, L3
6	Have a working knowledge to develop appropriate architectures through various case studies.	L1,L2, L3

Prerequisite: Software Engineering, Any Programming Language

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours	CO Mapping
0	Prerequisite	Software Engineering Concepts, Knowledge of Any programming Language	**02**	CO1
I	Basic Concepts and Architectures Design	Terminology, Models, Processes, Stakeholders, Design Process, Architectural Conceptions, Styles and architectural Patterns, Architectural conceptions in absences of experience, connectors, 4+1 view model of Architecture **Self Learning Topics** : Technical Paper "What_is_included_in_software_architectur"	**07**	CO1
II	Architectural Modeling and Analysis	Modeling Concepts, Ambiguity, Accuracy and Precisions, Complex Modeling, Evaluating Modeling Techniques, Specific Modeling Techniques, Analysis Goals, Scope of Analysis, Formality of Architectural Models, Types of Analysis, Level of Automation, System Stakeholders, Analysis Techniques **Self Learning Topics:** Technical Paper "Specification of Requirements and Software Architecture for the Customisation of Enterprise Software"	**09**	CO1, CO2
III	Implementation, Deployment and Mobility	Implementation Concepts, Existing Frameworks, Overview of Deployment and Mobility Challenges, Software Architecture and Deployment, Software Architecture and Mobility **Self Learning Topics:** Technical Paper"Application of Distributed System in Neuroscience: A Case Study of BCI Framework"	**06**	CO1, CO2
IV	Applied Architectures and Styles	Distributed and Network Architectures, Architectures for Network Based Applications, Decentralized Architectures, Service oriented Architectures and Web Services. **Self Learning Topics:**Technical Paper "Analysing the Behaviour of Distributed Software Architectures: a Case Study"	**06**	CO1, CO2, CO3
V	Designing for Non-Functional Properties	Efficiency, Complexity, Scalability and Heterogeneity, Adaptability, Dependability **Self Learning Topics:** Technical Paper "Threat-Modeling-in-Agile-Software-Development"	**04**	CO1,CO2, CO4, CO6
VI	Domain-Specific Software Engineering	Domain-Specific Software Engineering, Domain- Specific Architecture, Software Architects Roles **Self Learning Topics**: Research Paper "A Case Study of the Variability Consequences of the CQRS"	**05**	CO1,CO2, CO3

Text Books:

1. Software Architecture, Foundations, Theory, and Practise, Richard Taylor, Nenad Medvidovic, Eric M Dashofy, Wiley Student Edition.
2. The Art of Software Architecture: Design Methods and Techniques, Stephen T.Albin, Wiley India Private Limited.
3. Software Architecture in Practice by Len Bass, Paul Clements, Rick Kazman, Pearson

References:

1. DevOps A Software Architect's Perspective, Len Bass, Ingo Weber, Liming Zhu, Addison Wesley
2. Essentials of Software Architecture, Ion Gorton, Second Edition, Springer-verlag, 2011

Online Resources:

1. ArchStudio Software
2. https://www.coursera.org/learn/software-architecture
3. https://www.coursera.org/specializations/software-design-architecture
4. https://resources.sei.cmu.edu/library/asset-view.cfm?assetid=509483
5. http://infolab.stanford.edu/~backrub/google.html
6. https://web.njit.edu/~alexg/courses/cs345/OLD/F15/solutions/f3345f15.pdf

Assessment:

Internal Assessment (IA) for 20 marks:

- IA will consist of Two Compulsory Internal Assessment Tests. Approximately 40% to 50% of syllabus content must be covered in First IA Test and remaining 40% to 50% of syllabus content must be covered in Second IA Test

➢ **Question paper format**

- Question Paper will comprise of a total of **six questions each carrying 20 marksQ.1** will be **compulsory** and should **cover maximum contents of the syllabus**
- **Remaining questions** will be **mixed in nature** (part (a) and part (b) of each question must be from different modules. For example, if Q.2 has part (a) from Module 3 then part (b) must be from any other Module randomly selected from all the modules)
- A total of **four questions** need to be answered

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		
		Theory	Practical	Theory	Practical	Total
ITDO6012	Image Processing	03	--	03	--	03

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test1	Test 2	Avg.					
ITDO6012	Image Processing	20	20	20	80	--	--	--	100

Course Objectives:

Sr. No.	Course Objectives
The course aims:	
1	Define image and its formation and debate about the roles of image processing in today's world and also introduce students to the major research domains in the field of image processing.
2	Describe point, mask and histogram processing units of image enhancements that can be applied on a given image for improving the quality of digital image required for an application.
3	Explain the forward and reverse discrete image transforms and discuss the selection of the image transform used for enhancement, compression, or representation and description.
4	Make students understand the impacts and effects of image compression techniques over a given bandwidth to learn how effectively storage and retrieval can be achieved using lossy and lossless compression methods.
5	Describe and demonstrate the proper procedure for segmenting images, and demonstrate how the image object can be described using image representation techniques.
6	Illustrate how to shape and reshape a given object in an image using morphological techniques over binary and gray scale images.

Course Outcomes:

Sr. No.	Course Outcomes	Cognitive levels of attainment as per Bloom's Taxonomy
On successful completion, of course, learner/student will be able to:		
1	Define image and explain formation of image and recall its types and calculate image parameters by reading images using a programming language.	L1
2	Apply and differentiate point, mask and histogram processing techniques suitable for enhancing images required for an application.	L1,L2,L3
3	List and calculate discrete image transform coefficients and use it for enhancement, compression and representation.	L1,L2, L3
4	Compute compression ratio and fidelity criteria to evaluate and compare method efficiency and classify compression techniques into lossless and lossy methods.	L1,L2,L3, L4
5	Apply the segmentation techniques to highlight and select the region of interest and determine and describe using chain code, shape number and moments for representing objects in an image.	L1,L2,L3

6	Choose structuring elements and apply morphological operations to find a suitable shape for an object in the image.	L1,L2,L3

Prerequisite: Digital Signal Processing.

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours	CO Mapping
0	Prerequisite	Digital Signal Processing, Matrix Multiplication.	**01**	
I	Introduction to Image Processing	**Image Fundamentals:** Image Definition, Steps and Components of Image Processing, Image Sensing and Acquisition, Image Sampling and Quantization. **Relationship Between Pixels:** Adjacency, Connectivity and Distance. **Self-Learning Topics:** Different Image File Formats and Types of noise in image.	**04**	CO1
II	Image Enhancement	**Point Processing Techniques**: Image Negative, Bit Plane Slicing, Gray Level Slicing, Contrast Stretching, Clipping, Thresholding, Dynamic Range Compression. **Mask Processing Techniques:** Filtering in Spatial Domain, Average Filter, Weighted Average Filter, Order Statistic Filter: Min, Max, Median Filter. **Histogram Processing:** Histogram Equalization and Specification. **Self-Learning Topics:** Application of Image Enhancement in Spatial Domain.	**08**	CO2
III	Image Transforms	**Discrete Fourier Transform:** Transform Pair, Transform Matrix, Properties, Filtering in Frequency Domain. **Other Discrete Transforms:** Discrete Cosine Transform, Discrete Hadamard Transform, Discrete Walsh, Transform, Discrete Haar Transform. **Self-Learning Topics:** Application of Transforms in Steganography and CBIR.	**07**	CO3
IV	Image Compression	Entropy, Redundancy and Types, Compression Ratio, Compression Methods. **Lossless Compression:** Run-Length Encoding, Huffman Coding, Arithmetic Coding, LZW Coding, Lossless Predictive coding. **Lossy Compression**: Fidelity Criterion, Improved Gray scale Quantization**,** Symbol-Based Coding, Bit-Plane Coding, Vector Quantization. **Self-Learning Topics:** DPCM, Block Transform Coding, JPEG compression.	**07**	CO4
V	Image Segmentation and Representation	**Image Segmentation:** Point, Line and Edge Detections Methods, Hough Transform, Graph Theoretic Method, Region Based Segmentation.	**07**	CO5

		Image Representation: Chain Codes, Shape Number, Polygon Approximation, Statistical Moments. **Self-Learning Topics:** Fourier Descriptors, Otsu Thresholding, Application in Number Plate Recognition.		
VI	Morphological Image Processing	**Basic Morphological Methods:** Erosion, Dilation, Opening, Closing, Hit-or-Miss Transformation. **Advanced Morphological Methods:** Skeletonization, Thinning, Thickening, Pruning, Boundary Extraction. **Self-Learning Topics:** Gray Scale Morphology: Erosion and Dilation.	**05**	CO6

Text Books:

1. Rafael C. Gonzalez and Richard E. Woods, "Digital Image Processing", Addison - Wesley Publishing Company, 3e, 2007.
2. William K. Pratt, "Digital Image Processing", John Wiley, 4e, 2007.
3. S. Jayaraman, S. Esakkirajan and T. Veerakumar, "Digital Image Processing", MGH Publication, 2016.

References:

1. Rafael C. Gonzalez and Richard E. Woods, "Digital Image Processing using MATLAB," Pearson Education.
2. J. G. Proakis and D. G. Manolakis, "Digital Signal processing Principles, Algorithms and Applications," PHI Publications, 3e.
3. Anil K. Jain, "Fundamentals of Digital Image Processing," PHI, 1995.
4. Milan Sonka, "Digital Image Processing and Computer Vision," Thomson publication, Second Edition.2007.
5. Kenneth R. Castleman, "Digital Image Processing," PHI, 1996.
6. S. Sridhar, "Digital Image Processing," Oxford University Press, 2e, 2016.

Assessment:

Internal Assessment (IA) for 20 marks:

- IA will consist of Two Compulsory Internal Assessment Tests. Approximately 40% to 50% of syllabus content must be covered in First IA Test and remaining 40% to 50% of syllabus content must be covered in Second IA Test

- **Question paper format**

  - Question Paper will comprise of a total of **six questions each carrying 20 marksQ.1** will be **compulsory** and should **cover maximum contents of the syllabus**

  - **Remaining questions** will be **mixed in nature** (part (a) and part (b) of each question must be from different modules. For example, if Q.2 has part (a) from Module 3 then part (b) must be from any other Module randomly selected from all the modules)

  - A total of **four questions** need to be answered

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		
		Theory	Practical	Theory	Practical	Total
ITDO6013	Green IT	03	--	03	--	03

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test1	Test 2	Avg.					
ITDO6013	Green IT	20	20	20	80	--	--	--	100

Course Objectives:

Sr. No.	Course Objectives
The course aims:	
1	To understand what Green IT is and How it can help improve environmental Sustainability
2	To understand the principles and practices of Green IT.
3	To understand how Green IT is adopted or deployed in enterprises.
4	To understand how data centres, cloud computing, storage systems, software and networks can be made greener.
5	To measure the Maturity of Sustainable ICT world.
6	To implement the concept of Green IT in Information Assurance in Communication and Social Media and all other commercial field.

Course Outcomes:

Sr. No.	Course Outcomes	Cognitive levels of attainment as per Bloom's Taxonomy
On successful completion, of course, learner/student will be able to:		
1	Describe awareness among stakeholders and promote green agenda and green initiatives in their working environments leading to green movement	L1
2	Identify IT Infrastructure Management and Green Data Centre Metrics for software development	L1,L2
3	Recognize Objectives of Green Network Protocols for Data communication.	L1,L2
4	Use Green IT Strategies and metrics for ICT development.	L1,L2,L3
5	Illustrate various green IT services and its roles.	L1,L2
6	Use new career opportunities available in IT profession, audits and others with special skills such as energy efficiency, ethical IT assets disposal, carbon footprint estimation, reporting and development of green products, applications and services.	L1,L2,L3

Prerequisite: Environmental Studies

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours	CO Mapping
0	Prerequisite	Environmental Studies	2	
I	Introduction	Environmental Impacts of IT, Holistic Approach to Greening IT, Green IT Standards and Eco-Labeling, Enterprise Green IT Strategy **Hardware:** Life Cycle of a Device or Hardware, Reuse, Recycle and Dispose **Software:** Introduction, Energy-Saving Software Techniques **Self learning Topics:** Evaluating and Measuring Software Impact to Platform Power	7	CO 1
II	Software development and data centers	Sustainable Software, Software Sustainability Attributes, Software Sustainability Metrics Data Centres and Associated Energy Challenges, Data Centre IT Infrastructure, Data Centre Facility Infrastructure: Implications for Energy Efficiency, Green Data Centre Metrics **Self-learning Topics:** Sustainable Software: A Case Study, Data Centre Management Strategies: A Case Study	7	CO 1 CO 2
III	Data storage and communication	Storage Media Power Characteristics, Energy Management Techniques for Hard Disks Objectives of Green Network Protocols, Green Network Protocols and Standards **Self learning Topics:** System-Level Energy Management	6	CO 1 CO 3
IV	Information systems, green it strategy and metrics	Approaching Green IT Strategies, Business Drivers of Green IT Strategy Multilevel Sustainable Information, Sustainability Hierarchy Models, Product Level Information, Individual Level Information, Functional Level Information, Measuring the Maturity of Sustainable ICT: A Capability Maturity Framework for SICT, Defining the Scope and Goal, Capability Maturity Levels **Self learning Topics:** Business Dimensions for Green IT Transformation	6	CO 1 CO 4
V	Green IT services and roles	Factors Driving the Development of Sustainable IT, Sustainable IT Services (SITS), SITS Strategic Framework Organizational and Enterprise Greening, Information Systems in Greening Enterprises, Greening the Enterprise: IT Usage and Hardware **Self learning Topics:** Inter-organizational Enterprise Activities and Green Issues, Enablers and Making the Case for IT and the Green Enterprise	6	CO 1 CO 4 CO 5
VI	Managing and	Strategizing Green Initiatives, Implementation of Green	5	CO 1

	regulating green IT	IT, Communication and Social Media The Regulatory Environment and IT Manufacturers, Nonregulatory Government Initiatives, Industry Associations and Standards Bodies, Green Building Standards, Social Movements and Greenpeace. **Self learning Topics:** Information Assurance, Green Data Centers, Case Study: Managing Green IT		CO 5 CO 6

Text Books:

1. San Murugesan, G. R. Gangadharan, Harnessing Green IT, WILEY 1st Edition-2013
2. Mohammad Dastbaz Colin Pattinson Babak Akhgar, Green Information Technology A Sustainable Approach, Elsevier 2015
3. Reinhold, Carol Baroudi, and Jeffrey HillGreen IT for Dummies, Wiley 2009

References:

1. Mark O'Neil, Green IT for Sustainable Business Practice: An ISEB Foundation Guide, BCS
2. Jae H. Kim, Myung J. Lee Green IT: Technologies and Applications, Springer, ISBN: 978-3-642-22178-1
3. Elizabeth Rogers, Thomas M. Kostigen The Green Book: The Everyday Guide to Saving the Planet One Simple Step at a Time, Springer

Assessment:

Internal Assessment (IA) for 20 marks:

- IA will consist of Two Compulsory Internal Assessment Tests. Approximately 40% to 50% of syllabus content must be covered in First IA Test and remaining 40% to 50% of syllabus content must be covered in Second IA Test

➢ **Question paper format**

- Question Paper will comprise of a total of **six questions each carrying 20 marksQ.1** will be **compulsory** and should **cover maximum contents of the syllabus**
- **Remaining questions** will be **mixed in nature** (part (a) and part (b) of each question must be from different modules. For example, if Q.2 has part (a) from Module 3 then part (b) must be from any other Module randomly selected from all the modules)
- A total of **four questions** need to be answered

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		
		Theory	Practical	Theory	Practical	Total
ITDO6014	Ethical Hacking and Forensics	03	--	03	--	03

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test1	Test 2	Avg.					
ITDO6014	Ethical Hacking and Forensics	20	20	20	80	--	--	--	100

Course Objectives:

Sr. No.	Course Objectives
The course aims:	
1	To understand the concept of cybercrime and principles behind ethical hacking.
2	To explore the fundamentals of digital forensics, digital evidence and incident response.
3	To learn the tools and techniques required for computer forensics.
4	To understand the network attacks and tools and techniques required to perform network forensics.
5	To learn how to investigate attacks on mobile platforms.
6	To generate a forensics report after investigation.

Course Outcomes:

Sr. No.	Course Outcomes	Cognitive levels of attainment as per Bloom's Taxonomy
On successful completion, of course, learner/student will be able to:		
1	Define the concept of ethical hacking.	L1
2	Recognize the need of digital forensics and define the concept of digital evidence and incident response.	L1,L2
3	Apply the knowledge of computer forensics using different tools and techniques.	L1,L2,L3
4	Detect the network attacks and analyze the evidence.	L1, L2,L3,L4
5	Apply the knowledge of computer forensics using different tools and techniques.	L1,L2,L3
6	List the method to generate legal evidence and supporting investigation reports	L1,L2

Prerequisite: Computer Networks, Computer Network Security

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours	CO Mapping
0	Prerequisite	Computer Networks, Computer Network Security	**01**	--
I	**Cybercrime and Ethical Hacking**	Introduction to Cybercrime, Types of Cybercrime, Classification of Cybercriminals, Role of computer in Cybercrime, Prevention of Cybercrime. Ethical Hacking, Goals of Ethical Hacking, Phases of Ethical Hacking, Difference between Hackers, Crackers and Phreakers, Rules of Ethical Hacking. **Self Learning Topics**: exploring various online hacking tools for Reconnaissance and scanning Phase.	**06**	CO1
II	**Digital Forensics Fundamentals**	Introduction to Digital Forensics, Need and Objectives of Digital Forensics, Types of Digital Forensics, Process of Digital Forensics, Benefits of Digital Forensics, Chain of Custody, Anti Forensics. Digital Evidence and its Types, Rules of Digital Evidences. Incident Response, Methodology of Incident Response, Roles of CSIRT in handling incident. **Self Learning Topics:** Pre Incident preparation and Incident Response process	**06**	CO2
III	**Computer Forensics**	Introduction to Computer Forensics, Evidence collection (Disk, Memory, Registry, Logs etc), Evidence Acquisition, Analysis and Examination(Window, Linux, Email, Web, Malware) , Challenges in Computer Forensics, Tools used in Computer Forensics. **Self Learning Topics:** Open source tool for Data collection & analysis in windows or Unix	**08**	CO3
IV	**Network Forensics**	Introduction, Evidence Collection and Acquisition (Wired and Wireless), Analysis of network evidences(IDS, Router,), Challenges in network forensics, Tools used in network forensics. **Self Learning Topics:** IDS types and role of IDS in attack prevention	**08**	CO4
V	**Mobile Forensics**	Introduction, Evidence Collection and Acquisition, Analysis of Evidences, Challenges in mobile forensics, Tools used in mobile forensics **Self Learning Topics**: Tools / Techniques used in mobile forensics	**06**	CO5
VI	**Report Generation**	Goals of Report, Layout of an Investigative Report, Guidelines for Writing a Report, sample for writing a forensic report. **Self Learning Topics**: For an incident write a forensic report.	**04**	CO6

Text Books:

1. John Sammons, "The Basics of Digital Forensics: The Premier for Getting Started in Digital Forensics", 2nd Edition, Syngress, 2015.
2. Nilakshi Jain, Dhananjay Kalbande, "Digital Forensic: The fascinating world of Digital Evidences" Wiley India Pvt Ltd 2017.
3. Jason Luttgens, Matthew Pepe, Kevin Mandia, "Incident Response and computer forensics",3rd Edition Tata McGraw Hill, 2014.

References:

1. Sangita Chaudhuri, Madhumita Chatterjee, "Digital Forensics", Staredu, 2019.
2. Bill Nelson,Amelia Phillips,Christopher Steuart, "Guide to Computer Forensics and Investigations" Cengage Learning, 2014.
3. Debra Littlejohn Shinder Michael Cross "Scene of the Cybercrime: Computer Forensics Handbook", 2nd Edition Syngress Publishing, Inc.2008.

Assessment:
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- IA will consist of Two Compulsory Internal Assessment Tests. Approximately 40% to 50% of syllabus content must be covered in First IA Test and remaining 40% to 50% of syllabus content must be covered in Second IA Test

➢ **Question paper format**

- Question Paper will comprise of a total of **six questions each carrying 20 marksQ.1** will be **compulsory** and should **cover maximum contents of the syllabus**
- **Remaining questions** will be **mixed in nature** (part (a) and part (b) of each question must be from different modules. For example, if Q.2 has part (a) from Module 3 then part (b) must be from any other Module randomly selected from all the modules)
- A total of **four questions** need to be answered

AC:

Item No. :

UNIVERSITY OF MUMBAI

Bachelor of Engineering

in

Information Technology

Final Year with Effect from AY 2022-23

(REV- 2019 'C' Scheme) from Academic Year 2019 – 20

Under

FACULTY OF SCIENCE & TECHNOLOGY

(As per AICTE guidelines with effect from the academic year 2019–2020)

AC:
Item No.

UNIVERSITY OF MUMBAI

Syllabus for Approval

Sr. No.	Heading	Particulars
1	Title of the Course	**Final Year Bachelor of Information Technology**
2	Eligibility for Admission	**After Passing Third Year Engineering as per the Ordinance 0.6243**
3	Passing Marks	**40%**
4	Ordinances / Regulations (if any)	**Ordinance 0.6243**
5	No. of Years / Semesters	**8 semesters**
6	Level	**Under Graduation**
7	Pattern	**Semester**
8	Status	**Revised**
9	To be implemented from Academic Year	**With effect from Academic Year: 2022-2023**

Date :

Dr. S. K. Ukarande
Associate Dean
Faculty of Science and Technology
University of Mumbai

Dr Anuradha Muzumdar
Dean
Faculty of Science and Technology
University of Mumbai

Preamble

To meet the challenge of ensuring excellence in engineering education, the issue of quality needs to be addressed, debated and taken forward in a systematic manner. Accreditation is the principal means of quality assurance in higher education. The major emphasis of accreditation process is to measure the outcomes of the program that is being accredited. In line with this Faculty of Science and Technology (in particular Engineering)of University of Mumbai has taken a lead in incorporating philosophy of outcome based education in the process of curriculum development.

Faculty resolved that course objectives and course outcomes are to be clearly defined for each course, so that all faculty members in affiliated institutes understand the depth and approach of course to be taught, which will enhance learner's learning process. Choice based Credit and grading system enables a much-required shift in focus from teacher-centric to learner-centric education since the workload estimated is based on the investment of time in learning and not in teaching. It also focuses on continuous evaluation which will enhance the quality of education. Credit assignment for courses is based on 15 weeks teaching learning process, however content of courses is to be taught in 13 weeks and remaining 2 weeks to be utilized for revision, guest lectures, coverage of content beyond syllabus etc.

There was a concern that the earlier revised curriculum more focused on providing information and knowledge across various domains of the said program, which led to heavily loading of students in terms of direct contact hours. In this regard, faculty of science and technology resolved that to minimize the burden of contact hours, total credits of entire program will be of 170, wherein focus is not only on providing knowledge but also on building skills, attitude and self learning. Therefore in the present curriculum skill based laboratories and mini projects are made mandatory across all disciplines of engineering in second and third year of programs, which will definitely facilitate self learning of students. The overall credits and approach of curriculum proposed in the present revision is in line with AICTE model curriculum.

The present curriculum will be implemented for Second Year of Engineering from the academic year 2020-21. Subsequently this will be carried forward for Third Year and Final Year Engineering in the academic years 2021-22, 2022-23, respectively.

Dr. S. K. Ukarande
Associate Dean
Faculty of Science and Technology
University of Mumbai

Dr. Anuradha Muzumdar
Dean
Faculty of Science and Technology
University of Mumbai

Incorporation and Implementation of Online Contents from NPTEL/ Swayam Platform

The curriculum revision is mainly focused on knowledge component, skill based activities and project based activities. Self learning opportunities are provided to learners. In the revision process this time in particular Revised syllabus of 'C ' scheme wherever possible additional resource links of platforms such as NPTEL, Swayam are appropriately provided. In an earlier revision of curriculum in the year 2012 and 2016 in Revised scheme 'A' and 'B' respectively, efforts were made to use online contents more appropriately as additional learning materials to enhance learning of students.

In the current revision based on the recommendation of AICTE model curriculum overall credits are reduced to 171, to provide opportunity of self learning to learner. Learners are now getting sufficient time for self learning either through online courses or additional projects for enhancing their knowledge and skill sets.

The Principals/ HoD's/ Faculties of all the institute are required to motivate and encourage learners to use additional online resources available on platforms such as NPTEL/ Swayam. Learners can be advised to take up online courses, on successful completion they are required to submit certification for the same. This will definitely help learners to facilitate their enhanced learning based on their interest.

Dr. S. K. Ukarande
Associate Dean
Faculty of Science and Technology
University of Mumbai

Dr Anuradha Muzumdar
Dean
Faculty of Science and Technology
University of Mumbai

Preface By Board of Studies Team

It is our honor and a privilege to present the Rev-2019 'C' scheme syllabus of Bachelor of Engineering in Information Technology (effective from year 2019-20) with inclusion of cutting edge technology. Information Technology is comparatively a young branch among other engineering disciplines in the University of Mumbai. It is evident from the placement statistics of various colleges affiliated to the University of Mumbai that IT branch has taken the lead in the placement.

The branch also provides multi-faceted scope like better placement and promotion of entrepreneurship culture among students, and increased Industry Institute Interactions. Industries views are considered as stakeholders will design of the syllabus of Information Technology. As per Industries views only 16 % graduates are directly employable. One of the reasons is a syllabus which is not in line with the latest technologies. Our team of faculties has tried to include all the latest technologies in the syllabus. Also first time we are giving skill-based labs and Mini-project to students from third semester onwards which will help students to work on latest IT technologies. Also the first time we are giving the choice of elective from fifth semester such that students will be master in one of the IT domain. The syllabus is peer reviewed by experts from reputed industries and as per their suggestions it covers future trends in IT technology and research opportunities available due to these trends.

We would like to thank senior faculties of IT department of all colleges affiliated to University of Mumbai for significant contribution in framing the syllabus. Also on behalf of all faculties we thank all the industry experts for their valuable feedback and suggestions. We sincerely hope that the revised syllabus will help all graduate engineers to face the future challenges in the field of information and technology

Program Specific Outcome for graduate Program in Information Technology

1. Apply Core Information Technology knowledge to develop stable and secure IT system.
2. Design, IT infrastructures for an enterprise using concepts of best practices in information Technology and security domain.
3. Ability to work in multidisciplinary projects and make it IT enabled.
4. Ability to adapt latest trends and technologies like **A**nalytics, **B**lockchain, **C**loud, **D**ata science.

Board of Studies in Information Technology - Team
Dr. Deven Shah (Chairman)
Dr. Lata Ragha (Member)
Dr. Vaishali D. Khairnar (Member)
Dr. Sharvari Govilkar (Member)
Dr. Sunil B. Wankhade (Member)
Dr. Anil Kale (Member)
Dr. Vaibhav Narwade (Member)
Dr. GV Choudhary (Member)

Ad-hoc Board Information Technology
University of Mumbai

Program Structure for Fourth Year Information Technology
Semester VII & VIII
UNIVERSITY OFMUMBAI
(With Effect from2022-2023)

Semester VII

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		
		Theory	Pract. Tut.	Theory	Pract.	Total
ITC701	AI and DS –II	3	--	3	--	3
ITC702	Internet of Everything	3	--	3		3
ITDO701X	**Department Optional Course – 3**	**3**	**--**	**3**	**--**	**3**
ITDO702X	**Department Optional Course –4**	**3**	**--**	**3**	**--**	**3**
ITIO701X	**Institute Optional Course – 1**	**3**	**--**	**3**	**--**	**3**
ITL701	Data Science Lab	--	2	--	1	1
ITL702	IOE Lab	--	2	--	1	1
ITL703	Secure Application Development	--	2	--	1	1
ITL704	Recent Open Source Project Lab	--	2	--	1	1
ITP701	Major Project I	--	6#	--	3	3
Total		**15**	**14**	**15**	**7**	**22**

Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Prac/oral	Total
		Internal Assessment			End Sem Exam	Exam. Duration (in Hrs)			
		Test1	Test2	Avg					
ITC701	AI and DS –II	20	20	20	80	3	--	--	100
ITC702	Internet of Everything	20	20	20	80	3	--	--	100
ITDO701X	**Department Optional Course –3**	**20**	**20**	**20**	**80**	**3**	**--**	**--**	**100**
ITDO702X	**Department Optional Course –4**	**20**	**20**	**20**	**80**	**3**	**--**	**--**	**100**
ILO701X	**Institute Optional Course – 1**	**20**	**20**	**20**	**80**	**3**	**--**	**--**	**100**
ITL701	Data Science Lab	--	--	--	--	--	25	25	50
ITL702	IOE Lab	--	--	--	--	--	25	25	50
ITL703	Secure Application Development	--	--	--	--	--	25	25	50
ITL704	Recent Open Source Project Lab	--	--	--	--	--	25	25	50
ITP701	Major Project I	--	--	--	--	--	25	25	50
Total		**--**	**--**	**100**	**400**	**--**	**125**	**125**	**750**

# indicates work load of Learner (Not Faculty), for Major Project

ITDO701X	Department Optional Course –3
ITDO7011	Storage Area Network
ITDO7012	High Performance computing
ITDO7013	Infrastructure Security
ITDO7014	Software Testing and QA

ITDO702X	Department Optional Course –4
ITDO7021	MANET
ITDO7022	AR – VR
ITDO7023	Quantum Computing
ITDO7024	Information Retrieval System

 # Institute Level Optional Course (ILO)

Every student is required to take one Institute Elective Course for Semester VII, which is not closely allied to their disciplines. Different sets of courses will run in the both the semesters.

ILO701X	Institute Optional Course – 1 (Common for all branches will be notified)
ILO7011	Product Lifecycle Management
ILO7012	Reliability Engineering
ILO7013	Management Information System
ILO7014	Design of Experiments
ILO7015	Operation Research
ILO7016	Cyber Security and Laws
ILO7017	Disaster Management and Mitigation Measures
ILO7018	Energy Audit and Management
ILO7019	Development Engineering

Program Structure for Fourth Year Information Technology Semester VII & VIII
UNIVERSITY OFMUMBAI
(With Effect from2022-2023)

Semester VIII

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		
		Theory	Pract. Tut.	Theory	Pract.	Total
ITC801	Blockchain and DLT	3	--	3	--	3
ITDO801X	**Department Optional Course – 5**	**3**	**--**	**3**	**--**	**3**
ITDO802X	**Department Optional Course – 6**	**3**	**--**	**3**	**--**	**3**
ITIO801X	**Institute Optional Course – 2**	**3**	**--**	**3**	**--**	**3**
ITL801	Blockchain Lab	--	2	--	1	1
ITL802	Cloud computing	--	2	--	1	1
ITP801	Major Project II	--	12#	--	6	6
Total		**12**	**16**	**12**	**8**	**20**

Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Prac /oral	Total
		Internal Assessment			End Sem Exam	Exam. Duration (in Hrs)			
		Test1	Test2	Avg					
ITC801	Blockchain and DLT	20	20	20	80	3	--	--	100
ITDO801X	**Department Optional Course – 5**	**20**	**20**	**20**	**80**	**3**	**--**	**--**	**100**
ITDO802X	**Department Optional Course – 6**	**20**	**20**	**20**	**80**	**3**	**--**	**--**	**100**
ILO801X	**Institute Optional Course – 2**	**20**	**20**	**20**	**80**	**3**	**--**	**--**	**100**
ITL801	Blockchain Lab	--	--	--	--	--	25	25	50
ITL802	Cloud computing	--	--	--	--	--	25	25	50
ITP801	Major Project II	--	--	--	--	--	100	50	150
Total		**--**	**--**	**80**	**320**	**--**	**150**	**100**	**650**

# indicates work load of Learner (Not Faculty), for Major Project

Students group and load of faculty per week.

Mini Project 1 and 2 :
Students can form groups with minimum 2 (Two) and not more than 4 (Four)
Faculty Load : 1 hour per week per four groups

Major Project 1 and 2 :
Students can form groups with minimum 2 (Two) and not more than 4 (Four)
Faculty Load : In Semester VII – ½ hour per week per project group
In Semester VIII – 1 hour per week per project group

ITDO801X	Department Optional Course – 5
ITDO8011	Big Data Analytics
ITDO8012	Reinforcement learning
ITDO8013	Simulation and Modeling
ITDO8014	Knowledge management

ITDO802X	Department Optional Course –6
ITDO8021	User Interface Design
ITDO8022	Robotics
ITDO8023	ERP
ITDO8024	Cloud computing and Services

 # Institute Level Optional Course (ILO)

Every student is required to take one Institute Elective Course for Semester VIII, which is not closely allied to their disciplines. Different sets of courses will run in the both the semesters.

ILO801X	Institute Optional Course – 2 (Common for all branches will be notified)
ILO8011	Project Management
ILO8012	Finance Management
ILO8013	Entrepreneurship Development and Management
ILO8014	Human Resource Management
ILO8015	Professional Ethics and CSR
ILO8016	Research Methodology
ILO8017	IPR and Patenting
ILO8018	Digital Business Management
ILO8019	Environmental Management

Program Structure for Fourth Year Information Technology
Semester VII & VIII
UNIVERSITY OFMUMBAI
(With Effect from2022-2023)

Semester VII

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		
		Theory	Pract. Tut.	Theory	Pract.	Total
ITC701	AI and DS –II	3	--	3	--	3
ITC702	Internet of Everything	3	--	3		3
ITDO701X	**Department Optional Course – 3**	**3**	**--**	**3**	**--**	**3**
ITDO702X	**Department Optional Course –4**	**3**	**--**	**3**	**--**	**3**
ITIO701X	**Institute Optional Course – 1**	**3**	**--**	**3**	**--**	**3**
ITL701	Data Science Lab	--	2	--	1	1
ITL702	IOE Lab	--	2	--	1	1
ITL703	Secure Application Development	--	2	--	1	1
ITL704	Recent Open Source Project Lab	--	2	--	1	1
ITP701	Major Project I	--	6#	--	3	3
Total		**15**	**14**	**15**	**7**	**22**

Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Prac/oral	Total
		Internal Assessment			End Sem Exam	Exam. Duration (in Hrs)			
		Test1	Test2	Avg					
ITC701	AI and DS –II	20	20	20	80	3	--	--	100
ITC702	Internet of Everything	20	20	20	80	3	--	--	100
ITDO701X	**Department Optional Course –3**	**20**	**20**	**20**	**80**	**3**	**--**	**--**	**100**
ITDO702X	**Department Optional Course –4**	**20**	**20**	**20**	**80**	**3**	**--**	**--**	**100**
ITIO701X	**Institute Optional Course – 1**	**20**	**20**	**20**	**80**	**3**	**--**	**--**	**100**
ITL701	Data Science Lab	--	--	--	--	--	25	25	50
ITL702	IOE Lab	--	--	--	--	--	25	25	50
ITL703	Secure Application Development	--	--	--	--	--	25	25	50
ITL704	Recent Open Source Project Lab	--	--	--	--	--	25	25	50
ITP701	Major Project I	--	--	--	--	--	25	25	50
Total		**--**	**--**	**100**	**400**	**--**	**125**	**125**	**750**

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ITDO7022	AR – VR
ITDO7023	Quantum Computing
ITDO7024	Information Retrieval System

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ILO7012	Reliability Engineering
ILO7013	Management Information System
ILO7014	Design of Experiments
ILO7015	Operation Research
ILO7016	Cyber Security and Laws
ILO7017	Disaster Management and Mitigation Measures
ILO7018	Energy Audit and Management
ILO7019	Development Engineering

Course Code	Course Name	Theory	Practical	Tutorial	Theory	Practical/ Oral	Tutorial	Total
ITC701	AI and DS –II	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test1	Test 2	Avg. of 2 Tests					
ITC701	AI and DS – II	20	20	20	80	--	--	--	100

Course Objectives:

Sr. No.	Course Objectives
The course aims:	
1	To model a decision making for a new problem in an uncertain domain.
2	To demonstrate Cognitive skills of Artificial Intelligence.
3	To become familiar with the basics of Fuzzy Logic and Fuzzy Systems.
4	To become familiar with Deep Learning Concepts and Architectures.
5	To define and apply metrics to measure the performance of various learning algorithms.
6	To enable students to analyze data science methods for real world problems.

Course Outcomes:

Sr. No.	Course Outcomes	Cognitive levels of attainment as per Bloom's Taxonomy
On successful completion, of course, learner/student will be able to:		
1	Design models for reasoning with uncertainty as well as the use of unreliable information.	L1,L2,L3
2	Analyze the process of building a Cognitive application.	L1,L2,L3,L4
3	Design fuzzy controller system.	L1,L2,L3
4	Apply learning concepts to develop real life applications.	L1,L2,L3
5	Evaluate performance of learning algorithms.	L1,L2,L3,L4,L5
6	Analyze current trends in Data Science.	L1,L2,L3,L4

Prerequisite: AI and DS - 1 (ITC604) , Data Mining & Business Intelligence (ITC601)

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours	CO Mapping

0	Prerequisite	Intelligent Agents, Search Techniques, Knowledge and Reasoning, Data Science, Machine Learning.	**02**	--
I	Uncertainty	Uncertainty in AI, Inference using full joint distributions, Bayes Theorem, the semantics of Bayesian Networks, Inference in Bayesian networks, Decision Theory, Markov Decision Processes. **Self-learning Topics:** Hidden Markov Model (HMM), Gaussian Mixture Model (GMM).	**04**	CO1
II	Cognitive Computing	Foundation of Cognitive Computing, Design Principles for Cognitive Systems, Natural Language Processing in Support of a Cognitive System, Representing Knowledge in Taxonomies and Ontologies, Applying Advanced Analytics to Cognitive Computing, The Process of Building a Cognitive Application. **Self-learning Topics:** Cognitive Systems such as IBM's Watson.	**06**	CO2
III	Fuzzy Logic & Its Applications	Introduction to Fuzzy Sets, Properties of Fuzzy Sets, Operations on Fuzzy Sets, Fuzzy Membership Functions, Fuzzy Relations with Operations and its Properties, Fuzzy Composition: Max-Min Composition, Max-Product Composition, Defuzzification Methods, Architecture of Mamdani Type Fuzzy Control System, Design of Fuzzy Controllers like Domestic Shower Controller, Washing Machine Controller, Water Purifier Controller, etc. **Self-learning Topics:** Other Fuzzy Composition Operations, Fuzzy Inference System (FIS) & ANFIS.	**07**	CO3
IV	Introduction to Deep Learning	Introduction to Deep Learning, ANN, Machine Learning Vs Deep Learning, Working of Deep Learning; Convolutional Neural Network: Introduction, Components of CNN Architecture, Properties of CNN, Architectures of CNN, Applications of CNN, Recurrent Neural Network: Introduction, Simple RNN, LSTM Implementation, Deep RNN, Autoencoder: Introduction, Features, Types, Applications of Deep Learning. **Self-learning Topics:** Restricted Boltzmann Machine (RBM).	**08**	CO4
V	Advanced ML Classification Techniques	Ensemble Classifiers: Introduction to Ensemble Methods, Bagging, Boosting, Random forests, Improving classification accuracy of Class-Imbalanced Data. Metrics for Evaluating Classifier Performance, Holdout Method and Random Subsampling, Cross-Validation, Bootstrap, Model Selection Using Statistical Tests of Significance, Comparing Classifiers Based on Cost–Benefit and ROC Curves. **Self-learning Topics:** Introduction to ML (Revision),	**06**	CO4 CO5

		Introduction to Reinforcement Learning.		
VI	Trends and applications in Data Science	Data Science: applications and case studies, Data science for text, image, video, audio. Data science for Multimodal applications. **Self-learning Topics:** ImageNet Large Scale Visual Recognition Challenge (ILSVRC).	**06**	CO6

Text Books:

1. Stuart Russell and Peter Norvig, "Artificial Intelligence: A Modern Approach", Third Edition, Pearson Education.
2. Judith S. Hurwitz, Marcia Kaufman, Adrian Bowles, "Cognitive Computing and Big Data Analytics", Wiley India, 2015.
3. S.N. Sivanandam, S.N. Deepa, "Principles of Soft Computing", Wiley Publication.
4. Dr. S Lovelyn Rose, Dr. L Ashok Kumar, Dr. D Karthika Renuka, "Deep Learning Using Python", Wiley India, 2020.
5. B. Uma Maheshwari, R. Sujatha, "Introduction to Data Science Practical Approach with R and Python", Wiley India, 2021.
6. François Chollet, "Deep Learning with Python", Manning Publications, 2018.
7. Han J, Kamber M, Pei J, "Data Mining Concepts and Techniques", Third Edition, Morgan Kaufmann.

References:

1. Deepak Khemani, "A First Course in Artificial Intelligence", McGraw Hill Publication.
2. Ethem Alpaydin , "Introduction to Machine Learning", PHI Learning Pvt. Ltd.
3. Jon Krohn, Grant Beyleveld, Aglae Bassens, "Deep Learning Illustrated: A Visual, Interactive Guide to Artificial Intelligence", Pearson Education.
4. Prateek Joshi, "Artificial Intelligence with Python", Packt Publishing.

Online References:

Sr. No.	Website Links
1	https://d2l.ai/index.html
2	https://onlinecourses.nptel.ac.in/noc20_cs62/preview
3	https://onlinecourses.nptel.ac.in/noc22_cs35/preview
4	https://www.coursera.org/specializations/deep-learning
5	https://onlinecourses.nptel.ac.in/noc22_cs56/preview

Assessment:

Internal Assessment for 20 marks:

Consisting of **Two Compulsory Class Tests**

Approximately 40% to 50% of syllabus content must be covered in First test and remaining 40% to 50% of syllabus contents must be covered in second test.

End Semester Examination: Some guidelines for setting the question papers are as:

- Weightage of each module in end semester examination is expected to be/will be proportional to number of respective lecture hours mentioned in the syllabus.
- Question paper will comprise of total **six questions, each carrying 20 marks**.
- **Q.1** will be **compulsory** and should **cover maximum contents of the syllabus**.
- **Remaining question will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any other module. (Randomly selected from all the modules.)

- Total **four questions** need to be solved.

Course Code	Course Name	Theory	Practical	Tutorial	Theory	Practical/ Oral	Tutorial	Total
ITC702	Internet of Everything	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test1	Test 2	Avg. of 2 Tests					
ITC702	Internet of Everything	20	20	20	80	--	--	--	100

Course Objectives:

Sr. No.	Course Objectives
The course aims:	
1	To comprehend Characteristics and Conceptual Framework of IoT.
2	To understand levels of the IoT architectures.
3	To correlate the connection of smart objects and IoT access technologies.
4	To Interpret edge to cloud protocols.
5	To explore data analytics and data visualization on IoT Data.
6	To explore IoT applications.

Course Outcomes:

Sr. No.	Course Outcomes	Cognitive levels of attainment as per Bloom's Taxonomy
On successful completion, of course, learner/student will be able to:		
1	Describe the Characteristics and Conceptual Framework of IoT.	L1,L2
2	Differentiate between the levels of the IoT architectures.	L1,L2,L3,L4
3	Analyze the IoT access technologies.	L1,L2,L3,L4
4	Illustrate various edge to cloud protocol for IoT.	L1,L2,L3
5	Apply IoT analytics and data visualization.	L1,L2,L3
6	Analyze and evaluate IoT applications.	L1,L2,L3,L4

Prerequisite:

1. Python programming
2. C programing language
3. Computer Networks

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours	CO Mapping
0	Prerequisite	Ports, Timers ,Programming of controller , How to use IDE to write code of microcontroller, TCP-IP protocol stack	**02**	
I	Introduction to IoT	Introduction to IoT- Defining IoT, Characteristics of IoT, Conceptual Framework of IoT, Physical design of IoT, Logical design of IoT, Functional blocks of IoT, Brief review of applications of IoT. Smart Object – Definition, Characteristics and Trends **Self-learning Topics:** Hardware and software development tools for - Arduino, NodeMCU, ESP32, Raspberry Pi, for implementing internet of things, Simulators-Circuit.io,Eagle,Tinkercad	**04**	CO1
II	IoT Architecture	**Drivers Behind New Network Architectures** : Scale,Security,Constrained Devices and Networks ,Data,Legacy Device Support **Architecture :** The IoT World Forum (IoTWF) Standardized Architecture :Layer 1-7, IT and OT Responsibilities in the IoT Reference Model,Additional IoT Reference Models A Simplified IoT Architecture The Core IoT Functional Stack ::Layer 1-3 , Analytics Versus Control Applications , Data Versus Network Analytics Data Analytics Versus Business Benefits , Smart Services, **IoT Data Management and Compute Stack** :Fog Computing , Edge Computing ,The Hierarchy of Edge, Fog, and Cloud **Self-learning Topics:** Brief review of applications of IoT: Connected Roadways , Connected Factory, Smart Connected Buildings , Smart Creatures etc,	**06**	CO2
III	Principles of Connected Devices and Protocols in IoT	RFID and NFC (Near-Field Communication), Bluetooth Low Energy (BLE) roles, LiFi , WPAN std : 802.15 standards: Bluetooth, IEEE 802.15.4, Zigbee, Z-wave, Narrow Band IoT, Internet Protocol and Transmission Control Protocol, 6LoWPAN, WLAN and WAN , IEEE 802.11, Long-range Communication Systems and Protocols: Cellular Connectivity-LTE, LTE-A, LoRa and LoRaWAN.	**08**	CO3
IV	Edge to Cloud Protocol	HTTP, WebSocket, Platforms. HTTP - MQTT - .Complex Flows: IoT Patterns: Real-time Clients, MQTT, MQTT-SN, Constrained Application Protocol (CoAP), Streaming Text Oriented Message Protocol (STOMP), Advanced Message Queuing Protocol (AMQP), Comparison of Protocols.	**08**	CO4
V	IoT and Data Analytics	Defining IoT Analytics, IoT Analytics challenges, IoT analytics for the cloud, Strategies to organize Data for IoT Analytics, Linked Analytics Data Sets,	**06**	CO5

		Managing Data lakes, The data retention strategy, visualization and Dashboarding-Designing visual analysis for IoT data, creating a dashboard ,creating and visualizing alerts. **Self-learning Topics:** AWS and Hadoop Technology		
VI	IoT Application Design	Prototyping for IoT and M2M, Case study related to : Home Automation (Smart lighting, Home intrusion detection), Cities (Smart Parking), Environment (Weather monitoring, weather reporting Bot, Air pollution monitoring, Forest fire detection, Agriculture (Smart irrigation), Smart Library. Introduction to I-IoT, Use cases of the I-IoT,IoT and I-IoT – similarities and differences, Introduction to Internet of Behavior (IoB). **Self-learning Topics:** Internet of Behaviors (IoB) and its role in customer services	**04**	CO6

Text Book

1.Arsheep Bahga (Author), Vijay Madisetti, Internet Of Things: A Hands-On Approach Paperback, Universities Press, Reprint 2020
2.David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Robert Barton, Jerome Henry, IoT Fundamentals Networking Technologies, Protocols, and Use Cases for the Internet of Things CISCO.
3.Analytics for the Internet of Things (IoT) Intelligent Analytics for Your Intelligent Devices.Andrew Minteer,Packet
4.Giacomo Veneri , Antonio Capasso," Hands-On Industrial Internet of Things: Create a powerful Industrial IoT infrastructure using Industry 4.0", Packt

References:

1. Pethuru Raj, Anupama C. Raman, The Internet of Things: Enabling Technologies, Platforms, and Use Cases by , CRC press,
2. Raj Kamal, Internet of Things, Architecture and Design Principles, McGraw Hill Education, Reprint 2018.
3. Perry Lea, Internet of Things for Architects: Architecting IoT solutions by implementing sensors, communication infrastructure, edge computing, analytics, and security, Packt Publications, Reprint 2018.
4. Amita Kapoor, "Hands on Artificial intelligence for IoT", 1st Edition, Packt Publishing, 2019.
5. Sheng-Lung Peng, Souvik Pal, Lianfen Huang Editors: Principles of Internet of Things (IoT)Ecosystem:Insight Paradigm, Springer

Online Resources:

Sr. No.	Website Name
1.	https://owasp.org/www-project-internet-of-things/
2.	NPTEL: Sudip Misra, IIT Khargpur, Introduction to IoT: Part-1, https://nptel.ac.in/courses/106/105/106105166/
3.	NPTEL: Prof. Prabhakar, IISc Bangalore, Design for Internet of Things, https://onlinecourses.nptel.ac.in/noc21_ee85/preview
4.	Mohd Javaid, Abid Haleem, Ravi Pratap Singh, Shanay Rab, Rajiv Suman,Internet of Behaviors (IoB) and its role in customer services,Sensors International,Volume 2,2021,100122,ISSN 2666-3511,https://doi.org/10.1016/j.sintl.2021.100122

Assessment:

Internal Assessment (IA) for 20 marks:

- IA will consist of Two Compulsory Internal Assessment Tests. Approximately 40% to 50% of syllabus content must be covered in First IA Test and remaining 40% to 50% of syllabus content must be covered in Second IA Test

➢ **Question paper format**

- Question Paper will comprise of a total of **six questions each carrying 20 marks Q.1** will be **compulsory** and should **cover maximum contents of the syllabus**

- **Remaining questions** will be **mixed in nature** (part (a) and part (b) of each question must be from different modules. For example, if Q.2 has part (a) from Module 3 then part (b) must be from any other Module randomly selected from all the modules)

- A total of **four questions** need to be answered.

		Teaching Scheme (Contact Hours)			Credits Assigned			
Course Code	**Course Name**	**Theory**	**Practical**	**Tutorial**	**Theory**	**Practical & Oral**	**Tutorial**	**Total**
ITL701	Data Science Lab	--	2	--	--	1	--	01

Course Code	**Course Name**	**Examination Scheme**						
		Theory Marks				**Term Work**	**Practical/ Oral**	**Total**
		Internal assessment			**End Sem. Exam**			
		Test1	**Test 2**	**Avg. of 2 Tests**				
ITL701	Data Science Lab	--	--	--	--	25	25	50

Lab Objectives:

Sr. No	**Lab Objectives**
1	To apply reasoning for a problem in an uncertain domain.
2	To discuss the solution after building a Cognitive application.
3	To familiarize the students with the basics of Fuzzy Logic and Fuzzy Systems.
4	To familiarize the students with Learning Architectures and Frameworks.
5	To define and apply metrics to measure the performance of various learning algorithms**.**
6	To enable students to analyze data science methods for real world problems.

Lab Outcomes:

Sr. No	**Lab Outcomes**	**Cognitive levels of attainment as per Bloom's Taxonomy**
1	Implement reasoning with uncertainty.	L1, L2, L3
2	Explore use cases of Cognitive Computing	L1, L2
3	Implement a fuzzy controller system.	L1, L2, L3
4	Develop real life applications using learning concepts.	L1, L2, L3
5	Evaluate performance of applications.	L1, L2, L3, L4
6	Implement and analyze applications based on current trends in Data Science.	L1, L2, L3, L4, L5

Hardware & Software requirements:

Hardware Specifications	**Software Specifications**
PC with following Configuration 1. Intel Core i3/i5/i7 2. 4 GB RAM 3. 500 GB Hard disk	Python, MySQL or Database Software

Prerequisite: Artificial Intelligence and Data Science-I, Python Programming, Data Mining & Business Intelligence.

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours	LO Mapping
I	Uncertainty in AI	1.Implement Inferencing with Bayesian Network in Python	**02**	LO1
II	Cognitive Computing	2.Building a Cognitive Healthcare application 3.Smarter cities: Cognitive Computing in Government 4.Cognitive computing in Insurance 5.Cognitive computing in Customer Service	**04**	LO2
III	Fuzzy Logic & Its Applications	6.Implementation of Fuzzy Membership Functions. 7.Implementation of fuzzy set Properties. 8.Design of a Fuzzy control system using Fuzzy tool.	**04**	LO3
IV	Introduction to Deep Learning	9.Implementing Deep Learning Applications like a. Image Classification System b. Handwritten Digit Recognition System (like MNIST Dataset) c. Traffic Signs Recognition System. d. Image Caption Generator	**06**	LO4
V	Advanced ML Classification Techniques	10.Implementation of supervised learning algorithm like a. Ada-Boosting b. Random forests 11.Evaluation of Classification Algorithms.	**05**	LO4,LO5
VI	Mini-project on trends and applications in Data Science	12.Build text/ image/ video/ audio based DS Applications such as a. Chatbot b. Document Classification c. Sentiment Analysis d. Bounding Box Detection e. Music/Video Genre Classification	**05**	LO6

Text Books:

1. Stuart Russell and Peter Norvig, “Artificial Intelligence: A Modern Approach”, Third Edition, Pearson Education.
2. Judith S. Hurwitz, Marcia Kaufman, Adrian Bowles, “Cognitive Computing and Big Data Analytics”, Wiley India, 2015.

3. S.N. Sivanandam, S.N. Deepa, “Principles of Soft Computing”, Wiley Publication.
4. Dr. S Lovelyn Rose, Dr. L Ashok Kumar, Dr. D Karthika Renuka, “Deep Learning Using Python”, Wiley India, 2020.
5. B. Uma Maheshwari, R. Sujatha, “Introduction to Data Science Practical Approach with R and Python”, Wiley India, 2021.
6. François Chollet, “Deep Learning with Python”, Manning Publications, 2018.
7. Han J, Kamber M, Pei J, “Data Mining Concepts and Techniques”, Third Edition, Morgan Kaufmann.

References:

1. Deepak Khemani, “A First Course in Artificial Intelligence”, McGraw Hill Publication.
2. Ethem Alpaydin , “Introduction to Machine Learning”, PHI Learning Pvt. Ltd.
3. Jon Krohn, Grant Beyleveld, Aglae Bassens, “Deep Learning Illustrated: A Visual, Interactive Guide to Artificial Intelligence”, Pearson Education.
4. Prateek Joshi, “Artificial Intelligence with Python”, Packt Publishing.

Online References:

Sr. No.	Website Links
1	https://wisdomplexus.com/blogs/cognitive-computing-examples/
2	http://vlabs.iitb.ac.in/vlabs-dev/labs/machine_learning_old/labs/explist.php
3	https://infyspringboard.onwingspan.com/en/app/toc/lex_auth_013295170216763392494 01_shared/overview
4	https://infyspringboard.onwingspan.com/en/app/toc/lex_auth_013295002192683008418 60_shared/overview
5	https://www.udemy.com/course/ibm-watson-for-artificial-intelligence-cognitive-computing/

Term Work:

Term Work shall consist of at least 10 practical based on the above list. Also Term Work Journal must include Mini-Project as mentioned in above syllabus.

Term Work Marks: 25 Marks (Total marks) = 10 Marks (Experiments) + 10 Marks (Mini-project) + 5 Marks (Attendance)

Oral Exam: An Oral exam will be held based on the above syllabus.

		Teaching Scheme (Contact Hours)			Credits Assigned			
Course Code	**Course Name**	**Theory**	**Practical**	**Tutorial**	**Theory**	**Practical & Oral**	**Tutorial**	**Total**
ITL702	Internet of Everything Lab	--	2	--	--	1	--	01

Course Code	**Course Name**	**Examination Scheme**						
		Theory Marks				**Term Work**	**Practical/ Oral**	**Total**
		Internal assessment			**End Sem. Exam**			
		Test1	**Test 2**	**Avg. of 2 Tests**				
ITL702	Internet of Everything Lab	--	--	--	--	25	25	50

Lab Objectives:

Sr. No.	**Lab Objectives**
The Lab experiments aims:	
1	To learn different types of sensors.
2	To design the problem solution as per the requirement analysis done using sensors.
3	To study the basic concepts of programming/sensors/ emulators.
4	To design and implement the mini project intended solution for project based learning.
5	To build and test the mini project successfully.
6	To improve the team building, communication and management skills of the students.

Lab Outcomes:

Sr. No.	**Lab Outcomes**	**Cognitive Levels of Attainment as per Bloom's Taxanomy**
On successful completion, of course, learner/student will be able to:		
1	Identify the requirements for the real world problems.	L1,L2
2	Conduct a survey of several available literatures in the preferred field of study.	L1,L2
3	Study and enhance software/ hardware skills.	L1,L2
4	Demonstrate and build the project successfully by hardware/sensor requirements, coding, emulating and testing.	L1,L2,L3
5	To report and present the findings of the study conducted in the preferred domain.	L1,L2,L3,L4
6	Demonstrate an ability to work in teams and manage the conduct of the research study.	L1,L2,L3,L4

Hardware & Software requirements:

Hardware Specifications	**Software Specifications**
PC with following Configuration	Python/C, Conitiki, Cooja or any open source

1. Intel Core i3/i5/i7 2. 4 GB RAM 3. 500 GB Hard disk 4. Arduino/ Raspberry Pi kit	Simulator

Prerequisite: Basics of Java and Python Programming, Devops

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours	LO Mapping
0	Prerequisite	Experimentation with Microprocessor and Microcontroller , Experimentation with python and c	**02**	
I	Arduino	Introduction to Arduino, Hardware requirements, Software requirements, Arduino Programming Language, Arduino Uno Wired & Wireless connectivity, LCD commands, Serial Communication commands. Program for blinking LED using Arduino. Traffic Light pattern using Arduino. ESP8266 WiFi Module	**05**	LO1, LO2
II	Raspberry Pi	Introduction to Raspberry Pi, Installation of NOOBS and Raspbian on SD card, Libraries on Raspberry Pi, getting static IP address of Raspberry Pi, Interfacing of Relay, DHT11, DC Motor and LCD with Raspberry Pi.	**05**	LO1,LO2
III	Contiki OS	Contiki OS : History of Contiki OS, Applications, Features, ,Communication Components in Contiki OS, Cooja simulator ,Running Cooja Simulator,	**05**	LO3
IV	Cooja Simulator	Using the Contiki OS with the Cooja simulator to program the IoT for broadcasting data from sensors	**03**	LO5,LO6
V	Protocols and Security with Cooja	Understanding of 6LowPAN , COAP and protocol implementation in Cooja . Encryption Decryption techniques for IoT	**03**	LO5,LO6

VI	IoT data to Cloud	Installing the Remote desktop server. Installation of Pi camera, Face recognition, serial peripheral interface using Raspberry Pi. . DHT11 data logger with ThingSpeak/ thingsboard/ AWS/ Azure server .	**03**	LO4,L06

Text Books:

1. Interconnecting Smart Objects with IP: The Next Internet, Jean-Philippe Vasseur, Adam Dunkels, Morgan Kuffmann
2. Designing the Internet of Things , Adrian McEwen (Author), Hakim Cassimally
3. Internet of Things: Converging Technologies for Smart Environments and Integrated Ecosystems, Dr. Ovidiu Vermesan, Dr. Peter Friess, River Publishers
4. Internet of Things (A Hands-on-Approach) , Vijay Madisetti , Arshdeep Bahga

References:

1. 6LoWPAN: The Wireless Embedded Internet, Zach Shelby, Carsten Bormann, Wiley
2. Building the internet of things with ipv6 and mipv6, The Evolving World of M2M Communications, Daniel Minoli John Wiley & Sons
3. Contiki Cooja User Guide.
4. Fundamentals of Sensor Network Programming: Applications and Technology, By S. Sitharama Iyengar, Nandan Parameshwaran, Vir V. Phoha, N. Balakrishnan, Chuka D. Okoye, Wiley publication.
5. Recent research/white papers

Digital Reference :

1. IoT Analytics -Thingshttps://thingspeak.com
2. https://www.contiki-ng.org/
3. http://www.ideationinstru.com/training.htm

List of Experiments.

Guidelines for Mini Project

1. The mini project work is to be conducted by a group of three students
2. Each group will be associated with a subject Incharge/ mini project mentor. The group should meet with the concerned faculty during Laboratory hours and the progress of work discussed must be documented.
3. The students must understand the
   a. Concept
   b. Importance
   c. Interdisciplinary
   d. Challenges
   e. Various applications/smart objects
   f. Major Players/Industry Standards.

4. The students must understand the IoT Architecture:
   a. Node Structure: Sensing, Processing, Communication, Powering
   b. Networking: Topologies, Layer/Stack architecture
   c. Communication Technologies: Introduction to ZigBee, BLE, WiFi, LTE, IEEE 802.11ah, Discuss data rate, range, power, computations/bandwidth, QoS
   d. Smartness - Signal Processing/Analytics: Impact on Power/Energy savings, dynamic networks, simple case studies
   e. IoT Fabricator: Introduction to Embedded electronics, fabricating electronics, Communication Network

requirements, Data processing challenges – recreation, IP/security, Challenges
f. Hands-on in IoT: Projects based on some Hardware (Raspberry pi, Arduino, Intel, IITH Mote, Smartphones), Software (Contiki, TinyOS, Android), IoT Fabricator etc. can be used.

5. The students may visit different websites to identify their IOT topic for the mini project.
6. The students may do surveys for different applications using different types of sensors for their mini project.
7. Each group will identify the Hardware (Motes from different Motes families) & sensor configuration and software requirements for their mini project problem statement.
8. Design your own circuit board using multiple sensors etc.
9. Installation, configure and manage your sensors in such a way so that they can communicate with each other.
10. Work with operating system, emulator like contiki cooja and do coding to for input devices on sensors
11. Create an interface using Mobile/Web to publish or remotely access the data on the Internet.
12. Each group along with the concerned faculty shall identify a potential problem statement, on which the study and implementation is to be conducted.
13. Analyze data collected from different sensors on platform like thinkspeak/AWS/Azure etc
14. Devops and Advance Devops concepts students have learnt in earlier semesters can be used while working with IoT projects.
15. Each group may present their work in various project competitions or paper presentations.
16. A detailed report is to be prepared as per guidelines given by the concerned faculty.

Term Work:

Term Work shall consist of Mini-Project based on the above syllabus and guidelines. Also Term Work Journal must include at least 2 assignments.

Term Work Marks:

25 Marks (Total marks) = 15 Marks (Mini-Project) + 5 Marks (Assignments) + 5 Marks (Attendance)
Oral Exam: An Oral exam will be held based on the above syllabus.

		Teaching Scheme (Contact Hours)			Credits Assigned			
Course Code	**Course Name**	**Theory**	**Practical**	**Tutorial**	**Theory**	**Practical & Oral**	**Tutorial**	**Total**
ITL703	Secure Application Development	--	2	--	--	1	--	01

Course Code	**Course Name**	**Examination Scheme**						
		Theory Marks				**Term Work**	**Practical/ Oral**	**Total**
		Internal assessment			**End Sem. Exam**			
		Test1	**Test 2**	**Avg. of 2 Tests**				
ITL703	Secure Application Development	--	--	--	--	25	25	50

Lab Objectives:

Sr. No	**Lab Objectives**
The Lab experiments aims:	
1	To understand the secure programming of application code.
2	To understand the Owasp methodologies and standards.
3	Understand and Identify main vulnerabilities inherent in applications.
4	Understand how Data Validation and Authentication can be applied for application.
5	Understand how to apply Security at Session Layer Management.
6	Understand how to apply to secure coding for cryptography.

Lab Outcomes:

Sr. No	**Lab Outcomes**	**Cognitive levels of attainment as per Bloom's Taxonomy**
On successful completion, of course, learner/student will be able to:		
1	Apply secure programming of application code.	L1,L2,L3
2	Understand the Owasp methodologies and standards.	L1,L2,L3
3	Identify main vulnerabilities inherent in applications.	L1,L2,L3
4	Apply Data Validation and Authentication for application	L1,L2,L3,L4,L5
5	Apply Security at Session Layer Management	L1,L2,L3,L4,L5
6	Apply secure coding for cryptography.	L1,L2,L3,L4,L5

Hardware & Software requirements:

Hardware Specifications	Software Specifications
PC with following Configuration 1. Intel Core i3/i5/i7 2. 4 GB RAM 3. 500 GB Hard disk	Web Application, HTML5, CSS3, Java, C, Python, MySQL or Database Software. Internet Connection, Browser, Security tools. SAST tools etc.

- **Prerequisite:** Knowledge of programming languages like java/python/C is required.

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours	LO Mapping
0	Prerequisite	Programming Language and Web application basic concepts.	**02**	
I	Introduction to Secure Programming	Introduction to laws, standards and guidelines of cyber security. What do you mean by attacks, types of attacks and statistics of main vulnerabilities? Lab1: Study of different laws and standards of cyber security.	**04**	LO1
II	Methodologies for developing secure code	Software Development Lifecycle. Risk Analysis. Threat Modeling. Study different SAST (Static Application Security Testing) tools. Study different top 10 methodologies and guidelines of OWASP (Open Web Application Security Project) for the secure application development. Any top 5 OAT. Best eight guidelines for Secure Coding. Understand the flow of Verification testing for secure coding. Lab2: Case study for SDLC. Lab3: Exercise on Threat Modeling. Lab4: Study of SAST Tools (open Source like GitHub, GitLab and so on) and use at least one for practical Lab5: Study and implement at least any 5 methodologies of OWASP. Lab6: Study and implement at least any 5 OAT Denial of Inventory for E-commerce Website..	**06**	LO2
III	VAPT of Applications	Introduction to the HTTP protocol. Owasp Web Security Testing Guidelines. Tools for VAPT testing. Lab7: Use Burp proxy to test web applications.	**04**	LO3
IV	Data Validation & Authentication	Guidelines for input data validation (Data type, Data size, Data range, Data Content etc.) and authentication for login page. Types of Authentication attacks. Study different type of	**05**	LO4

		vulnerabilities like SQL Injection vulnerability, LDAP and XPath Injection vulnerabilities, Cross-Site Scripting (XSS) vulnerability, OS Command, LFI/RFI, Unvalidated file upload and buffer overflow etc. Lab8: Registration Page Data Validation. Lab9: SQL injection vulnerability allows login page to bypass. Lab10: LDAP and XPath Injection vulnerabilities for login /registration page. Lab11: Cross-Site Scripting (XSS) vulnerability Lab Lab12: OS Command vulnerability Lab Lab13: LFI/RFI or Unvalidated file upload or Buffer Overflow vulnerability Lab. Lab14: Online Password attack.		
V	Security in Session Layer	Introduction to Session Layer in Web Applications and management. Session Management Best practices according to OWASP. Lab15: Session Management for Web Application.	**03**	LO5
VI	Secure Coding for cryptography.	Overview of cryptography and guidelines for using encryption. Types of cryptography ie symmetric and asymmetric. Hashing Algorithms etc. Lab16: Symmetric and Asymmetric Lab17: Symmetric Encryption and Hashing.	**02**	LO6

Text & References Books:

1. Fundamental Practice for Secure Software Development.
2. The OWASP Automated Threat Handbook - Web Applications.
3. OWASP Alpha Release Code Review Guide 2.0
4. Secure Programming HOWTO
5. OWASP Quick reference guide 2.

Online References:

Sr. No.	Website Links
1	https://www.udemy.com/course/secure-coding-secure-application-development/
2	https://kirkpatrickprice.com/blog/secure-coding-best-practices/

3	https://owasp.org/www-project-automated-threats-to-web-applications/assets/oats/EN/OAT-021_Denial_of_Inventory

Term Work:

Term Work shall consist of at least 10 to 12 practical based on the above list. Also Term Work Journal must include at least 2 assignments as mentioned in above syllabus.

Term Work Marks: 25 Marks (Total marks) = 15 Marks (Experiments) + 5 Marks (Assignment) + 5 Marks (Attendance)

Oral Exam: An Oral exam will be held based on the above syllabus.

		Teaching Scheme (Contact Hours)			Credits Assigned			
Course Code	**Course Name**	**Theory**	**Practical**	**Tutorial**	**Theory**	**Practical & Oral**	**Tutorial**	**Total**
ITL704	Recent Open Source Project Lab	--	2	--	--	1	--	01

Course Code	**Course Name**	**Examination Scheme**						
		Theory Marks				**Term Work**	**Practical/ Oral**	**Total**
		Internal assessment			**End Sem. Exam**			
		Test1	**Test 2**	**Avg. of 2 Tests**				
ITL704	Recent Open Source Project Lab	--	--	--	--	25	25	50

Lab Objectives:

Sr. No	**Lab Objectives**
The Lab experiments aims:	
1	To understand the basic concepts of Open Source Software.
2	To understand the GPL(General Public Licence) and Contribute of Open Source.
3	To Understand Contribute to Open Source in different Operating System.
4	To Understand Contribute to Open Source in different Technologies.
5	To Understand Contribute to Open Source in different Network Management..
6	To Understand Contribute to Open Source in different Applications and Services.

Lab Outcomes:

Sr. No	**Lab Outcomes**	**Cognitive levels of attainment as per Bloom's Taxonomy**
On successful completion, of course, learner/student will be able to:		
1	Understand and apply the basic concepts of Open Source Software.	L1,L2,L3
2	Identify the difference between the GPL(General Public Licence) and Contribute to Open Source.	L1,L2,L3
3	Apply and evaluate your knowledge for the Contribute to Open Source in different Operating System.	L1,L2,L3,L4,L5
4	Apply and evaluate your knowledge for the Contribute to Open Source in different Technologies.	L1,L2,L3,L4,L5
5	Apply and evaluate your knowledge for the Contribute to Open Source in different Network Management..	L1,L2,L3,L4,L5
6	Apply and evaluate your knowledge for the Contribute to Open Source in different Applications and Services.	L1,L2,L3,L4,L5

Hardware & Software requirements:

Hardware Specifications	Software Specifications
PC with following Configuration 1. Intel Core i3/i5/i7 2. 4 GB RAM 3. 500 GB Hard disk	Internet Connection. Any Operating System. Any technology open source tools/simulator/emulator. Any open source Testing Tools Any open source Network Monitoring Tools. Any open Source Database tools. Any open source Latex report writing tools.

Prerequisite: OS, Programming Language, DBMS, IP, Network.

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours	LO Mapping
0	Prerequisite	Basic Concepts of OS, Programming Language, Network and DMBS.	**02**	--
I	Introduction to OSS	Overview of OSS. Basic Concepts of OSS. Advantages of OSS. Difference between free and open source software. What is GPL and Contribute to Open Source Project. Different ways to contribute.	**04**	LO1
II	Contribute to Open Source Project.	Overview of Contribute Open Source Project. Steps or Guidelines of Contribute to Open Source Projects : 1. Why to Contribute to open source Project. 2. What do you mean by Contribute Open Source Projects. 3. Identifying the new/existing open source projects to contribute. 4. Submit your contribute to open source.5. Results after submitting your contribute to Open Source.	**04**	LO2
III	Contribute to Open Source in Operating System.	As per Contribute to Operating System to introduce new OS version, Improve OS by removing bugs, Improve existing Skill sets for growth in career. Interact with Stakeholders for feedback and provide training and mentoring. Start own Startup.	**04**	LO3
IV	Contribute to Open Source in Technologies.	As per Contribute to various emerging technologies like AI/ML/DL/Blockchain/IoT/Data Analytics/Cyber Security/Andriod/iOS/Flutter/DeVoPs/Virtualization and Cloud Computing etc. To improve technologies. Introduce new version of technologies, Improve technologies by removing bugs, Improve existing Skill sets for growth in career. Interact with Stakeholders and provide training and mentoring. Start own Startup.	**04**	LO4
V	Contribute to Open Source in Network Management.	As per Contribute to different types of Network and Management Systems like LAN/WAN/MAN/Adhoc Network/Data Centre/Wireless Network/Enterprise Network etc. To improve Networks as a Network administrator. Design own Network as per customer	**04**	LO5

		requirements, Improve existing Skill sets for growth in career. Interact with Stakeholders and provide training and mentoring. Start own Startup.		
VI	Contribute to Open Source in Application & Cloud Services.	As per Contribute to various Applications or Case studies using Cloud Services etc. To improve applications, remove bugs. Improve existing Skill sets for growth in career. Interact with Stakeholders and provide training and mentoring. Start own Startup.	**04**	LO6

Guidelines for Recent Open Source Mini Project as per above syllabus.

- Students shall form a group of 3 to 4 students, while forming a group shall not be allowed less than three or more than four students, as it is a group activity.
- Students should do survey and identify needs, which shall be converted into problem statement how to contribute to open source mini project in consultation with faculty supervisor/head of department/internal committee of faculties.
- Students shall submit implementation plan in the form of Gantt/PERT/CPM chart, which will cover weekly activity of recent contribute to open source mini project.
- A log book to be prepared by each group, wherein group can record weekly work progress, guide/supervisor can verify and record notes/comments.
- Faculty supervisor may give inputs to students during mini project activity; however, focus shall be on self-learning.
- Students in a group shall understand contribute to open source problem effectively, propose multiple solution and select best possible solution in consultation with guide/ supervisor.
- Students shall convert the best solution into working model using various components of their domain areas and demonstrate.
- The solution to be validated with proper justification and report using open source tools to be compiled in standard format of University of Mumbai.
- With the focus on the self-learning, innovation, addressing societal problems and entrepreneurship quality development within the students through the open source Mini Projects.

Guidelines for Assessment of Recent Open Source Mini Project:

Term Work

- The review/ progress monitoring committee shall be constituted by head of departments of each institute. The progress of mini project to be evaluated on continuous basis, minimum two reviews in each semester.
- In continuous assessment focus shall also be on each individual student, assessment based on individual's contribution in group activity, their understanding and response to questions.
- Distribution of Term work marks for both semesters shall be as below;
    - Marks awarded by guide/supervisor based on log book : 10
    - Marks awarded by review committee : 10
    - Quality of Project Report :05

Text & Reference Books:

1. Forge Your Future with Open Source: Build Your Skills. Build Your Network. Build the Future of Technology. 1st Edition

Online References:

Sr. No.	Website Links
1	https://github.com/freeCodeCamp/how-to-contribute-to-open-source
2	https://opensource.guide/how-to-contribute/#why-contribute-to-open-source

Term Work:

Term Work shall consist of at least Open Source Project based on the above syllabus. Also Term Work Journal must include at least 2 assignments to explain contribute to open source as mentioned in above syllabus.

Term Work Marks: 25 Marks (Total marks) = 15 Marks (Mini-Project) + 5 Marks (Assignment) + 5 Marks (Attendance)

Oral Exam: An Oral exam will be held based on the above syllabus.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ITM701	Major Project – I	--	06	--	--	03	--	03

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Pract. /Oral	Total
		Internal assessment			End Sem. Exam			
		Test1	Test 2	Avg.				
ITM701	Major Project – I	--	--	--	--	25	25	50

Course Objectives

1. To acquaint with the process of identifying the needs and converting it into the problem.
2. To familiarize the process of solving the problem in a group.
3. To acquaint with the process of applying basic engineering fundamentals to attempt solutions to the problems.
4. To inculcate the process of self-learning and research.

Course Outcome: Learner will be able to…

1. Identify problems based on societal /research needs.
2. Apply Knowledge and skill to solve societal problems in a group.
3. Develop interpersonal skills to work as member of a group or leader.
4. Draw the proper inferences from available results through theoretical/ experimental/simulations.
5. Analyse the impact of solutions in societal and environmental context for sustainable development.
6. Use standard norms of engineering practices
7. Excel in written and oral communication.
8. Demonstrate capabilities of self-learning in a group, which leads to life long learning.
9. Demonstrate project management principles during project work.

Guidelines for Major Project

- Students shall form a group of 3 to 4 students, while forming a group shall not be allowed less than three or more than four students, as it is a group activity.
- Students should do survey and identify needs, which shall be converted into problem statement for mini project in consultation with faculty supervisor/head of department/internal committee of faculties.
- Students shall submit implementation plan in the form of Gantt/PERT/CPM chart, which will cover weekly activity of major project-I and major project-II.
- A log book to be prepared by each group, wherein group can record weekly work progress, guide/supervisor can verify and record notes/comments.
- Faculty supervisor may give inputs to students during major project-I & II activity; however, focus shall be on self-learning.
- Students in a group shall understand problem effectively, propose multiple solution and select best possible solution in consultation with guide/ supervisor.

- Students shall convert the best solution into working model using various components of their domain areas and demonstrate.
- The solution to be validated with proper justification and report to be compiled in standard format of University of Mumbai.
- With the focus on the self-learning, innovation, addressing societal problems and entrepreneurship quality development within the students through the Major Project, it is preferable that a single project of appropriate level and quality to be carried out in two semesters by all the groups of the students. i.e. Major Project-I in semester VII and Major Project-II in semesters VIII.
- However, based on the individual students or group capability, with the mentor's recommendations, if the proposed Major Project adhering to the qualitative aspects mentioned above gets completed in odd semester, then that group can be allowed to Scopus paper publications in Journal/Conference or motivate for Copyright or Indian Patent as an extension of the Major Project-1 with suitable improvements/modifications after testing and analysis in even semester. This policy can be adopted on case by case basis.

Guidelines for Assessment of Major Project:

Term Work

1. The review/ progress monitoring committee shall be constituted by head of departments of each institute. The progress of major project to be evaluated on continuous basis, minimum two reviews in each semester VII and VIII.
2. In continuous assessment focus shall also be on each individual student, assessment based on individual's contribution in group activity, their understanding and response to questions.
3. Distribution of Term work marks for both semesters shall be as below;
    a. Marks awarded by guide/supervisor based on log book : 10
    b. Marks awarded by review committee : 10
    c. Quality of Project report : 05

Review/progress monitoring committee may consider following points for assessment based on either one year major project as mentioned in general guidelines.

One-year project:

- In semester VII entire theoretical solution shall be ready, including components/system selection and cost analysis, building of working prototype. Two reviews will be conducted based on presentation given by students group.
    - First shall be for finalization of problem and proposed solution of the problem
    - Second shall be on readiness of working and testing of prototype to be conducted.
- In semester VIII expected work shall be procurement of testing and validation of results based on work completed in an odd semester.
    - First review is based on improvements in testing and validation results cum demonstration for publication to be conducted.
    - Second review shall be based on paper presentation in conference/journal or copyright or Indian patent in last month of the said semester.

Assessment criteria of Major Project.

Major Project shall be assessed based on following criteria;

1. Quality of survey/ need identification
2. Clarity of Problem definition based on need.
3. Innovativeness in solutions
4. Feasibility of proposed problem solutions and selection of best solution

5. Cost effectiveness
6. Societal impact
7. Innovativeness
8. Cost effectiveness and Societal impact
9. Full functioning of working model as per stated requirements
10. Effective use of skill sets
11. Effective use of standard engineering norms
12. Contribution of an individual's as member or leader
13. Clarity in written and oral communication

- In **one year, project**, first semester evaluation may be based on first six criteria's and remaining may be used for second semester evaluation of performance of students in mini project.

Guidelines for Assessment of Major Project Practical/Oral Examination:

- Report should be prepared as per the guidelines issued by the University of Mumbai.
- Major Project shall be assessed through a presentation and demonstration of working model by the student project group to a panel of Internal and External Examiners preferably from industry or research organizations having experience of more than five years approved by head of Institution.
- Students shall be motivated to publish a paper based on the work in Scopus Conferences/Journals or copy right or Indian Patent.

Major Project shall be assessed based on following points;

1. Quality of problem and Clarity
2. Innovativeness in solutions
3. Cost effectiveness and Societal impact
4. Full functioning of working model as per stated requirements
5. Effective use of skill sets
6. Effective use of standard engineering norms
7. Contribution of an individual's as member or leader
8. Clarity in written and oral communication
9. Publications in Sem VIII.

Course Code	Course Name	Theory	Practical	Tutorial	Theory	Practical /Oral	Tutorial	Total
ITDO7011	Storage Area Network	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Avg. of 2 Tests					
ITDO7011	Storage Area Network	20	20	20	80	--	--	--	100

Course Objectives:

Sr. No.	Course Objectives
The course aims:	
1	To provide the knowledge of types Storage Network.
2	To examine NAS technology and its applications in Storage Area Networks.
3	To study Emerging Technologies in SAN.
4	To define backup, recovery, disaster recovery and business continuity in the storage area Network.
5	To learn cloud based storage virtualization technologies in SAN.
6	To understand the logical and physical components of storage infrastructures.

Course Outcomes:

Sr. No.	Course Outcomes	Cognitive levels of attainment as per Bloom's Taxonomy
On successful completion, of course, learner/student will be able to:		
1	Identify the limitations of the client-server architecture and evaluate the need for data protection and storage centric architectures such as Intelligent storage system.	L1,L2
2	Understand various SAN technologies.	L1,L2
3	Interpret and examine NAS technologies and its application in Storage Area Network.	L1,L2
4	Explain Different I/O Techniques in SAN.	L1,L2
5	Describe Cloud based storage virtualization technologies in SAN.	L1,L2
6	Explain Storage infrastructure management with security.	L1,L2

Prerequisite: Operating System, Computer Organization, Computer Networks.

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours	CO Mapping
0	Prerequisite	Components of a Storage System Environment, Disk drive components, RAID levels, Cloud Computing	**02**	--
I	Introduction to Storage Area Network	**Intelligent Storage Systems (ISS)**, Storage Provisioning, Types of Intelligent Storage Systems **Evolution of Storage System:** Server-Centric IT Architecture and its Limitations, Storage-Centric IT Architecture and its Advantages, SAN & its advantages. **Self-learning Topics:** Case Study on Replacing a server with Storage networks**.**	**04**	CO1
II	Networked Attached Storage & its Application	**Local File Systems:** File systems and databases,Journaling, Snapshots,Volume manager **Network File Systems, and File Servers:** Network Attached Storage (NAS), Performance bottlenecks in file servers, Acceleration of network file systems, Case study: The Direct Access File System (DAFS), **Shared Disk File Systems:** A case study The General Parallel File System (GPFS), **Applying NAS solution:** NAS workload characterization, applying NAS to departmental workloads, enterprise web workloads, and specialized workloads; Considerations when integrating SN and NAS: Differences and similarities, the need to integrate, future storage connectivity and integration. **Self-learning Topics:** Case study on Successful SAN Deployment steps**.**	**07**	CO2
III	Storage I/O Techniques	The Physical I/O Path from the CPU to the Storage System, SCSI, The Fibre Channel Protocol Stack, Fibre Channel SAN, IP Storage, Infiniband-based Storage Networks, Fibre Channel over Ethernet (FCoE). **Self-learning Topics: C**ase Study on FCoE SAN.	**06**	CO3
IV	Backup and Data Archive	**Introduction to Business Continuity:** Information Availability, BC Terminology, BC Planning Lifecycle, Failure Analysis, Business Impact Analysis **Backup and Archive:** Backup Purpose, Backup Considerations, Backup Granularity, Recovery Considerations, Backup Methods ,Backup Architecture, Backup and Restore Operations, Backup Topologies	**06**	CO4

		Self-learning Topics: Case Study on Replication strategy		
V	Storage Area Network as a Service for Cloud Computing & Virtualization	**Virtualization and the cloud:** Cloud infrastructure virtualization, Cloud platforms, Storage virtualization, SAN virtualization **Virtualization Appliances:** Black Box Virtualization, In-Band Virtualization Appliances, Out-of-Band Virtualization Appliances High Availability for Virtualization Appliances, Appliances for Mass Consumption. **Storage Automation and Virtualization:** Policy-Based Storage Management, Application-Aware Storage Virtualization, Virtualization-Aware Applications. **Self-learning Topics:** Case study on symmetric and asymmetric virtualization in networks.	**06**	CO5
VI	Securing and Managing storage infrastructure	**Securing and Storage Infrastructure:** Information Security Framework, Risk Triad, Storage Security Domains, Security Implementations in Storage Networking, Securing Storage Infrastructure in Virtualized and Cloud Environments. **Managing the Storage Infrastructure:** Monitoring the Storage Infrastructure, Storage Infrastructure Management activities, Storage Infrastructure Management Challenges, Information Lifecycle Management, Storage Tiering **Self-learning Topics:** Case study on SAN Management and Standards.	**08**	CO6

Text Books:

1. G. Somasundaram, Alok Shrivastava, EMC Educational Services, “Information Storage and Management”, Wiley India.
2. Storage Virtualization, Author: Clark Tom, Publisher: Addison Wesley Publishing Company
3. Ulf Troppens, Wolfgang Muller-Friedt, Rainer Wolafka, “Storage Networks Explained” Wiley Publication
4. "Introduction to Storage Area Networks" Jon Tate, Pall Beck, Hector Hugo Ibarra, Shanmuganathan Kumaravel, Libor Miklas, IBM Redbooks.

References:

1. Richard Barker and Paul Massiglia, ìStorage Area Network Essentials: A Complete Guide to Understanding and Implementing SANsî, Wiley India.
2. Storage Networks: The Complete Reference, by Robert Spalding (Author)
3.“Storage Network Management and Retrieval”, Vaishali Khairnar, Nilima Dongre. Wiley

Online References:

1. https://www.itprc.com/ultimate-guide-to-storage-area-networks/
2. https://www.techtarget.com/searchstorage/definition/storage-area-network-SAN

3. https://www.snia.org/educational-library/object-storage-trends-use-cases-2021
4. https://www.sciencedirect.com/topics/computer-science/network-attached-storage
5. https://www.techtarget.com/searchstorage/tip/Understand-your-storage-infrastructure-management
6. https://sites.google.com/site/testwikiforfirstciscolab/shd/14-securing-the-storage-infrastructure
7. https://www.techtarget.com/searchdatabackup/tip/What-is-the-difference-between-archives-and-backups

Assessment:

Internal Assessment (IA) for 20 marks:

- IA will consist of Two Compulsory Internal Assessment Tests. Approximately 40% to 50% of syllabus content must be covered in First IA Test and remaining 40% to 50% of syllabus content must be covered in Second IA Test

➢ **Question paper format**

- Question Paper will comprise of a total of **six questions each carrying 20 marks Q.1** will be **compulsory** and should **cover maximum contents of the syllabus**
- **Remaining questions** will be **mixed in nature** (part (a) and part (b) of each question must be from different modules. For example, if Q.2 has part (a) from Module 3 then part (b) must be from any other Module randomly selected from all the modules)
- A total of **four questions** need to be answered.

Course Code	Course Name	Theory	Practical	Tutorial	Theory	Practical /Oral	Tutorial	Total
ITDO7012	High Performance Computing	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test1	Test 2	Avg. of 2 Tests					
ITDO7012	High Performance Computing	20	20	20	80	--	--	--	100

Course Objectives:

Sr. No.	Course Objectives
The course aims:	
1	Learn the concepts of high-performance computing.
2	Gain knowledge of platforms for high performance computing.
3	Design and implement algorithms for parallel programming applications.
4	Analyze the performance metrics of High Performance Computing.
5	Understand the parallel programming paradigm, algorithms and applications.
6	Demonstrate the understanding of different High Performance Computing tools.

Course Outcomes:

Sr. No.	Course Outcomes	Cognitive levels of attainment as per Bloom's Taxonomy
On successful completion, of course, learner/student will be able to:		
1	Understand fundamentals of parallel Computing.	L1,L2
2	Describe different parallel processing platforms involved in achieving High Performance Computing.	L1,L2,L3
3	Demonstrate the principles of Parallel Algorithms and their execution.	L1,L2,L3
4	Evaluate the performance of HPC systems.	L1,L2,L3,L4
5	Apply HPC programming paradigm to parallel applications.	L1,L2,L3
6	Discuss different current HPC Platforms.	L1,L2

Prerequisite: Computer Organization, C Programming, Data structures and Algorithm Analysis.

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours	CO Mapping
0	Prerequisite	Computer Organization, C Programming, Data structures and Algorithm Analysis.	**02**	--
I	Introduction	**Introduction to Parallel Computing:** Motivating Parallelism, Scope of Parallel Computing, Levels of parallelism (instruction, transaction, task, thread, memory, function), Models (SIMD, MIMD, SIMT, SPMD, Dataflow Models, Demand-driven Computation). **Self-learning Topics:** Parallel Architectures: Interconnection network, Processor Array, Multiprocessor.	**05**	CO1
II	Parallel Programming Platforms	**Parallel Programming Platforms:** Implicit Parallelism: Dichotomy of Parallel Computing Platforms, Physical Organization of Parallel Platforms, Communication Costs in Parallel Machines. **Self-learning Topics:** Trends in Microprocessor & Architectures, Limitations of Memory System Performance.	**04**	CO2
III	Parallel Algorithm And Concurrency	**Principles of Parallel Algorithm Design:** Preliminaries, Decomposition Techniques, Characteristics of Tasks and Interactions, Mapping Techniques for Load Balancing, Basic Communication operations: Broadcast and Reduction Communication types. **Self-learning Topics: Parallel Algorithm Models**	**09**	CO3
IV	Performance Measures for HPC	**Performance Measures:** Speedup, execution time, efficiency, cost, scalability, Effect of granularity on performance, Scalability of Parallel Systems, Amdahl's Law, Gustavson's Law. **Self-learning Topics:** Performance Bottlenecks.	**05**	CO4
V	Programming Paradigms for HPC	**Programming Using the Message-Passing Paradigm :** Principles of Message Passing Programming, The Building Blocks: Send and Receive Operations, MPI: the Message Passing Interface, Topology and Embedding. **Parallel Algorithms and Applications :** One-Dimensional Matrix-Vector Multiplication, Graph Algorithms, Sample Sort, Two-Dimensional Matrix Vector Multiplication. **Self-learning Topics:** Introduction to OpenMP.	**09**	CO5
VI	General Purpose	OpenCL Device Architectures, Introduction to OpenCL Programming.	**05**	CO6

	Graphics Processing Unit(GPGPU) Architecture and Programming	**Self-learning Topics:** Introduction to CUDA architecture, and Introduction to CUDA Programming.		

Text Books:

1. AnanthGrama, Anshul Gupta, George Karypis, Vipin Kumar , "Introduction to Parallel Computing", Pearson Education, Second Edition, 2007.
2. Kai Hwang, Naresh Jotwani, "Advanced Computer Architecture: Parallelism, Scalability, Programmability", McGraw Hill, Second Edition, 2010.
3. Edward Kandrot and Jason Sanders, "CUDA by Example – An Introduction to General Purpose GPU Programming", Addison-Wesley Professional ©, 2010.
4. Georg Hager, Gerhard Wellein, "Introduction to High Performance Computing for Scientists and Engineers", Chapman & Hall / CRC Computational Science series, 2011.
5. Benedict Gaster, Lee Howes, David Kaeli, Perhaad Mistry, Dana Schaa , "Heterogeneous Computing with OpenCL" , 2nd Edition, Elsevier, 2012.

References Books:

1. Michael J. Quinn, "Parallel Programming in C with MPI and OpenMP", McGraw-Hill International Editions, Computer Science Series, 2008.
2. Kai Hwang, Zhiwei Xu, "Scalable Parallel Computing: Technology, Architecture, Programming", McGraw Hill, 1998.
3. Laurence T. Yang, MinyiGuo, "High- Performance Computing: Paradigm and Infrastructure" Wiley, 2006.
4. Fayez Gebali, "Algorithms and Parallel Computing", John Wiley & Sons, Inc., 2011.

Online References:

Sr. No.	Website Name
1.	https://onlinecourses.nptel.ac.in/noc21_cs46/preview
2.	https://onlinecourses.nptel.ac.in/noc22_cs21/preview

Assessment:

Internal Assessment (IA) for 20 marks:

- IA will consist of Two Compulsory Internal Assessment Tests. Approximately 40% to 50% of syllabus content must be covered in First IA Test and remaining 40% to 50% of syllabus content must be covered in Second IA Test

➢ **Question paper format**

- Question Paper will comprise of a total of **six questions each carrying 20 marks Q.1** will be **compulsory** and should **cover maximum contents of the syllabus**
- **Remaining questions** will be **mixed in nature** (part (a) and part (b) of each question must be from different modules. For example, if Q.2 has part (a) from Module 3 then part (b) must be from any other Module randomly selected from all the modules)
- A total of **four questions** need to be answered.

Course Code	Course Name	Theory	Practical	Tutorial	Theory	Practical /Oral	Tutorial	Total
ITDO7013	Infrastructure Security	03	--	-	03	--	-	03

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test1	Test 2	Avg. of 2 Tests					
ITDO7013	Infrastructure Security	20	20	20	80	-	-	-	100

Course Objectives:

Sr. No.	Course Objectives
The course aims:	
1	To understand underlying principles of infrastructure security.
2	To explore software vulnerabilities, attacks and protection mechanisms to learn security aspects of wireless network infrastructure and protocols.
3	To investigate web server vulnerabilities and their countermeasures.
4	To investigate cloud infrastructure vulnerabilities and their countermeasures.
5	To learn the different attacks on Open Web Applications and Web services.
6	To learn the different security policies.

Course Outcomes:

Sr. No.	Course Outcomes	Cognitive levels of attainment as per Bloom's Taxonomy
On successful completion, of course, learner/student will be able to:		
1	Understand the concept of vulnerabilities, attacks and protection mechanisms.	L1,L2
2	Analyze and evaluate software vulnerabilities and attacks on databases and operating systems.	L1,L2,L3
3	Explain the need for security protocols in the context of wireless communication.	L1,L2,L3
4	Understand and explain various security solutions for Cloud infrastructure.	L1,L2
5	Understand, and evaluate different attacks on Open Web Applications and Web services.	L1,L2
6	Design appropriate security policies to protect infrastructure components.	L1,L2,L3

Prerequisite: Computer Networks, Cryptography and Network Security

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours	CO Mapping
0	Prerequisite	Basic of OSI Model, Topology's and Computer Networks,	**02**	--

		Cryptography and Network Security.		
I	Introduction	Cyber-attacks, Vulnerabilities, Defense Strategies and Techniques, Authentication Methods- Password, Token and Biometric, Access Control Policies and Models (DAC,MAC, RBAC, ABAC, BIBA, Bell La Padula), **Self-Learning Topics:** Authentication and Access Control Services- RADIUS, TACACS, and TACACS+	**04**	CO1
II	Software Security	**Software Vulnerabilities:** Buffer overflow, Format String, Cross-Site Scripting, SQL Injection, Malware: Viruses, Worms, Trojans, Logic Bomb, Bots, Rootkits **Operating System Security:** Memory and Address Protection, File Protection Mechanism, User Authentication. **Database Security:** Database Security Requirements, Reliability and Integrity, Sensitive Data, Inference Attacks, Multilevel Database Security **Self-Learning Topics:** Format String**,** File System Security (Windows and Linux OS)	**08**	CO2
III	Wireless Security	Mobile Device Security- Security Threats, Device Security, IEEE 802.11xWireless LAN Security, VPN Security, Wireless Intrusion Detection System (WIDS) **Self-Learning Topics:** Wireshark, Cain and Abel, Aircrack.	**06**	CO3
IV	Cloud Security	Cloud Security Risks and Countermeasures, Data Protection in Cloud, Cloud Application Security, Cloud Identity and Access Management, Cloud Security as a Service. **Self-Learning Topics:** Metasploit, Ettercap.	**06**	CO4

V	Web Security	Web Security Considerations, User Authentication and Session Management, Cookies, SSL, HTTPS, SSH, Privacy on Web, Web Browser Attacks, Account Harvesting, Web Bugs, Clickjacking, Cross- Site Request Forgery, Session Hijacking and Management, Phishing and Pharming Techniques, DNS Attacks, Web Service Security, Secure Electronic Transaction, Email Attacks, Web Server Security as per OWASP, Firewalls. **Self-Learning Topics:** Penetration Testing tools: SQL Map, Wapiti.	**08**	CO5
VI	Information Security and Risk Management	Security Policies, Business Continuity Plan, Risk Analysis, Incident Management, Legal System and Cybercrime, Ethical Issues in Security Management. **Self-Learning Topics:** The Indian IT Act, Indian Cyber Law	**05**	CO6

Text Books:

1. Computer Security Principles and Practice, William Stallings, Sixth Edition, Pearson Education
2. Security in Computing, Charles P. Pfleeger, Fifth Edition, Pearson Education
3. Network Security and Cryptography, Bernard Menezes, Cengage Learning
4. Network Security Bible, Eric Cole, Second Edition, Wiley

References Books:

1. Web Application Hackers Handbook by Wiley.
2. Computer Security, Dieter Gollman, Third Edition, Wiley
3. CCNA Security Study Guide, Tim Boyle, Wiley
4. Introduction to Computer Security, Matt Bishop, Pearson.
5. Cloud Security and Privacy, Tim Mather, Subra Kumaraswamy, Shahed Latif , O'Riely
6. Nina Godbole, Sunit Belapure, *Cyber Security*, Wiley India, New Delhi

Online References:

1. https://www.cousera.org
2. https://nptel.ac.in

Assessment:

Internal Assessment (IA) for 20 marks:

- IA will consist of Two Compulsory Internal Assessment Tests. Approximately 40% to 50% of syllabus content must be covered in First IA Test and remaining 40% to 50% of syllabus content must be covered in Second IA Test

- **Question paper format**

- Question Paper will comprise of a total of **six questions each carrying 20 marks Q.1** will be **compulsory** and should **cover maximum contents of the syllabus**

- **Remaining questions** will be **mixed in nature** (part (a) and part (b) of each question must be from different modules. For example, if Q.2 has part (a) from Module 3 then part (b) must be from any other Module randomly selected from all the modules)

- A total of **four questions** need to be answered.

Course Code	Course Name	Theory	Practical	Tutorial	Theory	Practical/ Oral	Tutorial	Total
ITDO7014	Software Testing and QA	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test1	Test 2	Avg. of 2 Tests					
ITDO7014	Software Testing and QA	20	20	20	80	--	--	--	100

Course Objectives:

Sr. No.	Course Objectives
The course aims:	
1	To provide students with knowledge in Software Testing techniques.
2	To provide knowledge of Black Box and White Box testing techniques.
3	To provide skills to design test case plans for testing software.
4	To prepare test plans and schedules for testing projects.
5	To understand how testing methods can be used in a specialized environment.
6	To understand how testing methods can be used as an effective tool in providing quality assurance concerning software.

Course Outcomes:

Sr. No.	Course Outcomes	Cognitive levels of attainment as per Bloom's Taxonomy
On successful completion, of course, learner/student will be able to:		
1	Investigate the reason for bugs and analyze the principles in software testing to prevent and remove bugs.	L1, L2, L3
2	Understand various software testing methods and strategies.	L1, L2
3	Manage the testing process and testing metrics.	L1, L2, L3
4	Understand fundamental concepts of software automation and use automation tools.	L1, L2
5	Apply the software testing techniques in the real time environment.	L1, L2. L3
6	Use practical knowledge of a variety of ways to test software and quality attributes.	L1, L2

Prerequisite: Programming Language (C++, Java), Software Engineering

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours	CO Mapping
0	Prerequisite	Software Engineering Concepts, Basics of programming Language	**02**	
I	Testing Methodology	Introduction, Goals of Software Testing, Software Testing Definitions, Model for Software Testing, Effective Software Testing vs Exhaustive Software Testing, Software Failure Case Studies, Software Testing Terminology, Software Testing Life Cycle (STLC), Software Testing methodology, Verification and Validation, Verification requirements, Verification of high level design, Verification of low level design, validation. **Self-learning Topics:** Study any system/application, find requirement specifications and design the system. Select software testing methodology suitable to the application.	**07**	CO1
II	Testing Techniques	Dynamic Testing: Black Box Testing: Boundary Value Analysis, Equivalence Class Testing, State Table Based testing, Cause-Effect Graphing Based Testing, Error Guessing. White Box Testing Techniques: need, Logic Coverage Criteria, Basis Path Testing, Graph Matrices, Loop Testing, Data Flow testing, Mutation testing. Static Testing. Validation Activities: Unit validation, Integration, Function, System, Acceptance Testing. Regression Testing: Progressive vs. Regressive, Regression Testing, Regression Testability, Objectives of Regression Testing, Regression Testing Types, Define Problem, Regression Testing Techniques. **Self-learning Topics:** Select the test cases (positive and negative scenarios) for the selected system and Design Test cases for the system using any two studied testing techniques.	**09**	CO2
III	Managing the Test Process	Test Management: test organization, structure and of testing group, test planning, detailed test design and test Specification. Software Metrics: need, definition and Classification of software matrices. Testing Metrics for Monitoring and Controlling the Testing Process: attributes and corresponding metrics, estimation model for testing effort, architectural design, information flow matrix used for testing, function point and test point analysis. Efficient Test Suite Management:	**08**	CO3

		minimizing the test suite and its benefits, test suite minimization problem, test suite prioritization its type , techniques and measuring effectiveness. **Self-learning Topics:** Design quality matrix for your selected system		
IV	Test Automation	Automation and Testing Tools: need, categorization, selection and cost in testing tool, guidelines for testing tools. Study of testing tools: JIRA, Bugzilla, TestDirector and IBM Rational Functional Tester, Selenium etc. **Self-learning Topics:** Write down test cases, execute and manage using studied tools	**05**	CO4
V	Testing for specialized environment	Agile Testing, Agile Testing Life Cycle, Testing in Scrum phases, Challenges in Agile Testing Testing Web based Systems: Web based system, web technology evaluation, traditional software and web based software, challenges in testing for web based software, testing web based testing **Self-learning Topics:** Study the recent technical papers on software testing for upcoming technologies (Mobile, Cloud, Blockchain, IoT)	**04**	CO5
VI	Quality Management	Software Quality Management, McCall's quality factors and Criteria, ISO9000:2000, SIX sigma, Software quality management **Self-learning Topics:** Case Studies to Identify Quality Attributes Relationships for different types of Applications (Web based, Mobile based etc.)	**04**	CO6

Text Books:

1. Software Testing Principles and Practices Naresh Chauhan Oxford Higher Education
2. Software Testing and quality assurance theory and practice by Kshirasagar Naik, Priyadarshi Tripathy , Wiley Publication

References Books:

1. Effective Methods for Software Testing , third edition by Willam E. Perry, Wiley Publication
2. Software Testing Concepts and Tools by Nageswara Rao Pusuluri , Dreamtech press

Online References:

1. www.swayam.gov.in
2. www.coursera.org
3. http://onlinelibrary.wiley.com/journal/10.1002/(ISSN)1099 -1689

4. https://onlinecourses.nptel.ac.in/noc17_cs32/preview
5. https://www.youtube.com/channel/UC8w8_H_1uDfi2ftQx7a64uQ

Assessment:
Internal Assessment (IA) for 20 marks:

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➢ **Question paper format**

- Question Paper will comprise of a total of **six questions each carrying 20 marks Q.1** will be **compulsory** and should **cover maximum contents of the syllabus**
- **Remaining questions** will be **mixed in nature** (part (a) and part (b) of each question must be from different modules. For example, if Q.2 has part (a) from Module 3 then part (b) must be from any other Module randomly selected from all the modules)
- A total of **four questions** need to be answered.

Course Code	Course Name	Theory	Practical	Tutorial	Theory	Practical/ Oral	Tutorial	Total
ITDO7021	Theory Course	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test1	Test 2	Avg. of 2 Tests					
ITDO7021	Mobile Ad-hoc Network	20	20	20	80	--	--	--	100

Course Objectives:

Sr. No.	Course Objectives
The course aims:	
1	To identify and distinguish major issues associated with ad-hoc networks.
2	To analyze the basic concepts for designing a routing protocol for MANETs.
3	To explore and analyze routing protocols of Ad-hoc network.
4	To learn the concepts of Transport layer and Security issues for MANETs.
5	To apply fundamental principles characteristics of QoS and understand the need of Energy Management in wireless ad-hoc network.
6	To learn the basic concepts of Sensor Networks for Communication in Mobile Ad-hoc network.

Course Outcomes:

Sr. No.	Course Outcomes	Cognitive levels of attainment as per Bloom's Taxonomy

On successful completion, of course, learner/student will be able to:		
1	Understand the fundamentals of Mobile ad-hoc Networks.	L1,L2
2	Understand and be able to use advanced concept of MAC layer protocols more effectively.	L1,L2
3	Analyse different routing technologies for designing a routing protocol.	L1,L2,L3,L4
4	Understand the concepts of Transport layer and security features of Ad-hoc network.	L1,L2
5	Create the awareness of QoS and Energy Management in Ad hoc network.	L6
6	Demonstrate the ability of wireless sensor network.	L2,L3,L4

Prerequisite: Wireless Technology.

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours	CO Mapping
0	Prerequisite	Fundamentals of Wireless Communication, Wireless Metropolitan and Local Area Networks: IEEE 802.16 (WiMax) – Mesh mode, IEEE 802.11(Wi-Fi) – Architecture, Wireless Ad hoc Networks: WPAN Device Architecture, Wireless Sensor Network Applications, Advantages and Limitations, Wireless Network Security: Security in GSM; UMTS Security; Bluetooth Security; WEP.	**02**	--
I	Introduction to Ad-hoc Wireless Networks	Introduction: Cellular and Ad Hoc Wireless Networks, Applications of Ad Hoc Wireless Networks, Issues In Ad Hoc Wireless Networks: Medium Access Scheme, Routing, Multicasting, Transport Layer Protocols, Pricing, Quality of Service Provisioning, Addressing and Service Discovery, Energy Management, Scalability, Deployment Considerations, Ad Hoc Wireless Internet **Self-learning Topics:** Global Mobile Ad Hoc Network Market	**05**	CO1
II	Medium Access Control Protocols	Issues in Designing a MAC Protocol, Design Goals of MAC Protocols, Classification of MAC protocols, Contention-Based Protocols with Reservation Mechanisms and Scheduling Mechanisms, IEEE 802.11a and HiperLan standard **Self-learning Topics:** MAC Protocols that use Directional Antennas and Other MAC Protocols	**07**	CO2
III	Routing Protocols	**Routing Protocols in Ad-hoc Wireless Networks:** Introduction, Design issues, Classification of Routing Protocols: Routing information update mechanism, Use of temporal information for routing, Routing topology, Utilization of specific resources, **Multicast Routing in Ad-hoc Wireless Networks**: Introduction, Design Issues, Operation of Multicast Routing Protocols, An Architecture Reference Model for Multicast Routing Protocols **Self-learning Topics:** Table Driven Routing Protocols, Classifications of Multicast Routing Protocols	**08**	CO3

IV	Transport Layer and Security Protocols	**Transport Layer in Ad-hoc Wireless Networks**: Introduction, Design Issues and Goals of a Transport Layer Protocol; Classification of Transport Layer Solutions. **Security in Ad-hoc Wireless Networks:** Issues and Challenges in Security Provisioning, Network Security Attacks classification. **Self-learning Topics:** TCP over Transport Layer Solutions, Key Management and Secure Touting	**07**	CO4
V	Quality of Service and Energy Management	**Quality of Service in Ad-hoc Wireless Networks**: Introduction, Issues and Challenges in Providing QoS in Ad-hoc Wireless Networks, Classification of QoS Solutions **Energy Management in Ad-hoc Wireless Networks**: Introduction, Need for Energy Management in Ad-hoc Wireless Networks, Classification of Energy Management Schemes **Self-learning Topics:** MAC Layer Solutions Battery Management Schemes	**06**	CO5
VI	Wireless Sensor Networks	Introduction, Sensor Network Architecture, Data Dissemination, Data Gathering **Self-learning Topics:** Location Discovery and Quality of a Sensor Network	**04**	CO6

Text Books:

1. C. S. Ram Murthy, B. S. Manoj, "Ad Hoc Wireless Networks: Architectures and Protocols", Prentice Hall of India, 2nd Edition, 2005
2. C. K. Toh, "Adhoc Mobile Wireless Networks", Pearson Education, 2002
3. Wireless Communications & Networks, By William Stallings, Second Edition, Pearson Education

References Books:

1. Shih-Lin Wu Yu-Chee Tseng, "Wireless Ad Hoc Networking: Personal-Area, Local-Area, and the Sensory-Area Networks", Auerbach Publications, 2007
2. Subir Kumar Sarkar, "Adhoc Mobile Wireless Network: Principles, Protocols and Applications" CRC Press
3. Prashant Mohapatra and Sriramamurthy, "Ad Hoc Networks: Technologies and Protocols", Springer International Edition, 2009

Online References:

1. https://www.cousera.org
2. https://nptel.ac.in

Assessment:
Internal Assessment (IA) for 20 marks:

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- **Question paper format**

  - Question Paper will comprise of a total of **six questions each carrying 20 marks Q.1** will be **compulsory** and should **cover maximum contents of the syllabus**

  - **Remaining questions** will be **mixed in nature** (part (a) and part (b) of each question must be from different modules. For example, if Q.2 has part (a) from Module 3 then part (b) must be from any other Module randomly selected from all the modules)

  - A total of **four questions** need to be answered.

Course Code	Course Name	Theory	Practical	Tutorial	Theory	Practical/ Oral	Tutorial	Total
ITDO7022	ARVR	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test1	Test2	Avg. of 2 Tests					
ITDO7022	ARVR	20	20	20	80	--	--	--	100

Course Objectives:

Sr. No.	Course Objectives
The course aims:	
1	To understand the concepts of Augmented Reality and related technologies.
2	To understand the AR tracking system and use of computer vision in AR/MR.
3	To describe the technology for multimodal user interaction and authoring in AR.
4	To understand primitives of computer graphics fundamental.
5	To analyze various Hardware devices suitable for VR.
6	To analyze visual physiology and issues related to it.

Course Outcomes:

Sr. No.	Course Outcomes	Cognitive levels of attainment as per Bloom's Taxonomy
On successful completion, of course, learner/student will be able to:		
1	Identify and compare different Augmented Reality and Mixed Reality Technologies.	L1, L2
2	Apply concepts of Computer Vision for tracking in AR and MR Systems.	L3
3	Model different interfaces and authoring in AR/MR.	L3
4	Solve Computer Graphics Problems.	L1
5	Analyze application of VR hardware and software components.	L1, L2, L3
6	Identify issues related to visual physiology.	L1, L2

Prerequisite: Programming Language, Computer Graphics, Virtual Reality

DETAILED SYLLABUS:

Module	Title	Description	Hours	CO
0	Pre-requisite	Basics of Computer Graphics, Coordinate Systems, VR Introduction, Tracking in VR	**02**	--
I	Introduction to Augmented Reality and Mixed Reality	Definition and Scope, A Brief History of Augmented Reality, AR Architecture, Related Fields of AR (like Mixed Reality, Virtual Reality, Immersive Reality, Extended Reality) and Their comparison, General Architecture of Mixed Reality System, Algorithm Steps in Mixed Reality	**04**	CO1

		Self-Learning Topics: How AR/MR are related to Ubiquitous Computing, Multidimensional Systems.		
II	Tracking and Computer Vision for AR and MR	Multimodal Displays; Visual Perception; Spatial Display Model; Visual Displays; Tracking, Calibration and Registration; Coordinate Systems; Characteristics of Tracking Technology; Stationary Tracking Systems; Mobile Sensors; Optical Tracking; Sensor Fusion; Marker Tracking; Multiple Camera Infrared Tracking; Natural Feature Tracking by Detection; Incremental Tracking; Simultaneous Localization and Tracking; Outdoor Tracking **Self-Learning Topics**: Indoor Tracking, Full Body Tracking	**06**	CO2
III	Interaction, Modeling and Annotation and Authoring	Output Modalities, Input Modalities, Tangible Interfaces, Virtual User Interfaces on Real Surfaces, Multi-view Interfaces, Haptic Interaction, Multimodal Interaction, Specifying Geometry, Specifying Appearance, Semi-automatic Reconstruction, Free-form Modeling, Annotation, Requirement of AR Authoring, Elements of Authoring, Stand-alone Authoring Solutions, Plug-in Approaches, Web Technology **Self-Learning Topics**: Case Study on Object Annotation in Real Time, Avatar Modeling.	**06**	CO3
IV	Geometry of Virtual World	Geometric Modeling, 2D transformations, Homogenous coordinate system, 3D rotation and 6 degree of freedom, Viewport Transformation **Self:** Eye Transformation, demo of 2D transformation	**08**	CO4
V	Introduction to VR	Introduction to VR and definitions and its components,, Hardware components: Display devices: LCD, OLED Audio: Speakers, Earphones, Bone conduction Touch: Haptic Device GPU and CPU, Input devices like game controller, data glows, Joysticks Tracking Hardware: Industrial measurement Unit-IMU, Gyroscope, accelerometer Software component: Java3D, VRML **Self:** Feedback mechanisms in VR environment	**07**	CO5
VI	Visual Physiology, perception and tracking	Functioning of Eye with photoreceptors, Resolution for VR, Eye movements and issues with it in VR, Neuroscience of vision, Depth and motion perception, Frame rates and display, Orientation tracking, tilt and yaw drift correction, Tracking with camera **Self:** Light House approach	**06**	CO6

Textbooks:

1. Dieter Schmalsteig and Tobias Hollerer, "Augmented Reality- Principles and Practice", Pearson Education, Inc. 2016 Edition.
2. Chetankumar G Shetty, "Augmented Reality- Theory, Design and Development", Mc Graw Hill, 2020 Edition.
3. Alan B. Craig, "Understanding Augmented Reality – Concepts and Applications", Morgan Kaufmann, Elsevier, 2013 Edition.
4. **.** Hearn and Baker, "Computer Graphics- C version", 2nd edition, Pearson, 2002.
5. **.** R. K Maurya, "Computer Graphics with Virtual Reality", 3rd Edition, Wiley India, 2018.
6. . Steven M. LaVelle," Virtual Reality", Cambridge University press, 2019
7. **.** Grigore Burdea, Philippe Coiffet, "Virtual Reality Technology", 2nd Edition, Wiley India, 2003
8. **.** Vince, "Virtual Reality Systems", 1st Edition, Pearson Education, 2002

References Books:

1. Borko Furht, "Handbook of Augmented Reality", Springer, 2011 Edition.
2. Erin Pangilinan, Steve Lukas, and Vasanth Mohan, "Creating Augmented and Virtual Realities- Theory and Practice for Next-Generation Spatial Computing", O'Reilly Media, Inc., 2019 Edition.
3. Jens Grubert, Dr. Raphael Grasset, "Augmented Reality for Android Application Development", PACKT Publishing, 2013 Edition.
4. George Mather, "Foundations of Sensation and Perception", Psychology Press book; 3rd Edition, 2016
5. Tony Parisi, " Learning Virtual Reality", 1st edition, O'Reilly, 2015
6. Alan Craig and William Sherman," Understanding virtual reality: Interface, application and design", 2nd Edition, Morgan Kaufmann Publisher, 2019
7. Peter Shirley, Michael Ashikhmin, and Steve Marschner, "Fundamentals of Computer Graphics" ,A K Peters/CRC Press; 4th Edition, 2016.

Online Resources:

Sr. No.	Website Name
1.	www.nptel.ac.in
2.	www.coursera.org
3.	https://nptel.ac.in/courses/121/106/121106013/#
4.	http://msl.cs.uiuc.edu/vr/
5.	http://lavalle.pl/vr/

Assessment:

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- **Remaining questions** will be **mixed in nature** (part (a) and part (b) of each question must be from different modules. For example, if Q.2 has part (a) from Module 3 then part (b) must be from any other Module randomly selected from all the modules)
- A total of **four questions** need to be answered.

Course Code	Course Name	Theory	Practical	Tutorial	Theory	Practical /Oral	Tutorial	Total
ITDO7023	Quantum Computing	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test1	Test2	Avg. of 2 Tests					
ITDO7023	Quantum Computing	20	20	20	80	--	--	--	100

Course Objectives:

Sr. No.	Course Objectives
The course aims:	
1	To know the fundamentals of Quantum computing and its applications.
2	To understand the efficient quantum algorithms for several basic promise problems.
3	To gain knowledge about quantum computers and their principles.
4	To understand the principles, quantum information and limitation of quantum operations formalizing.
5	To gain knowledge about different quantum error and its correction techniques.
6	To gain knowledge about different quantum cryptographic algorithms.

Course Outcomes:

Sr. No.	Course Outcomes	Cognitive levels of attainment as per Bloom's Taxonomy
On successful completion, of course, learner/student will be able to:		
1	Basics of Quantum computing and its applications.	L1,L2
2	Solve various problems using quantum algorithms.	L1,L2
3	Methodology for quantum computers and their principles.	L1,L2,L3
4	Comprehend quantum noise and operations.	L1,L2,L3
5	Gain knowledge about different quantum error correction techniques.	L1,L2,L3
6	To gain knowledge about different quantum cryptographic algorithms.	L1,L2,L3

Prerequisite: NA

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours	CO Mapping

I	FUNDAMENTALS OF QUANTUM COMPUTING	Fundamental Concepts: Introduction and Overview – Global Perspectives – Quantum Bits – Quantum Computation – Quantum Algorithms – Experimental Quantum Information Processing – Quantum Information. Problems on Qubits **Self-learning Topics:** Detail of Quantum computing and its applications https://www.ibm.com/quantum-computing/what-is-quantum-computing/	**07**	**CO1**
II	QUANTUM COMPUTATION	Quantum Circuits – Quantum algorithms, Single Orbit operations, Control Operations, Measurement, Universal Quantum Gates, Simulation of Quantum Systems, Quantum Fourier transform, Phase estimation, Applications, Quantum search algorithms – Quantum counting – Speeding up the solution of NP – complete problems – Quantum Search for an unstructured database. Problems on Boolean functions and Quantum gates, Quantum gates and circuits. **Self-learning Topics:** Application of Quantum Computing	**08**	CO2
III	QUANTUM COMPUTERS	Guiding Principles, Conditions for Quantum Computation, Harmonic Oscillator Quantum Computer, Optical Photon Quantum Computer – Optical cavity Quantum electrodynamics, Ion traps, Nuclear Magnetic resonance. **Self-learning Topics:** Qiskit	**06**	CO3
IV	QUANTUM INFORMATIONS	Quantum noise and Quantum Operations – Classical Noise and Markov Processes, Quantum Operations, Examples of Quantum noise and Quantum Operations – Applications of Quantum operations, Limitations of the Quantum operations formalism, Distance Measures for Quantum information. Problems on Measurement **Self-learning Topics:** Case study on Quantum noise and operations.	**07**	CO4
V	QUANTUM ERROR CORRECTION	Introduction, Shor code, Theory of Quantum Error –Correction, Constructing Quantum Codes, Stabilizer codes, Fault – Tolerant Quantum Computation. **Self-learning Topics:** Case study on Quantum error correction.	**05**	CO5
VI	QUANTUM CRYPTOGRAPHY	Quantum Cryptography-Private Key Cryptography, Privacy Amplification and Information Reconciliation, Quantum Key Distribution, Privacy and Coherent Information, The Security of Quantum Key Distribution. Problems on Quantum error correction and cryptography. **Self-learning Topics:** Attacks on Quantum Cryptography	**06**	CO6

Text Books:

1. Chris Bernhardt," Quantum Computing for Everyone", (The MIT Press) Hardcover – Illustrate ,September 2020,
2. Willi-Hans Steeb; "Problems and Solutions in Quantum Computing and Quantum Information", Yorick Hardy Academic Consulting and Editorial Services (ACES) Private Limited, January 2020.
3. M.A. Nielsen and I.Chuang,"Quantum Computation and Quantum Information", Cambridge University Press 2010.

References Books:

1. Computer Science: An Introduction by N. DavidMermin 5. Yanofsky's and Mannucci, Quantum Computing for Computer Scientists.
2. Parag K. Lala ,Quantum Computing: A Beginner's Introduction Paperback" , McGraw Hill November 2020.
3. V. Sahni, "Quantum Computing", Tata McGraw-Hill Publishing company,2007.

4. Nayak, Chetan; Simon, Steven; Stern, Ady; Das Sarma, Sankar, "NonabelianAnyons and Quantum Computation", 2008.

Online References:

1. https://www.cousera.org
2. https://nptel.ac.in

Assessment:

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  - A total of **four questions** need to be answered.

Course Code	Course Name	Theory	Practical	Tutorial	Theory	Practical/ Oral	Tutorial	Total
ITDO7024	Information Retrieval System	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test1	Test 2	Avg. of 2 Tests					
ITDO7024	Information Retrieval System	20	20	20	80	--	--	--	100

Course Objectives:

Sr. No.	Course Objectives
The course aims:	
1	To learn the fundamentals of the information retrieval system.
2	To classify various Information retrieval models.
3	To demonstrate the query processing techniques and operations.
4	To compare the relevance of query languages for text and multimedia data.
5	To evaluate the significance of various indexing and searching techniques for information retrieval.
6	To develop an effective user interface for information retrieval.

Course Outcomes:

Sr. No.	Course Outcomes	Cognitive levels of attainment as per Bloom's Taxonomy
On successful completion, of course, learner/student will be able to:		
1	Define and describe the objectives of the basic concepts of the Information retrieval system.	L1,L2
2	Evaluate the taxonomy of different information retrieval models.	L1,L2,L3,L4
3	Try to solve and process text and multimedia retrieval queries and their operations.	L1,L2
4	Evaluate text processing techniques and operations in the information retrieval system.	L1,L2,L3,L4
5	Demonstrate and evaluate various indexing and searching techniques.	L1,L2,L3,L4
6	Design the user interface for an information retrieval system.	L1,L2,L3,L4

Prerequisite: Data Structures

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours	CO Mapping

0	Prerequisite	**Indexing and searching Algorithms**	**02**	
I	Introduction	Motivation, Basic Concepts, The Retrieval Process, Information System: Components, parts and types on information system; Definition and objectives on information retrieval system, Information versus Data Retrieval. Search Engines and browsers **Self-learning Topics:** Search Engines , Search API	**06**	CO1
II	IR Models	Modeling: Taxonomy of Information Retrieval Models, Retrieval: Formal Characteristics of IR models, Classic Information Retrieval, Alternative Set Theoretic models, Probabilistic Models, Structured text retrieval Models, models for Browsing; **Self-learning Topics:** Terrier	**06**	CO2
III	Query Processing and Operations	Query Languages: Keyword based Querying, Pattern Matching, Structural Queries, Query Protocols; Query Operations: User relevance feedback, Multimedia IR models: Data Modeling **Self-learning Topics:** Proximity Queries and Wildcard Queries	**06**	CO3
IV	Text Processing	Text and Multimedia languages and properties: Metadata, Markup Languages, Multimedia; Text Operations: Document Preprocessing, Document Clustering. **Self-learning Topics:** Digital Library : Greenstone	**06**	CO4
V	Indexing and Searching	Inverted files, Other indices for text, Boolean Queries, Sequential Searching, Pattern Matching, Structural Queries, Compression; Multimedia IR: Indexing and Searching:- A Generic Multimedia indexing approach, , Automatic Feature extraction; Searching Web: Challenges, Characterizing the web, Search Engines. Browsing, Meta searches, Searching using Hyperlinks. **Self-learning Topics:** Koha	**07**	CO5
VI	User interface and visualization	Human Computer interaction, the information access process, starting points, query specifications, context, using relevance judgments, interface support for the search process. **Self-learning Topics:** SeeSoft	**06**	CO6

Text Books:

1. Modern Information Retrieval, Ricardo Baeza-Yates,berthier Ribeiro- Neto, ACM Press- Addison Wesley
2. Information Retrieval Systems: Theory and Implementation, Gerald Kowaski, Kluwer Academic Publisher
3. Storage Network Management and Retrieval by Dr. Vaishali Khairnar, Nilima Dongre, Wiley India.

References Books:

1. Introduction to Information Retrieval By Christopher D. Manning and Prabhakar Raghavan, Cambridge University Press.
2. Information Storage & Retrieval By Robert Korfhage – John Wiley & Sons
3. Introduction to Modern Information Retrieval. G.G. Chowdhury. NealSchuman.

Online References:

1. https://www.geeksforgeeks.org/what-is-information-retrieval/
2. https://nlp.stanford.edu/IR-book/
3. https://en.wikipedia.org/wiki/Information_retrieval
4. https://people.ischool.berkeley.edu/~hearst/irbook/10/node1.html

Assessment:
Internal Assessment (IA) for 20 marks:

- IA will consist of Two Compulsory Internal Assessment Tests. Approximately 40% to 50% of syllabus content must be covered in First IA Test and remaining 40% to 50% of syllabus content must be covered in Second IA Test

➢ **Question paper format**

- Question Paper will comprise of a total of **six questions each carrying 20 marks Q.1** will be **compulsory** and should **cover maximum contents of the syllabus**
- **Remaining questions** will be **mixed in nature** (part (a) and part (b) of each question must be from different modules. For example, if Q.2 has part (a) from Module 3 then part (b) must be from any other Module randomly selected from all the modules)
- A total of **four questions** need to be answered.

Course Code	Course Name	Credits
ILO7011	Product Life Cycle Management	03

Course Objectives: Students will try :

1. To familiarize the students with the need, benefits and components of PLM
2. To acquaint students with Product Data Management & PLM strategies
3. To give insights into new product development program and guidelines for designing and developing a product
4. To familiarize the students with Virtual Product Development

Course Outcomes: Students will be able to :

1. Gain knowledge about phases of PLM, PLM strategies and methodology for PLM feasibility study and PDM implementation.
2. Illustrate various approaches and techniques for designing and developing products.
3. Apply product engineering guidelines / thumb rules in designing products for moulding, machining, sheet metal working etc.
4. Acquire knowledge in applying virtual product development tools for components, machining and manufacturing plant

Module	Detailed Contents	Hrs
01	**Introduction to Product Lifecycle Management (PLM):**Product Lifecycle Management (PLM), Need for PLM, Product Lifecycle Phases, Opportunities of Globalization, Pre-PLM Environment, PLM Paradigm, Importance & Benefits of PLM, Widespread Impact of PLM, Focus and Application, A PLM Project, Starting the PLM Initiative, PLM Applications **PLM Strategies:**Industrial strategies, Strategy elements, its identification, selection and implementation, Developing PLM Vision and PLM Strategy , Change management for PLM	10
02	**ProductDesign:**Product Design and Development Process, Engineering Design, Organization and Decomposition in Product Design, Typologies of Design Process Models, Reference Model, Product Design in the Context of the Product Development Process, Relation with the Development Process Planning Phase, Relation with the Post design Planning Phase, Methodological Evolution in Product Design, Concurrent Engineering, Characteristic Features of Concurrent Engineering, Concurrent Engineering and Life Cycle Approach, New Product Development (NPD) and Strategies, Product Configuration and Variant Management, The Design for X System, Objective Properties and Design for X Tools, Choice of Design for X Tools and Their Use in the Design Process	09
03	**Product Data Management (PDM):**Product and Product Data, PDM systems and importance, Components of PDM, Reason for implementing a PDM system, financial justification of PDM, barriers to PDM implementation	05
04	**Virtual Product Development Tools:**For components, machines, and manufacturing plants, 3D CAD systems and realistic rendering techniques,	05

	Digital mock-up, Model building, Model analysis, Modeling and simulations in Product Design, Examples/Case studies	
05	**Integration of Environmental Aspects in Product Design:** Sustainable Development, Design for Environment, Need for Life Cycle Environmental Strategies, Useful Life Extension Strategies, End-of-Life Strategies, Introduction of Environmental Strategies into the Design Process, Life Cycle Environmental Strategies and Considerations for Product Design	05
06	**Life Cycle Assessment and Life Cycle Cost Analysis:** Properties, and Framework of Life Cycle Assessment, Phases of LCA in ISO Standards, Fields of Application and Limitations of Life Cycle Assessment, Cost Analysis and the Life Cycle Approach, General Framework for LCCA, Evolution of Models for Product Life Cycle Cost Analysis	05

Assessment:

Internal:
Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

End Semester Theory Examination:
Some guidelines for setting up the question paper.Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

REFERENCES:

1. John Stark, "Product Lifecycle Management: Paradigm for 21st Century Product Realisation", Springer-Verlag, 2004. ISBN: 1852338105
2. Fabio Giudice, Guido La Rosa, AntoninoRisitano, "Product Design for the environment-A life cycle approach", Taylor & Francis 2006, ISBN: 0849327229
3. SaaksvuoriAntti, ImmonenAnselmie, "Product Life Cycle Management", Springer, Dreamtech, ISBN: 3540257314
4. Michael Grieve, "Product Lifecycle Management: Driving the next generation of lean thinking", Tata McGraw Hill, 2006, ISBN: 0070636265

Course Code	Course Name	Credits
ILO7012	Reliability Engineering	03

Objectives:

1. To familiarize the students with various aspects of probability theory
2. To acquaint the students with reliability and its concepts
3. To introduce the students to methods of estimating the system reliability of simple and complex systems
4. To understand the various aspects of Maintainability, Availability and FMEA procedure

Outcomes: Learner will be able to…

1. Understand and apply the concept of Probability to engineering problems
2. Apply various reliability concepts to calculate different reliability parameters
3. Estimate the system reliability of simple and complex systems
4. Carry out a Failure Mode Effect and Criticality Analysis

Module	Detailed Contents	Hrs
01	**Probability theory:** Probability: Standard definitions and concepts; Conditional Probability, Baye's Theorem. **Probability Distributions:** Central tendency and Dispersion; Binomial, Normal, Poisson, Weibull, Exponential, relations between them and their significance. **Measures of Dispersion:** Mean, Median, Mode, Range, Mean Deviation, Standard Deviation, Variance, Skewness and Kurtosis.	08
02	**Reliability Concepts:** Reliability definitions, Importance of Reliability, Quality Assurance and Reliability, Bath Tub Curve. **Failure Data Analysis:** Hazard rate, failure density, Failure Rate, Mean Time To Failure (MTTF), MTBF, Reliability Functions. **Reliability Hazard Models:** Constant Failure Rate, Linearly increasing, Time Dependent Failure Rate, Weibull Model. Distribution functions and reliability analysis.	08
03	**System Reliability:** System Configurations: Series, parallel, mixed configuration, k out of n structure, Complex systems.	05
04	**Reliability Improvement:** Redundancy Techniques: Element redundancy, Unit redundancy, Standby redundancies. Markov analysis. System Reliability Analysis – Enumeration method, Cut-set method, Success Path method, Decomposition method.	08
05	**Maintainability and Availability:** System downtime, Design for Maintainability: Maintenance requirements, Design methods: Fault Isolation and self-diagnostics, Parts standardization and Interchangeability, Modularization and Accessibility, Repair Vs Replacement. Availability – qualitative aspects.	05
06	**Failure Mode, Effects and Criticality Analysis:** Failure mode effects analysis, severity/criticality analysis, FMECA examples. Fault tree construction, basic symbols, development of functional reliability block diagram, Fau1t tree analysis and Event tree Analysis	05

Assessment:

Internal:
Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

End Semester Theory Examination:
Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

REFERENCES:

1. L.S. Srinath, "Reliability Engineering", Affiliated East-Wast Press (P) Ltd., 1985.
2. Charles E. Ebeling, "Reliability and Maintainability Engineering", Tata McGraw Hill.
3. B.S. Dhillion, C. Singh, "Engineering Reliability", John Wiley & Sons, 1980.
4. P.D.T. Conor, "Practical Reliability Engg.", John Wiley & Sons, 1985.
5. K.C. Kapur, L.R. Lamberson, "Reliability in Engineering Design", John Wiley & Sons.
6. Murray R. Spiegel, "Probability and Statistics", Tata McGraw-Hill Publishing Co. Ltd.

Course Code	Course Name	Credits
ILO7013	Management Information System	03

Objectives:

1. The course is blend of Management and Technical field.
2. Discuss the roles played by information technology in today's business and define various technology architectures on which information systems are built
3. Define and analyze typical functional information systems and identify how they meet the needs of the firm to deliver efficiency and competitive advantage
4. Identify the basic steps in systems development

Outcomes: Learner will be able to…

1. Explain how information systems Transform Business
2. Identify the impact information systems have on an organization
3. Describe IT infrastructure and its components and its current trends
4. Understand the principal tools and technologies for accessing information from databases to improve business performance and decision making
5. Identify the types of systems used for enterprise-wide knowledge management and how they provide value for businesses

Module	Detailed Contents	Hrs
01	Introduction To Information Systems (IS): Computer Based Information Systems, Impact of IT on organizations, Imporance of IS to Society. Organizational Strategy, Competitive Advantages and IS.	4
02	Data and Knowledge Management: Database Approach, Big Data, Data warehouse and Data Marts, Knowledge Management. Business intelligence (BI): Managers and Decision Making, BI for Data analysis and Presenting Results	7
03	Ethical issues and Privacy: Information Security. Threat to IS, and Security Controls	7
04	Social Computing (SC): Web 2.0 and 3.0, SC in business-shopping, Marketing, Operational and Analytic CRM, E-business and E-commerce – B2B B2C. Mobile commerce.	7
05	Computer Networks Wired and Wireless technology, Pervasive computing, Cloud computing model.	6
06	Information System within Organization: Transaction Processing Systems, Functional Area Information System, ERP and ERP support of Business Process. Acquiring Information Systems and Applications: Various System development life cycle models.	8

Assessment:

Internal:
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End Semester Theory Examination:

Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

REFERENCES:

1. Kelly Rainer, Brad Prince,Management Information Systems, Wiley
2. K.C. Laudon and J.P. Laudon, Management Information Systems: Managing the Digital Firm, 10th Ed., Prentice Hall, 2007.
3. D. Boddy, A. Boonstra, Managing Information Systems: Strategy and Organization, Prentice Hall, 2008

Course Code	Course Name	Credits
ILO7014	Design of Experiments	03

Objectives:

1. To understand the issues and principles of Design of Experiments (DOE)
2. To list the guidelines for designing experiments
3. To become familiar with methodologies that can be used in conjunction with experimental designs for robustness and optimization

Outcomes: Learner will be able to…

1. Plan data collection, to turn data into information and to make decisions that lead to appropriate action
2. Apply the methods taught to real life situations
3. Plan, analyze, and interpret the results of experiments

Module	Detailed Contents	Hrs
01	**Introduction** Strategy of Experimentation Typical Applications of Experimental Design Guidelines for Designing Experiments Response Surface Methodology	06
02	**Fitting Regression Models** Linear Regression Models Estimation of the Parameters in Linear Regression Models Hypothesis Testing in Multiple Regression Confidence Intervals in Multiple Regression Prediction of new response observation Regression model diagnostics Testing for lack of fit	08
03	**Two-Level Factorial Designs** The 2^2 Design The 2^3 Design The General 2^k Design A Single Replicate of the 2^k Design The Addition of Center Points to the 2^k Design, Blocking in the 2^k Factorial Design Split-Plot Designs	07
04	**Two-Level Fractional Factorial Designs** The One-Half Fraction of the 2^k Design The One-Quarter Fraction of the 2^k Design The General 2^{k-p} Fractional Factorial Design Resolution III Designs Resolution IV and V Designs Fractional Factorial Split-Plot Designs	07

05	**Response Surface Methods and Designs** Introduction to Response Surface Methodology The Method of Steepest Ascent Analysis of a Second-Order Response Surface Experimental Designs for Fitting Response Surfaces	07
06	**Taguchi Approach** Crossed Array Designs and Signal-to-Noise Ratios Analysis Methods Robust design examples	04

Assessment:

Internal:
Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

End Semester Theory Examination:
Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

REFERENCES:

1. Raymond H. Mayers, Douglas C. Montgomery, Christine M. Anderson-Cook, Response Surface Methodology: Process and Product Optimization using Designed Experiment, 3rd edition,John Wiley & Sons, New York, 2001
2. D.C. Montgomery, Design and Analysis of Experiments, 5th edition, John Wiley &Sons, New York, 2001
3. George E P Box, J Stuart Hunter, William G Hunter, Statics for Experimenters: Design, Innovation and Discovery, 2nd Ed. Wiley
4. W J Dimond, Peactical Experiment Designs for Engineers and Scintists, John Wiley and Sons Inc. ISBN: 0-471-39054-2
5. Design and Analysis of Experiments (Springer text in Statistics), Springer by A.M. Dean, and D. T.Voss

Course Code	Course Name	Credits
ILO7015	Operations Research	03

Objectives:

1. Formulate a real-world problem as a mathematical programming model.
2. Understand the mathematical tools that are needed to solve optimization problems.
3. Use mathematical software to solve the proposed models.

Outcomes: Learner will be able to…

1. Understand the theoretical workings of the simplex method, the relationship between a linear program and its dual, including strong duality and complementary slackness.
2. Perform sensitivity analysis to determine the direction and magnitude of change of a model's optimal solution as the data change.
3. Solve specialized linear programming problems like the transportation and assignment problems, solve network models like the shortest path, minimum spanning tree, and maximum flow problems.
4. Understand the applications of integer programming and a queuing model and compute important performance measures

Module	Detailed Contents	Hrs
01	**Introduction to Operations Research**: Introduction, , Structure of the Mathematical Model, Limitations of Operations Research **Linear Programming**: Introduction, Linear Programming Problem, Requirements of LPP, Mathematical Formulation of LPP, Graphical method, Simplex Method Penalty Cost Method or Big M-method, Two Phase Method, Revised simplex method, **Duality**, Primal – Dual construction, Symmetric and Asymmetric Dual, Weak Duality Theorem, Complimentary Slackness Theorem, Main Duality Theorem, Dual Simplex Method, Sensitivity Analysis **Transportation Problem**: Formulation, solution, unbalanced Transportation problem. Finding basic feasible solutions – Northwest corner rule, least cost method and Vogel's approximation method. Optimality test: the stepping stone method and MODI method. **Assignment Problem**: Introduction, Mathematical Formulation of the Problem, Hungarian Method Algorithm, Processing of n Jobs Through Two Machines and m Machines, Graphical Method of Two Jobs m Machines Problem Routing Problem, Travelling Salesman Problem **Integer Programming Problem**: Introduction, Types of Integer Programming Problems, Gomory's cutting plane Algorithm, Branch and Bound Technique. Introduction to Decomposition algorithms.	14
02	**Queuing models**: queuing systems and structures, single server and multi-server models, Poisson input, exponential service, constant rate service, finite and infinite population	05
03	**Simulation**: Introduction, Methodology of Simulation, Basic Concepts,	05

	Simulation Procedure, Application of Simulation Monte-Carlo Method: Introduction, Monte-Carlo Simulation, Applications of Simulation, Advantages of Simulation, Limitations of Simulation	
04	**Dynamic programming**. Characteristics of dynamic programming. Dynamic programming approach for Priority Management employment smoothening, capital budgeting, Stage Coach/Shortest Path, cargo loading and Reliability problems.	05
05	**Game Theory**. Competitive games, rectangular game, saddle point, minimax (maximin) method of optimal strategies, value of the game. Solution of games with saddle points, dominance principle. Rectangular games without saddle point – mixed strategy for 2 X 2 games.	05
06	**Inventory Models**: Classical EOQ Models, EOQ Model with Price Breaks, EOQ with Shortage, Probabilistic EOQ Model,	05

Assessment:

Internal:
Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

End Semester Theory Examination:
Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

REFERENCES:

1. Taha, H.A. "Operations Research - An Introduction", Prentice Hall, (7th Edition), 2002.
2. Ravindran, A, Phillips, D. T and Solberg, J. J. "Operations Research: Principles and Practice", John Willey and Sons, 2nd Edition, 2009.
3. Hiller, F. S. and Liebermann, G. J. "Introduction to Operations Research", Tata McGraw Hill, 2002.
4. Operations Research, S. D. Sharma, KedarNath Ram Nath-Meerut.
5. Operations Research, KantiSwarup, P. K. Gupta and Man Mohan, Sultan Chand & Sons.

Course Code	Course Name	Credits
ILO7016	Cyber Security and Laws	03

Objectives:

1. To understand and identify different types cybercrime and cyber law
2. To recognized Indian IT Act 2008 and its latest amendments
3. To learn various types of security standards compliances

Outcomes: Learner will be able to…

1. Understand the concept of cybercrime and its effect on outside world
2. Interpret and apply IT law in various legal issues
3. Distinguish different aspects of cyber law
4. Apply Information Security Standards compliance during software design and development

Module	Detailed Contents	Hrs
01	**Introduction to Cybercrime:** Cybercrime definition and origins of the world, Cybercrime and information security, Classifications of cybercrime, Cybercrime and the Indian ITA 2000, A global Perspective on cybercrimes.	4
02	**Cyber offenses & Cybercrime:** How criminal plan the attacks, Social Engg, Cyber stalking, Cyber café and Cybercrimes, Bot nets, Attack vector, Cloud computing, Proliferation of Mobile and Wireless Devices, Trends in Mobility, Credit Card Frauds in Mobile and Wireless Computing Era, Security Challenges Posed by Mobile Devices, Registry Settings for Mobile Devices, Authentication Service Security, Attacks on Mobile/Cell Phones, Mobile Devices: Security Implications for Organizations, Organizational Measures for Handling Mobile, Devices-Related Security Issues, Organizational Security Policies and Measures in Mobile Computing Era, Laptops	9
03	**Tools and Methods Used in Cyber line** Phishing, Password Cracking, Key loggers and Spywares, Virus and Worms, Steganography, DoS and DDoS Attacks, SQL Injection, Buffer Over Flow, Attacks on Wireless Networks, Phishing, Identity Theft (ID Theft)	6
04	**The Concept of Cyberspace** E-Commerce , The Contract Aspects in Cyber Law ,The Security Aspect of Cyber Law ,The Intellectual Property Aspect in Cyber Law , The Evidence Aspect in Cyber Law , The Criminal Aspect in Cyber Law, Global Trends in Cyber Law , Legal Framework for Electronic Data Interchange Law Relating to Electronic Banking , The Need for an Indian Cyber Law	8
05	**Indian IT Act.** Cyber Crime and Criminal Justice : Penalties, Adjudication and Appeals Under the IT Act, 2000, IT Act. 2008 and its Amendments	6
06	**Information Security Standard compliances** SOX, GLBA, HIPAA, ISO, FISMA, NERC, PCI.	6

Assessment:

Internal:
Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

End Semester Theory Examination:

Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination.

In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

REFERENCES:

1. Nina Godbole, Sunit Belapure, *Cyber Security*, Wiley India, New Delhi
2. The Indian Cyber Law by Suresh T. Vishwanathan; Bharat Law House New Delhi
3. The Information technology Act, 2000; Bare Act- Professional Book Publishers, New Delhi.
4. Cyber Law & Cyber Crimes By Advocate Prashant Mali; Snow White Publications, Mumbai
5. Nina Godbole, *Information Systems Security*, Wiley India, New Delhi
6. Kennetch J. Knapp, *Cyber Security* &*Global Information Assurance* Information Science Publishing.
7. William Stallings, *Cryptography and Network Security*, Pearson Publication
8. Websites for more information is available on : The Information Technology ACT, 2008- TIFR : https://www.tifrh.res.in
9. Website for more information , A Compliance Primer for IT professional : https://www.sans.org/reading-room/whitepapers/compliance/compliance-primer-professionals- 33538

Course Code	Course Name	Credits
ILO7017	Disaster Management and Mitigation Measures	03

Objectives:

1. To understand physics and various types of disaster occurring around the world
2. To identify extent and damaging capacity of a disaster
3. To study and understand the means of losses and methods to overcome /minimize it.
4. To understand role of individual and various organization during and after disaster
5. To understand application of GIS in the field of disaster management
6. To understand the emergency government response structures before, during and after disaster

Outcomes: Learner will be able to…

1. Get to know natural as well as manmade disaster and their extent and possible effects on the economy.
2. Plan of national importance structures based upon the previous history.
3. Get acquainted with government policies, acts and various organizational structure associated with an emergency.
4. Get to know the simple do's and don'ts in such extreme events and act accordingly.

Module	Detailed Contents	Hrs
01	Introduction 1.1 Definition of Disaster, hazard, global and Indian scenario, general perspective, importance of study in human life, Direct and indirect effects of disasters, long term effects of disasters. Introduction to global warming and climate change.	03
02	Natural Disaster and Manmade disasters: Natural Disaster: Meaning and nature of natural disaster, Flood, Flash flood, drought, cloud burst, Earthquake, Landslides, Avalanches, Volcanic eruptions, Mudflow, Cyclone, Storm, Storm Surge, climate change, global warming, sea level rise, ozone depletion Manmade Disasters: Chemical, Industrial, Nuclear and Fire Hazards. Role of growing population and subsequent industrialization, urbanization and changing lifestyle of human beings in frequent occurrences of manmade disasters.	09
03	Disaster Management, Policy and Administration Disaster management: meaning, concept, importance, objective of disaster management policy, disaster risks in India, Paradigm shift in disaster management. Policy and administration: Importance and principles of disaster management policies, command and co-ordination of in disaster management, rescue operations-how to start with and how to proceed in due course of time, study of flowchart showing the entire process.	06
04	Institutional Framework for Disaster Management in India: 4.1 Importance of public awareness, Preparation and execution of emergency management programme.Scope and responsibilities of National Institute of Disaster Management (NIDM) and National disaster management authority (NDMA) in India.Methods and measures to avoid disasters, Management of	06

	casualties, set up of emergency facilities, importance of effective communication amongst different agencies in such situations. 4.2 Use of Internet and softwares for effective disaster management. Applications of GIS, Remote sensing and GPS in this regard.	
05	Financing Relief Measures: Ways to raise finance for relief expenditure, role of government agencies and NGO's in this process, Legal aspects related to finance raising as well as overall management of disasters. Various NGO's and the works they have carried out in the past on the occurrence of various disasters, Ways to approach these teams. International relief aid agencies and their role in extreme events.	09
06	Preventive and Mitigation Measures: Pre-disaster, during disaster and post-disaster measures in some events in general Structural mapping: Risk mapping, assessment and analysis, sea walls and embankments, Bio shield, shelters, early warning and communication Non Structural Mitigation: Community based disaster preparedness, risk transfer and risk financing, capacity development and training, awareness and education, contingency plans. Do's and don'ts in case of disasters and effective implementation of relief aids.	06

Assessment:

Internal:
Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

End Semester Theory Examination:
Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

REFERENCES:

1. 'Disaster Management' by Harsh K.Gupta, Universities Press Publications.
2. 'Disaster Management: An Appraisal of Institutional Mechanisms in India' by O.S.Dagur, published by Centre for land warfare studies, New Delhi, 2011.
3. 'Introduction to International Disaster Management' by Damon Copolla, Butterworth Heinemann Elseveir Publications.
4. 'Disaster Management Handbook' by Jack Pinkowski, CRC Press Taylor and Francis group.
5. 'Disaster management & rehabilitation' by Rajdeep Dasgupta, Mittal Publications, New Delhi.
6. 'Natural Hazards and Disaster Management, Vulnerability and Mitigation – R B Singh, Rawat Publications
7. Concepts and Techniques of GIS –C.P.Lo Albert, K.W. Yonng – Prentice Hall (India) Publications. (Learners are expected to refer reports published at national and International level and updated information available on authentic web sites)

Course Code	Course Name	Credits
ILO7018	Energy Audit and Management	03

Objectives:

1. To understand the importance energy security for sustainable development and the fundamentals of energy conservation.
2. To introduce performance evaluation criteria of various electrical and thermal installations to facilitate the energy management
3. To relate the data collected during performance evaluation of systems for identification of energy saving opportunities.

Outcomes: Learner will be able to…

1. To identify and describe present state of energy security and its importance.
2. To identify and describe the basic principles and methodologies adopted in energy audit of an utility.
3. To describe the energy performance evaluation of some common electrical installations and identify the energy saving opportunities.
4. To describe the energy performance evaluation of some common thermal installations and identify the energy saving opportunities
5. To analyze the data collected during performance evaluation and recommend energy saving measures

Module	Detailed Contents	Hrs
01	**Energy Scenario:** Present Energy Scenario, Energy Pricing, Energy Sector Reforms, Energy Security, Energy Conservation and its Importance, Energy Conservation Act- 2001 and its Features. Basics of Energy and its various forms, Material and Energy balance	04
02	**Energy Audit Principles:** Definition, Energy audit- need, Types of energy audit, Energy management (audit) approach-understanding energy costs, Bench marking, Energy performance, Matching energy use to requirement, Maximizing system efficiencies, Optimizing the input energy requirements, Fuel and energy substitution. Elements of monitoring& targeting; Energy audit Instruments; Data and information-analysis. Financial analysis techniques: Simple payback period, NPV, Return on investment (ROI), Internal rate of return (IRR)	08
03	**Energy Management and Energy Conservation in Electrical System:** Electricity billing, Electrical load management and maximum demand Control; Power factor improvement, Energy efficient equipments and appliances, star ratings. **Energy efficiency measures in lighting system, Lighting control:** Occupancy sensors, daylight integration, and use of intelligent controllers. Energy conservation opportunities in: water pumps, industrial drives, induction motors, motor retrofitting, soft starters, variable speed drives.	10

04	**Energy Management and Energy Conservation in Thermal Systems:** Review of different thermal loads; Energy conservation opportunities in: Steam distribution system, Assessment of steam distribution losses, Steam leakages, Steam trapping, Condensate and flash steam recovery system. General fuel economy measures in Boilers and furnaces, Waste heat recovery, use of insulation- types and application. HVAC system: Coefficient of performance, Capacity, factors affecting Refrigeration and Air Conditioning system performance and savings opportunities.	10
05	**Energy Performance Assessment:** On site Performance evaluation techniques, Case studies based on: Motors and variable speed drive, pumps, HVAC system calculations; Lighting System: Installed Load Efficacy Ratio (ILER) method, Financial Analysis.	04
06	**Energy conservation in Buildings:** Energy Conservation Building Codes (ECBC): Green Building, LEED rating, Application of Non-Conventional and Renewable Energy Sources	03

Assessment:

Internal:
Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

End Semester Theory Examination:
Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

REFERENCES:

1. Handbook of Electrical Installation Practice, Geofry Stokes, Blackwell Science
2. Designing with light: Lighting Handbook, By Anil Valia, Lighting System
3. Energy Management Handbook, By W.C. Turner, John Wiley and Sons
4. Handbook on Energy Audits and Management, edited by A. K. Tyagi, Tata Energy Research Institute (TERI).
5. Energy Management Principles, C.B.Smith, Pergamon Press
6. Energy Conservation Guidebook, Dale R. Patrick, S. Fardo, Ray E. Richardson, Fairmont Press
7. Handbook of Energy Audits, Albert Thumann, W. J. Younger, T. Niehus, CRC Press
8. www.energymanagertraining.com
9. www.bee-india.nic.in

Course Code	Course Name	Credits
ILO7019	Development Engineering	03

Objectives:

1. To familiarise the characteristics of rural Society and the Scope, Nature and Constraints of rural Development
2. To provide an exposure toimplications of 73rdCAA on Planning, Development and Governance of Rural Areas
3. An exploration of human values, which go into making a 'good' human being, a 'good' professional, a 'good' society and a 'good life' in the context of work life and the personal life of modern Indian professionals
4. To familiarise the Nature and Type of Human Values relevant to Planning Institutions

Outcomes: Learner will be able to…

1. Demonstrateunderstanding of knowledge for Rural Development.
2. Prepare solutions for Management Issues.
3. Take up Initiatives and design Strategies to complete the task
4. Develop acumen for higher education and research.
5. Demonstrate the art of working in group of different nature
6. Develop confidence to take up rural project activities independently

Module	Contents	Hrs
1	Introduction to Rural Development Meaning, nature and scope of development; Nature of rural society in India; Hierarchy of settlements; Social, economic and ecological constraints for rural development Roots of Rural Development in India Rural reconstruction and Sarvodaya programme before independence; Impact of voluntary effort and Sarvodaya Movement on rural development; Constitutional direction, directive principles; Panchayati Raj - beginning of planning and community development; National extension services.	08
2	Post-Independence rural Development Balwant Rai Mehta Committee - three tier system of rural local Government; Need and scope for people's participation and Panchayati Raj; Ashok Mehta Committee - linkage between Panchayati Raj, participation and rural development.	06
3	Rural Development Initiatives in Five Year Plans Five Year Plans and Rural Development; Planning process at National, State, Regional and District levels; Planning, development, implementing and monitoring organizations and agencies; Urban and rural interface - integrated approach and local plans; Development initiatives and their convergence; Special component plan and sub-plan for the weaker section; Micro-eco zones; Data base for local planning; Need for decentralized planning; Sustainable rural development	07

4	Post 73rd Amendment Scenario 73rd Constitution Amendment Act, including - XI schedule, devolution of powers, functions and finance; Panchayati Raj institutions - organizational linkages; Recent changes in rural local planning; Gram Sabha - revitalized Panchayati Raj; Institutionalization; resource mapping, resource mobilization including social mobilization; Information Technology and rural planning; Need for further amendments.	**04**
5	Values and Science and Technology Material development and its values; the challenge of science and technology; Values in planning profession, research and education Types of Values Psychological values — integrated personality; mental health; Societal values — the modern search for a good society; justice, democracy, rule of law, values in the Indian constitution; Aesthetic values — perception and enjoyment of beauty; Moral and ethical values; nature of moral judgment; Spiritual values; different concepts; secular spirituality; Relative and absolute values; Human values— humanism and human values; human rights; human values as freedom, creativity, love and wisdom	**10**
6	Ethics Canons of ethics; ethics of virtue; ethics of duty; ethics of responsibility; Work ethics; Professional ethics; Ethics in planning profession, research and education	**04**

Assessment:

Internal Assessment for 20 marks:
Consisting **Two Compulsory Class Tests**
First test based onapproximately 40% of contents and second test based on remainingcontents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:
Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved**

Reference

1. ITPI, Village Planning and Rural Development, ITPI, New Delhi
2. Thooyavan, K.R. Human Settlements: A 2005 MA Publication, Chennai
3. GoI, Constitution (73rdGoI, New Delhi Amendment) Act, GoI, New Delhi
4. Planning Commission, Five Year Plans, Planning Commission
5. Planning Commission, Manual of Integrated District Planning, 2006, Planning Commission New Delhi
6. Planning Guide to Beginners
7. Weaver, R.C., The Urban Complex, Doubleday
8. Farmer, W.P. et al, Ethics in Planning, American Planning Association, Washington

9. How, E., Normative Ethics in Planning, Journal of Planning Literature, Vol.5, No.2, pp. 123-150
10. Watson, V. Conflicting Rationalities: -- Implications for Planning Theory and Ethics, Planning Theory and Practice, Vol. 4, No.4, pp.395 – 407

Program Structure for Fourth Year Information Technology

Semester VII & VIII

UNIVERSITY OF MUMBAI

(With Effect from 2022-2023)

Semester VIII

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		
		Theory	Pract. Tut.	Theory	Pract.	Total
ITC801	Blockchain and DLT	3	--	3	--	3
ITDO801X	**Department Optional Course – 5**	**3**	**--**	**3**	**--**	**3**
ITDO802X	**Department Optional Course – 6**	**3**	**--**	**3**	**--**	**3**
ITIO801X	**Institute Optional Course – 2**	**3**	**--**	**3**	**--**	**3**
ITL801	Blockchain Lab	--	2	--	1	1
ITL802	Cloud computing	--	2	--	1	1
ITP801	Major Project II	--	12#	--	6	6
Total		**12**	**16**	**12**	**8**	**20**

Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Prac /oral	Total
		Internal Assessment			End Sem Exam	Exam. Duration (in Hrs)			
		Test1	Test2	Avg					
ITC801	Blockchain and DLT	20	20	20	80	3	--	--	100
ITDO801X	**Department Optional Course – 5**	**20**	**20**	**20**	**80**	**3**	**--**	**--**	**100**
ITDO802X	**Department Optional Course – 6**	**20**	**20**	**20**	**80**	**3**	**--**	**--**	**100**
ITIO801X	**Institute Optional Course – 2**	**20**	**20**	**20**	**80**	**3**	**--**	**--**	**100**
ITL801	Blockchain Lab	--	--	--	--	--	25	25	50
ITL802	Cloud computing	--	--	--	--	--	25	25	50
ITP801	Major Project II	--	--	--	--	--	100	50	150
Total		**--**	**--**	**80**	**320**	**--**	**150**	**100**	**650**

# indicates work load of Learner (Not Faculty), for Major Project

Students group and load of faculty per week.

Mini Project 1 and 2 :
Students can form groups with minimum 2 (Two) and not more than 4 (Four)

Faculty Load : 1 hour per week per four groups

Major Project 1 and 2 :
Students can form groups with minimum 2 (Two) and not more than 4 (Four)
Faculty Load : In Semester VII – ½ hour per week per project group
In Semester VIII – 1 hour per week per project group

ITDO801X	**Department Optional Course – 5**
ITDO8011	Big Data Analytics
ITDO8012	Reinforcement learning
ITDO8013	Simulation and Modeling
ITDO8014	Knowledge management

ITDO802X	**Department Optional Course –6**
ITDO8021	User Interface Design
ITDO8022	Robotics
ITDO8023	ERP
ITDO8024	Cloud computing and Services

ILO801X	**Institute Optional Course – 2 (Common for all branches will be notified)**
ILO8011	Project Management
ILO8012	Finance Management
ILO8013	Entrepreneurship Development and Management
ILO8014	Human Resource Management
ILO8015	Professional Ethics and CSR
ILO8016	Research Methodology
ILO8017	IPR and Patenting
ILO8018	Digital Business Management
ILO8019	Environmental Management

Course Code	Course Name	Theory	Practical	Tutorial	Theory	Practical/ Oral	Tutorial	Total
ITC801	Blockchain and DLT	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test1	Test 2	Avg. of 2 Tests					
ITC801	Blockchain and DLT	20	20	20	80	--	--	--	100

Course Objectives:

Sr.No	Course Objectives
1	To get acquainted with the concept of Distributed ledger system and Blockchain.
2	To learn the concepts of consensus and mining in Blockchain through the Bitcoin network.
3	To understand Ethereum and develop-deploy smart contracts using different tools and frameworks.
4	To understand permissioned Blockchain and explore Hyperledger Fabric.
5	To understand different types of crypto assets.
6	To apply Blockchain for different domains IOT, AI and Cyber Security.

Course Outcomes:

Sr. No	Course Outcomes	Cognitive levels of attainment as per Bloom's Taxonomy
On successful completion, of course, learner/student will be able to:		
1	Describe the basic concept of Blockchain and Distributed Ledger Technology.	L1,L2
2	Interpret the knowledge of the Bitcoin network, nodes, keys, wallets and transactions	L1,L2,L3
3	Implement smart contracts in Ethereum using different development frameworks.	L1,L2,L3
4	Develop applications in permissioned Hyperledger Fabric network.	L1,L2,L3
5	Interpret different Crypto assets and Crypto currencies	L1,L2,L3
6	Analyze the use of Blockchain with AI, IoT and Cyber Security using case studies.	L1,L2,L3,L4

Prerequisite: Cryptography and Distributed Systems.

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours	CO Mapping
0	Cryptography and Distributed Systems (prerequisite)	Hash functions, Public – Private keys, SHA, ECC, Digital signatures, Fundamental concepts of Distributed systems	**02**	—-

I	Introduction to DLT and Blockchain	Introduction to Blockchain: Technical definition of Blockchain. Elements of a blockchain Features of Blockchain Type of Blockchain, What is DLT . DLT V/S Blockchain CAP theorem Byzantine Generals Problem Consensus Mechanism and its Type Cryptographic primitives and data structure used in blockchain **Block in a Blockchain**: Structure of a Block, Block Header Hash and Block Height, The Genesis Block, Linking Blocks in the Blockchain, Merkle Tree. **Self-learning Topics:** Blockchain Demo	**04**	CO1
II	Bitcoin	What is Bitcoin and the history of Bitcoin, Bitcoin Transactions, Bitcoin Concepts: keys, addresses and wallets, Bitcoin Transactions, UTXO. validation of transactions, Bitcoin Keys , Addresses, ECC , Base58 , BIP-38 , Pay-to Script and Multisig Addresses, Vanity Addresses , Concept of Wallet, Wallet Technologies in Bitcoin HD wallet from Seed. Transaction Scripts and Scripts address, Bitcoin Mining and Difficulty levels Structure of Blocks and Blockheader and Genesis Block , linking of Block. **Bitcoin Network**: Bitcoin Core node and API, Peer-to-Peer Network Architecture, Node Types and Roles, Incentive based Engineering, The Extended Bitcoin Network, Bitcoin Relay Networks, Network Discovery, Full Nodes, Exchanging "Inventory", Simplified Payment Verification (SPV) Nodes, SPV Nodes and Privacy, Transaction Pools, Blockchain Forks Bitcoin Testnet Basics of Bitcoin Forensics: Analysis of Address and Wallet , Clustering of Addresses following Money **Self-learning Topics:** Study and compare different consensus algorithms like PoA, PoS, pBFT	**08**	CO2
III	Permissionless Blockchain: Ethereum	Introduction to Ethereum, Ethereum 1.0 and 2.0 , Turing completeness EVM and compare with bitcoin Basics of Ether Units, Ethereum Wallets Working with Metamask EOA and Contracts Transaction:: Structure of Transaction, Transaction Nonce, Transaction GAS, Recipient, Values and Data, Transmitting Values to EOA and Contracts **Smart Contracts and Solidity** Development environment and client , Basic of Solidity and Web 3 Life cycle of Smart contract, Smart Contract programming using solidity, Metamask (Ethereum	**10**	CO3

		Wallet), Setting up development environment, Use cases of Smart Contract, Smart Contracts: Opportunities and Risk. **Smart Contract Deployment**: Introduction to Truffle, Use of Remix and test networks for deployment **Self-learning Topics:** Smart contract development using Java or Python		
IV	Permissioned Blockchain: Hyperledger Fabric	Introduction to Framework, Tools and Architecture of Hyperledger Fabric Blockchain. **Components**: Certificate Authority, Nodes, Chain codes, Channels, Consensus: Solo, Kafka, RAFT Designing Hyperledger Blockchain Other Challenges : Interoperability and Scalability of blockchain **Self-learning Topics:** Fundamentals of Hyperledger Composer	**07**	CO4
V	Crypto assets and Cryptocurrencies	ERC20 and ERC721 Tokens, comparison between ERC20 & ERC721, NFT, ICO, STO, Different Crypto currencies **Self-learning Topics:** Defi, Metaverse, Types of cryptocurrencies	**04**	CO5
VI	Blockchain Applications & case studies	Blockchain in IoT, AI, Cyber Security **Self-learning Topics:** Applications of Blockchain in various domains Education, Energy, Healthcare, real-estate, logistics, supply chain	**04**	CO6

Text Books:

1. "Mastering Bitcoin, PROGRAMMING THE OPEN BLOCKCHAIN", 2nd Edition by Andreas M. Antonopoulos, June 2017, Publisher(s): O'Reilly Media, Inc. ISBN: 9781491954386.
2. Mastering Ethereum, Building Smart Contract and Dapps, Andreas M. Antonopoulos Dr. Gavin Wood, O'reilly.
3. Blockchain Technology, Chandramouli Subramanian, Asha A George, Abhillash K. A and Meena Karthikeyen, Universities press.
4. Hyperledger Fabric In-Depth: Learn, Build and Deploy Blockchain Applications Using Hyperledger Fabric, Ashwani Kumar, BPB publications
5. Solidity Programming Essentials: A beginner's Guide to Build Smart Contracts for Ethereum and Blockchain, Ritesh Modi, Packt publication
6. Cryptoassets: The Innovative Investor's Guide to Bitcoin and Beyond, Chris Burniske & Jack Tatar.

Reference Books:

1. Mastering Blockchain, Imran Bashir, Packt Publishing 2. Mastering Bitcoin Unlocking Digital Cryptocurrencies, Andreas M. Antonopoulos, O'Reilly Media
2. Blockchain Technology: Concepts and Applications, Kumar Saurabh and Ashutosh Saxena, Wiley.
3. The Basics of Bitcoins and Blockchains: An Introduction to Cryptocurrencies and the Technology that Powers Them, Antony Lewis. for Ethereum and Blockchain, Ritesh Modi, Packt publication.

4. Mastering Bitcoin Unlocking Digital Cryptocurrencies, Andreas M. Antonopoulos, O'Reilly Media

Online References:

1. NPTEL courses:
    a. Blockchain and its Applications,
    b. Blockchain Architecture Design and Use Cases
2. www.swayam.gov.in/
3. www.coursera.org
4. https://ethereum.org/en/
5. https://www.trufflesuite.com/tutorials
6. https://hyperledger-fabric.readthedocs.io/en/release-2.2/whatis.h
7. Blockchain demo: https://andersbrownworth.com/blockchain/
8. Blockchain Demo: Public / Private Keys & Signing: https://andersbrownworth.com/blockchain/public-private-keys/

Assessment:
Internal Assessment (IA) for 20 marks:

- IA will consist of Two Compulsory Internal Assessment Tests. Approximately 40% to 50% of syllabus content must be covered in First IA Test and remaining 40% to 50% of syllabus content must be covered in Second IA Test

- **Question paper format**

    - Question Paper will comprise of a total of **six questions each carrying 20 marks Q.1** will be **compulsory** and should **cover maximum contents of the syllabus**

    - **Remaining questions** will be **mixed in nature** (part (a) and part (b) of each question must be from different modules. For example, if Q.2 has part (a) from Module 3 then part (b) must be from any other Module randomly selected from all the modules)

A total of **four questions** need to be answered.

		Teaching Scheme (Contact Hours)			Credits Assigned			
Course Code	**Course Name**	**Theory**	**Practical**	**Tutorial**	**Theory**	**Practical & Oral**	**Tutorial**	**Total**
ITL801	Blockchain Lab	--	2	--	--	1	--	01

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Practical/ Oral	Total
		Internal assessment			End Sem. Exam			
		Test1	Test 2	Avg. of 2 Tests				
ITL801	Blockchain Lab	--	--	--	--	25	25	50

Lab Objectives:

Sr.No	Lab Objectives
1	To develop and deploy smart contracts on local Blockchain.
2	To deploy the smart contract on test networks.
3	To deploy and publish smart contracts on Ethereum test network.
4	To design and develop crypto currency.
5	To deploy chain code on permissioned Blockchain.
6	To design and develop a Full-fledged DApp using Ethereum/Hyperledger.

Lab Outcomes:

Sr.No	Lab Outcomes	Cognitive levels of attainment as per Bloom's Taxonomy
1	Develop and test smart contract on local Blockchain.	L3,L4
2	Develop and test smart contract on Ethereum test networks.	L3,L4
3	Write and deploy smart contract using Remix IDE and Metamask.	L4
4	Design and develop Cryptocurrency.	L4
5	Write and deploy chain code in Hyperledger Fabric.	L4
6	Develop and test a Full-fledged DApp using Ethereum/Hyperledger.	L5

Prerequisite: Programming Langauges.

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours	LO Mapping
0	Prerequisite	Java, Python, JavaScript	**02**	—
I	Local Blockchain	Introduction to Truffle, establishing local Blockchain using Truffle Mini Project: Allocation of the groups	**02**	LO1
II	Smart contracts and	Solidity programming language, chain code (Java/JavaScript/Go), deployment on Truffle local	**04**	LO2

	Chain code	Blockchain Mini Project: Topic selection		
III	Deployment and publishing smart contracts on Ethereum test network	Ethereum Test networks (Ropsten/Gorelli/Rinkeby), deployment on test networks, Web3.js/Web3.py for interaction with Ethereum smart contract Mini Project: Topic validation and finalizing software requirements	**04**	LO3
IV	Remix IDE and Metamask	Smart contract development and deployment using Metamask and Remix Design and develop Crypto currency Mini Project: Study the required programming language for smart contract	**04**	LO4
V	Chain code deployment in Hyperledger Fabric	Chain code deployment in Hyperledger fabric Mini project: Study required front end tools	**04**	LO5
VI	Mini-project on Design and Development of a DApps using Ethereum/Hyperledger Fabric	Implementation of Mini Project 1. Design, configure and testing of mini project 2. Report submission as per guidelines	**06**	LO6

Mini project:

1. Students should carry out mini-project in a group of three/four students with a subject In-charge
2. The group should meet with the concerned faculty during laboratory hours and the progress of work discussed must be documented.
3. Each group should perform a detailed literature survey and formulate a problem statement.
4. Each group will identify the hardware and software requirement for their defined mini project problem statement.
5. Design, develop and test their smart contract/chain code.
6. Each group may present their work in various project competitions and paper presentations

Documentation of the Mini Project

The Mini Project Report can be made on following lines:

1. Abstract
2. Contents
3. List of figures and tables
4. Chapter-1 (Introduction, Literature survey, Problem definition, Objectives, Proposed Solution, Technology/platform used)
5. Chapter-2 (System design/Block diagram, Flow chart, Software requirements, cost estimation)
6. Chapter-3 (Implementation snapshots/figures with explanation, code, future directions)
7. Chapter-4 (Conclusion)
8. References

Text Books:

1. Ethereum Smart Contract Development, Mayukh Mukhopadhyay, Packt publication.
2. Solidity Programming Essentials: A Beginner's Guide to Build Smart Contracts for Ethereum and Blockchain, Ritesh Modi, Packt publication.
3. Hands-on Smart Contract Development with Hyperledger Fabric V2, Matt Zand, Xun Wu and Mark Anthony Morris, O'Reilly.

References Books:

1. Mastering Blockchain, Imran Bashir, Packt Publishing
2. Introducing Ethereum and Solidity, Chris Dannen, APress.
3. Hands-on Blockchain with Hyperledger, Nitin Gaur, Packt Publishing.

Online References:

1. https://trufflesuite.com/
2. https://metamask.io/
3. https://remix.ethereum.org/
4. https://www.hyperledger.org/use/fabric

Term-Work: Term-Work shall consist of 5 experiments and Mini-Project on above guidelines/syllabus. Also, Term-work must include at least 2 assignments and Mini-Project report.
Term Work Marks: 25 Marks (Total marks) =15 Marks (5 Experiments + Mini Project) + 5 Marks (Assignments) + 5 Marks (Attendance)

Oral Exam: An Oral exam will be held based on the Mini Project and Presentation.

		Teaching Scheme (Contact Hours)			Credits Assigned			
Course Code	**Course Name**	**Theory**	**Practical**	**Tutorial**	**Theory**	**Practical & Oral**	**Tutorial**	**Total**
ITL802	Cloud Computing	--	2	--	--	1	--	01

Course Code	**Course Name**	**Examination Scheme**						
		Theory Marks				**Term Work**	**Practical/ Oral**	**Total**
		Internal assessment			**End Sem. Exam**			
		Test1	**Test 2**	**Avg. of 2 Tests**				
ITL802	Cloud Computing	--	--	--	--	25	25	50

Lab Objectives:

Sr.No	Lab Objectives
1	To make students familiar with key concepts of virtualization.
2	To make students familiar with various deployment models of cloud such as private, public,hybrid and community.
3	To understand the using and adopting appropriate type of cloud for their application.
4	To make students familiar with various service models such as IaaS, SaaS, PaaS, Security as a Service (SECaaS) and Database as a Service.
5	Apply the different service models for the application.
6	To make students familiar with security and privacy issues in cloud computing and how to address them.

Lab Outcomes:

Sr.No	Lab Outcomes	Cognitive levels of attainment as per Bloom's Taxonomy
1	Implement different types of virtualization techniques.	L1,LL3,L4
2	Analyze various cloud computing service models and implement them to solve the given problems.	L1,L2,L3,L4
3	Design and develop real world web applications and deploy them on commercial cloud(s).	L6
4	Explain major security issues in the cloud and mechanisms to address them.	L1,L2,L3
5	Explore various commercially available cloud services and recommend the appropriate one for the given application.	L1,L2,L3
6	Implement the concept of containerization.	L1,L2,L3

Prerequisite: Programming Langauges, DBMS.

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours	LO Mapping

0	Prerequisite	DBMS, Programming Language.	**02**	—
I	Overview & Virtualization.	Introduction and overview of cloudcomputing. Hosted Virtualization using KVM. Lab1: To study and implement Hosted Virtualization usingVirtual Box & KVM. Lab2: To study and Implement Bare-metal Virtualization using Xen, HyperV or VMware Esxi.	**04**	LO1
II	Infrastructure Services.	To study the infrastructure services using different cloud platform Lab3: To study and Implement Infrastructure as a Service usingAWS/Microsoft Azure/Google cloud platform	**04**	LO2
III	Platform Services	To study the different platform services. Lab4: To study and Implement Platform as a Service using AWS Elastic Beanstalk/ Microsoft Azure App Service.	**03**	LO3
IV	Cloud Services	IaaS, PaaS, STaaS, DbaaS, IAM andSecurity as a Service on AWS and Azure. Lab5: To study and Implement Security as a Service onAWS/Azure. Lab6: To study and implement Identity and Access Management (IAM) practices on AWS/Azure cloud.	**04**	LO4
V	Storage Services	To study the storage services using Docker. Lab7: To study and Implement Storage as a Service using Own Cloud/ AWS S3, Glaciers/ Azure Storage. Lab8: To study and Implement Database as a Service on SQL/NOSQL databases like AWS RDS, AZURE SQL/MongoDB Lab/ Firebase. Lab9: To study and Implement Containerization using Docker on AWS/Azure/Google cloud platform.	**04**	LO5
VI	Kubermetes	Introduction and overview of Kubernetes. Lab10: To study and implement container orchestration using Kubernetes on AWS/Azure/Google cloud platform	**05**	LO6

Textbooks:	
1	Bernard Golden, “Amazon Web Services for Dummies”, John Wiley & Sons, Inc.

2	Michael Collier, Robin Shahan, "Fundamentals of Azure, Microsoft Azure Essentials", Microsoft Press.
3	RajkumarBuyya, Christian Vecchiola, S ThamaraiSelvi, "Mastering Cloud Computing", Tata McGraw-Hill Education.
4	Barrie Sosinsky, "Cloud Computing Bible", Wiley publishing.
5	John Paul Mueller, "AWS for Admins for Developers", John Wiley & Sons, Inc.
6	Ken Cochrane, Jeeva S. Chelladhurai, NeependraKhare , "Docker Cookbook - Second Edition", Packt publication
7	Jonathan Baier, "Getting Started with Kubernetes-Second Edition", Packt Publication.

Online References:

1. https://phoenixnap.com/kb/ubuntu-install- kvm\
2. NIST Cloud Computing Security Reference Architecture
3. https://docs.citrix.com/en-us/xenserver/7- 1/install.html
4. https://docs.aws.amazon.com
5. https://docs.microsoft.com/en-us/azure
6. https://docs.docker.com/get-started/
7. https://kubernetes.io/docs/home/

Term-Work: Term-Work shall consist of 10 experiments on above guidelines/syllabus. Also, Term-work must include at least 2 assignments.
Term Work Marks: 25 Marks (Total marks) =15 Marks (Experiments) + 5 Marks (Assignments) + 5 Marks (Attendance)

Oral Exam: An Oral exam will be held based on the syllabus.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ITM701	Major Project – II	--	12	--	--	06	--	06

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Pract. /Oral	Total
		Internal assessment			End Sem. Exam			
		Test1	Test 2	Avg.				
ITM701	Major Project – II	--	--	--	--	100	50	150

Course Objectives

1. To acquaint with the process of identifying the needs and converting it into the problem.
2. To familiarize the process of solving the problem in a group.
3. To acquaint with the process of applying basic engineering fundamentals to attempt solutions to the problems.
4. To inculcate the process of self-learning and research.

Course Outcome: Learner will be able to…

1. Identify problems based on societal /research needs.
2. Apply Knowledge and skill to solve societal problems in a group.
3. Develop interpersonal skills to work as member of a group or leader.
4. Draw the proper inferences from available results through theoretical/ experimental/simulations.
5. Analyse the impact of solutions in societal and environmental context for sustainable development.
6. Use standard norms of engineering practices
7. Excel in written and oral communication.
8. Demonstrate capabilities of self-learning in a group, which leads to life long learning.
9. Demonstrate project management principles during project work.

Guidelines for Major Project

- Students shall form a group of 3 to 4 students, while forming a group shall not be allowed less than three or more than four students, as it is a group activity.
- Students should do survey and identify needs, which shall be converted into problem statement for mini project in consultation with faculty supervisor/head of department/internal committee of faculties.
- Students shall submit implementation plan in the form of Gantt/PERT/CPM chart, which will cover weekly activity of major project-I and major project-II.
- A log book to be prepared by each group, wherein group can record weekly work progress, guide/supervisor can verify and record notes/comments.
- Faculty supervisor may give inputs to students during major project -I & II activity; however, focus shall be on self-learning.
- Students in a group shall understand problem effectively, propose multiple solution and select best possible solution in consultation with guide/ supervisor.

- Students shall convert the best solution into working model using various components of their domain areas and demonstrate.
- The solution to be validated with proper justification and report to be compiled in standard format of University of Mumbai.
- With the focus on the self-learning, innovation, addressing societal problems and entrepreneurship quality development within the students through the Major Project, it is preferable that a single project of appropriate level and quality to be carried out in two semesters by all the groups of the students. i.e. Major Project-I in semester VII and Major Project-II in semesters VIII.
- However, based on the individual students or group capability, with the mentor's recommendations, if the proposed Major Project adhering to the qualitative aspects mentioned above gets completed in odd semester, then that group can be allowed to Scopus paper publications in Journal/Conference or Copyright or Patent as an extension of the Major Project-1 with suitable improvements/modifications after testing and analysis in even semester. This policy can be adopted on case by case basis.

Guidelines for Assessment of Major Project:

Term Work

1. The review/ progress monitoring committee shall be constituted by head of departments of each institute. The progress of major project to be evaluated on continuous basis, minimum two reviews in each semester VII and VIII.
2. In continuous assessment focus shall also be on each individual student, assessment based on individual's contribution in group activity, their understanding and response to questions.
3. Distribution of Term work marks for both semesters shall be as below;
    a. Marks awarded by guide/supervisor based on log book : 10
    b. Marks awarded by review committee : 10
    c. Quality of Project report : 05

Review/progress monitoring committee may consider following points for assessment based on either one year major project as mentioned in general guidelines.

One-year project:

- In semester VII entire theoretical solution shall be ready, including components/system selection and cost analysis, building of working prototype. Two reviews will be conducted based on presentation given by students group.
    - First shall be for finalization of problem and proposed solution of the problem
    - Second shall be on readiness of working and testing of prototype to be conducted.
- In semester VIII expected work shall be procurement of testing and validation of results based on work completed in an odd semester.
    - First review is based on improvements in testing and validation results cum demonstration for publication to be conducted.
    - Second review shall be based on paper presentation in conference/journal or motivate for copyright or Indian patent in last month of the said semester.

Assessment criteria of Major Project.

Major Project shall be assessed based on following criteria;

14. Quality of survey/ need identification
15. Clarity of Problem definition based on need.
16. Innovativeness in solutions
17. Feasibility of proposed problem solutions and selection of best solution

18. Cost effectiveness
19. Societal impact
20. Innovativeness
21. Cost effectiveness and Societal impact
22. Full functioning of working model as per stated requirements
23. Effective use of skill sets
24. Effective use of standard engineering norms
25. Contribution of an individual's as member or leader
26. Clarity in written and oral communication

- In **one year, project**, first semester evaluation may be based on first six criteria's and remaining may be used for second semester evaluation of performance of students in mini project.

Guidelines for Assessment of Major Project Practical/Oral Examination:

- Report should be prepared as per the guidelines issued by the University of Mumbai.
- Major Project shall be assessed through a presentation and demonstration of working model by the student project group to a panel of Internal and External Examiners preferably from industry or research organizations having experience of more than five years approved by head of Institution.
- Students shall be motivated to publish a paper based on the work in Scopus Conferences/Journals or copy right or Indian Patent.

Major Project shall be assessed based on following points;

1. Quality of problem and Clarity
2. Innovativeness in solutions
3. Cost effectiveness and Societal impact
4. Full functioning of working model as per stated requirements
5. Effective use of skill sets
6. Effective use of standard engineering norms
7. Contribution of an individual's as member or leader
8. Clarity in written and oral communication
9. Publications in Sem VIII.

Course Code	Course Name	Theory	Practical	Tutorial	Theory	Practical/ Oral	Tutorial	Total
ITDO8011	Big Data Analytics	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test1	Test 2	Avg. of 2 Tests					
ITDO8011	Big Data Analytics	20	20	20	80	--	--	--	100

Course Objectives:

Sr.No	Course Objectives
1	To provide an overview of an exciting growing field of Big Data analytics.
2	To discuss the challenges traditional data mining algorithms face when analyzing Big Data.
3	To introduce the tools required to manage and analyze big data like Hadoop, NoSql MapReduce.
4	To teach the fundamental techniques and principles in achieving big data analytics with scalability and streaming capability.
5	To introduce to the students several types of big data like social media, web graphs and data streams.
6	To enable students to have skills that will help them to solve complex real-world problems in decision support.

Course Outcomes:

Sr. No	Course Outcomes	Cognitive levels of attainment as per Bloom's Taxonomy
On successful completion, of course, learner/student will be able to:		
1	Explain the motivation for big data systems and identify the main sources of Big Data in the real world.	L1,L2,L3
2	Demonstrate an ability to use frameworks like Hadoop, NOSQL to efficiently store, retrieve and process Big Data for Analytics.	L1,L2,L3
3	Implement several Data Intensive tasks using the Map Reduce Paradigm.	L1,L2,L3
4	Apply several newer algorithms for Clustering Classifying and finding associations in Big Data.	L1,L2,L3
5	Design algorithms to analyze Big data like streams, Web Graphs and Social Media data.	L6
6	Design and implement successful Recommendation engines for enterprises.	L6

Prerequisite: AI and DS

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours	CO Mapping
0	Prerequisite	Data Mining, Data Science	**02**	
I	Introduction to Big Data	Introduction to Big Data, Big Data characteristics, types of Big Data, Traditional vs. Big Data business approach, Big Data Challenges, Examples of Big Data in Real Life, Big Data Applications	**03**	CO1

		Self-learning Topics: Identification of Big Data applications and its solutions		
II	Introduction to Big Data Frameworks	What is Hadoop? Core Hadoop Components; Hadoop Ecosystem; Working with Apache Spark What is NoSQL? NoSQL data architecture patterns: Key-value stores, Graph stores, Column family (Bigtable) stores, Document stores, MongoDB **Self-learning Topics:** HDFS vs GFS, MongoDB vs other NoSQL system, Implementation of Apache Spark	**06**	CO2
III	MapReduce Paradigm	MapReduce: The Map Tasks, Grouping by Key, The Reduce Tasks, Combiners, Details of MapReduce Execution, Coping With Node Failures. Algorithms Using MapReduce: Matrix-Vector Multiplication by MapReduce , Relational-Algebra Operations, Computing Selections by MapReduce, Computing Projections by MapReduce, Union, Intersection, and Difference by MapReduce, Computing Natural Join by MapReduce, Grouping and Aggregation by MapReduce, Matrix Multiplication, Matrix Multiplication with One MapReduce Step . Illustrating use of MapReduce with use of real life databases and applications. **Self-learning Topics:** Implementation of MapReduce algorithms like Word count, Matrix-Vector and Matrix-Matrix algorithm	**07**	CO3
IV	Mining Big Data Streams	The Stream Data Model: A DataStream-Management System, Examples of Stream Sources, Stream Queries, Issues in Stream Processing. Sampling Data in a Stream : Sampling Techniques. Filtering Streams: The Bloom Filter Counting Distinct Elements in a Stream : The Count-Distinct Problem, The Flajolet-Martin Algorithm, Combining Estimates, Space Requirements . Counting Ones in a Window: The Cost of Exact Counts, The Datar-Gionis-Indyk, Motwani Algorithm, Query Answering in the DGIM Algorithm. **Self-learning Topics:** Streaming services like Apache Kafka/Amazon Kinesis/Google Cloud DataFlow. Standard spark streaming library. Integration with IOT devices to capture real time stream data.	**07**	CO4
V	Big Data Mining Algorithms	Frequent Pattern Mining : Handling Larger Datasets in Main Memory Basic Algorithm of Park, Chen, and Yu. The SON Algorithm and MapReduce. Clustering Algorithms: CURE Algorithm. Canopy Clustering, Clustering with MapReduce Classification Algorithms: Overview SVM classifiers, Parallel SVM, KNearest Neighbor classifications for Big Data, One Nearest Neighbour. **Self-learning Topics:** Standard libraries included with spark like graphX, MLlib	**07**	CO5
VI	Big Data Analytics Applications	**Link Analysis :** PageRank Definition, Structure of the web, dead ends, Using Page rank in a search engine, Efficient computation of Page Rank: PageRank Iteration Using MapReduce, Topic sensitive Page Rank, link Spam, Hubs and Authorities, HITS Algorithm. **Mining Social- Network Graphs :** Social Networks as Graphs, Types , Clustering of Social Network Graphs, Direct	**07**	CO6

		Discovery of Communities, Counting triangles using Map-Reduce. **Recommendation Engines:** A Model for Recommendation Systems, Content-Based Recommendations, Collaborative Filtering **Self-learning Topics:** Sample applications like social media feeds, multiplayer game interactions, retail industry, financial data analysis. Use case like location data, real-time stock trades, log monitoring etc		

Text Books:

1. Anand Rajaraman and Jeff Ullman "Mining of Massive Datasets", Cambridge University Press.
2. Alex Holmes "Hadoop in Practice", Manning Press, Dreamtech Press.
3. Professional NoSQL Paperback, by Shashank Tiwari, Dreamtech Press
4. Rajkumar Buyya, ,Rodrigo N. Calheiros and Amir Vahid Dastjerdi, "Big Data Principles and Paradigms", Morgan Kaufmann

References Books:

1. Analytics in a Big Data World: The Essential Guide to Data Science and its Applications, Bart Baesens , WILEY Big Data Series.
2. Big Data Analytics with R and Hadoop by Vignesh Prajapati Paperback, Packt Publishing Limited
3. Hadoop: The Definitive Guide by Tom White, O'Reilly Publications

Online References:

1. https://nptel.ac.in/courses/106/104/106104189/
2. https://nptel.ac.in/courses/106106142/
3. https://nptel.ac.in/courses/106105186/

Assessment:

Internal Assessment (IA) for 20 marks:

- IA will consist of Two Compulsory Internal Assessment Tests. Approximately 40% to 50% of syllabus content must be covered in First IA Test and remaining 40% to 50% of syllabus content must be covered in Second IA Test

- **Question paper format**

  - Question Paper will comprise of a total of **six questions each carrying 20 marks Q.1** will be **compulsory** and should **cover maximum contents of the syllabus**

  - **Remaining questions** will be **mixed in nature** (part (a) and part (b) of each question must be from different modules. For example, if Q.2 has part (a) from Module 3 then part (b) must be from any other Module randomly selected from all the modules)

A total of **four questions** need to be answered.

Course Code	Course Name	Theory	Practical	Tutorial	Theory	Practical/Oral	Tutorial	Total
ITDO8012	Reinforcement Learning	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test1	Test 2	Avg. of 2 Tests					
ITDO8012	Reinforcement Learning	20	20	20	80	--	--	--	100

Course Objectives:

Sr.No	Course Objectives
1	Define the key features of reinforcement learning that distinguishes it from AI and non-interactive machine learning.
2	Introduce to statistical learning techniques where an agent explicitly takes actions and interacts with the world.
3	Implement in code common RL algorithms.
4	Describe multiple criteria for analyzing RL algorithms & evaluate algorithms on these metrics: e.g. regret, sample complexity, computational complexity, empirical performance, convergence, etc.
5	Know how to implement dynamic programming as an efficient solution approach to an industrial control problem.
6	Explore solutions to the Exploration-Exploitation Dilemma.

Course Outcomes:

Sr. No	Course Outcomes	Cognitive levels of attainment as per Bloom's Taxonomy
On successful completion, of course, learner/student will be able to:		
1	Learn how to define RL tasks and the core principles behind the RL, including policies, value functions, deriving Bellman equations.	L1,L2
2	Evaluate work with tabular methods to solve classical control problems.	L1,L2,L3
3	Apply Markov Decision Processes to solve real-world problems.	L1,L2,L3
4	Understand the dynamic programming for policy Evaluation.	L1,L2
5	Implement reinforcement learning problems based on averaging sample returns using Monte Carlo method.	L1,L2,L3
6	Recognize current advanced techniques and applications in RL.	L1,L2,L3

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours	CO Mapping
0	Prerequisite	Probability distributions and expected values, and basic linear algebra (e.g., inner products).	**02**	
I	Introduction to Reinforcement Learning:	**Reinforcement Learning**: Key features and Elements of RL, Types of RL, rewards. **Reinforcement Learning Algorithms**: Q-Learning, State Action Reward State Action (SARSA),	**04**	CO1

		Self-learning Topics: Deep Q Neural Network (DQN)**,** Applications of RL		
II	Bandit problems and online learning:	An n-Armed Bandit Problem, Action-Value Methods Tracking a Nonstationary Problem, Optimistic Initial Values Upper-Confidence-Bound Action Selection Gradient Bandits **Self-learning Topics:** Associative Search (Contextual Bandits)	**07**	CO2
III	Markov Decision Processes:	The Agent–Environment Interface, Goals and Rewards, Returns, Markov properties, Markov Decision Process, Value Functions and Optimal Value Functions, **Self-learning Topics:** Optimality and Approximation	**07**	
IV	Dynamic Programming:	Policy Evaluation (Prediction), Policy Improvement, Policy Iteration, Value Iteration, Asynchronous Dynamic Programming, Generalized Policy Iteration **Self-learning Topics:**	**07**	CO4
V	Monte Carlo Methods and Temporal-Difference Learning	Monte Carlo Prediction, Monte Carlo Estimation of Action Values, Monte Carlo Control, TD Prediction, TD control using Q-Learning **Self-learning Topics:** Off -policy Prediction via Importance Sampling	**07**	CO5
VI	Applications and Case Studies	Elevator Dispatching, Dynamic Channel Allocation, Job-Shop Scheduling **Self-learning Topics:** Study of applications.	**05**	CO6

Text Books:

1. Reinforcement Learning: An Introduction, by Richard S. Sutton and Andrew G. Barto
2. Alessandro Palmas, Dr. Alexandra Galina Petre, Emanuele Ghelfi, The Reinforcement Learning Workshop: Learn how to Apply Cutting-edge Reinforcement Learning Algorithms to a Wide Range of Control Problems, 2020 Packt publishing.
3. Phil Winder, Reinforcement Learning Industrial Applications with Intelligent Agents, O'Reilly
4. Dr Engr S M Farrukh Akhtar, Practical Reinforcement Learning, Packt Publishing, 2017.

References Books:

1. Maxim Lapan, Deep Reinforcement Learning Hands-On: Apply modern RL methods, with deep Q-networks, value iteration, policy gradients, TRPO, AlphaGo Zero.
2. Csaba Szepesv´ari, Algorithms for Reinforcement Learning, Morgan & Claypool Publishers
3. Alberto Leon-Garcia, Probability, Statistics and Random Processes for Electrical Engineering, Third Edition, Pearson Education, Inc.

Assessment:

Internal Assessment (IA) for 20 marks:

- IA will consist of Two Compulsory Internal Assessment Tests. Approximately 40% to 50% of syllabus content must be covered in First IA Test and remaining 40% to 50% of syllabus content must be covered in Second IA Test

- **Question paper format**

  - Question Paper will comprise of a total of **six questions each carrying 20 marks Q.1** will be **compulsory** and should **cover maximum contents of the syllabus**

- **Remaining questions** will be **mixed in nature** (part (a) and part (b) of each question must be from different modules. For example, if Q.2 has part (a) from Module 3 then part (b) must be from any other Module randomly selected from all the modules)

A total of **four questions** need to be answered.

Course Code	Course Name	Theory	Practical	Tutorial	Theory	Practical/ Oral	Tutorial	Total
ITDO8013	Theory Course	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Avg. of 2 Tests					
ITDO8013	Simulation and Modeling	20	20	20	80	--	--	--	100

Course Objectives:

Sr.No	Course Objectives
1	To introduce the discrete event simulation systems.
2	To discuss the modeling techniques of entities, queues, resources and entity transfers in the discrete event environment.
3	To formulate and apply the statistical models in simulation and queuing theory.
4	To gain knowledge of random numbers, random variates and various statistical tests on random numbers.
5	To formulate and build valid models and perform simulation analysis of the system and analyze results properly.
6	To familiarize with various applications of Simulation.

Course Outcomes:

Sr. No	Course Outcomes	Cognitive levels of attainment as per Bloom's Taxonomy
On successful completion, of course, learner/student will be able to:		
1	Understand the meaning of simulation and Identify the common applications of discrete-event system simulation.	L1,L2
2	Practice formulation and modeling skills.	L1,L2,L3
3	Analyze events and inter-arrival time, arrival process, queuing strategies, resources and disposal of entities using statistical models.	L1,L2,L3,L4
4	Understand pseudo-random numbers and perform statistical tests to measure the quality of pseudo-random numbers.	L1,L2
5	Apply different distributions to fit the collected data and describe the process of verification and validation of simulation models.	L1,L2,L3
6	Describe various applications of simulation.	L1,L2

Prerequisite: Probability and Statistics

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours	CO Mapping

0	Prerequisite	Concepts of Probability: Probability mass function, Probability density function, Mean, Variance, Median, Mode	**02**	-
I	Introduction to Simulation	Simulation Definition, When Simulation is an appropriate tool and when it is not, Advantages and disadvantages of simulation, Areas of application of simulation, System and its types, Models and its types, Steps in simulation study **Self-learning Topics:** Monte Carlo simulation	**04**	CO1
II	Simulation Examples and General Principles	Simulation Process, Simulation of Single-server and multi-server queueing systems, Simulation of (M, N) Inventory and Newspaper Seller Problem, Simulation of Lead-time Demand Concepts in Discrete Event Simulation, Event Scheduling Algorithm, Manual Simulation of Single Server and Dump Truck Problem using Event Scheduling Algorithm **Self-learning Topics:** Simulation of Reliability Problem, Process Interaction Approach in Simulation.	**08**	CO2
III	Mathematical ,Statistical and Queueing Models in Simulation	Statistical Models: Terminology and concepts, Useful statistical models, Discrete Distributions (Bernoulli's trial, Binomial and Negative Binomial, Poisson Distributions), Continuous Distributions (Exponential, Uniform, Erlang, Triangular and Normal Distributions), Poisson Process, Queueing Models: Queuing Notations, Long Run Performance Measures, M/M/1 and M/G/1 Queueing Systems **Self-learning Topics:**	**08**	CO3
IV	Random Numbers and Variates	Random Number Generation: Why are random numbers required in simulation? Properties of random numbers, Linear Congruential Method to generate Random Numbers, Test for Uniformity: Kolmogorov-Smirnov, Chi-Square, Test for Independence: Runs up and runs down, Runs above and below mean, Poker test), Random Variate Generation: Inverse Transform Technique, Direct Transformation for Normal and Lognormal distribution, Acceptance Rejection Technique **Self-learning Topics:** Tests for Autocorrelation	**08**	CO4
V	Analysis of Simulation Data	Steps in Input Modeling, Goodness-of-fit tests, Selecting Input Model without data, Multivariate and Time Series Models,Model Building verification and validation,Verification of simulation models, Naylor and Finger Approach for calibration and Validation of simulation models **Self-learning Topics:** Input-Output Validation: Using Historical Input Data	**06**	CO5
VI	Applications of Simulation	High-Level Computer-System Simulation and Memory Simulation, Simulation of Manufacturing and Material Handling Systems **Self-learning Topics:** Simulation of Computer	**03**	CO6

		Networks		

Text Books:

1. J. Banks, J. S. Carson, B. L. Nelson and D. M. Nicol (2001), Discrete Event System Simulation, 3rd Ed., Prentice-Hall.
2. J. Banks, J. S. Carson, B. L. Nelson and D. M. Nicol (2001), Discrete Event System Simulation, 4th Ed., Prentice-Hall.

References Books:

1. A. M. Law and W. D. Kelton (2000), Simulation Modeling and Analysis, 4th Ed., McGraw Hill.
2. K. S. Trivedi (2001), Probability and Statistics with Reliability, Queuing and Computer Science Applications, Eastern Economy Edition, Prentice-Hall (India).
3. Banks C M, Sokolowski J A, Principles of Modeling and Simulation, Wiley
4. Geoffrey Gordon, System Simulation, EEE
5. Narsing Deo, System Simulation with Digital Computer; PHI

Online References:

1. https://www.udemy.com/course/discrete-event-system-simulation/
2. https://www.tutorialspoint.com/modelling_and_simulation/index.htm

Assessment:
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- IA will consist of Two Compulsory Internal Assessment Tests. Approximately 40% to 50% of syllabus content must be covered in First IA Test and remaining 40% to 50% of syllabus content must be covered in Second IA Test

➢ **Question paper format**

- Question Paper will comprise of a total of **six questions each carrying 20 marks Q.1** will be **compulsory** and should **cover maximum contents of the syllabus**

- **Remaining questions** will be **mixed in nature** (part (a) and part (b) of each question must be from different modules. For example, if Q.2 has part (a) from Module 3 then part (b) must be from any other Module randomly selected from all the modules)

A total of **four questions** need to be answered.

Course Code	Course Name	Theory	Practical	Tutorial	Theory	Practical /Oral	Tutorial	Total
ITDO8014	Knowledge Management	03	--	--	03	--	--	03

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test1	Test 2	Avg. of 2 Tests					
ITDO8014	Knowledge Management	20	20	20	80	--	--	--	100

Course Objectives:

Sr.No	Course Objectives
1	Establish a foundation of key terms and concepts, historical events and contributions, organizational benefits, and guiding principles on which to build greater understanding of knowledge management.
2	Appreciate the role and use of knowledge for individuals, as well as organizations and institutions.
3	Increase information and understanding about knowledge transfer using low- and high technology strategies.
4	Explore the future of knowledge management and its influence on our jobs, communities, and society.
5	Explore different tools for knowledge codification and knowledge transfer.
6	Discuss impact of knowledge management on product, people and organization, etc. with qualitative and quantitative measures.

Course Outcomes:

Sr. No	Course Outcomes	Cognitive levels of attainment as per Bloom's Taxonomy
On successful completion, of course, learner/student will be able to:		
1	Discuss KM, learning organizations, intellectual capital and related terminologies in clear terms and understand the role of knowledge management in organizations.	L1,L2,L3
2	Demonstrate an understanding of the history, concepts, and the antecedents of management of knowledge and describe several successful knowledge management systems.	L1,L2,L3
3	Evaluate the impact of technology including telecommunications, networks, and Internet/intranet role in managing knowledge.	L4,L5
4	Discuss new jobs, roles and responsibilities resulting from the New or Knowledge Economy Ponder KM's current and future impact on individuals, organizations and society at large.	L1,L2,L3
5	Apply different tools for knowledge transfer and Business Intelligence in knowledge sharing.	L1,L2,L3
6	Analyze different modes of knowledge conversion and testing tools for knowledge codification.	L1,L2,L3,L4

Prerequisite: An introductory course in IT/ IS

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours	CO Mapping
0	Prerequisite	Meaning of data, information, knowledge and expertise Meaning of epistemology, Types of Knowledge -Subjective & Objective views of knowledge, procedural Vs. declarative, tacit Vs. explicit, general Vs. specific.	**02**	
I	Introduction to Knowledge Management	What is Knowledge? Data, information and knowledge, Knowledge management process, Types of expertise – associational, motor skill, theoretical Characteristics of knowledge – explicitness, codifiability, teachability, specificity, Reservoirs of knowledge, Meaning of Knowledge Management, Forces Driving Organizational issues in KM, KM Systems & their role, Relevance of KM in today's dynamic & complex environment, Future of Knowledge Management **Self-Learning Topics:** Study the various KM process.	**07**	**CO1**
II	Knowledge management system life cycle	Challenges in Building KM Systems – Conventional versus KM System Life Cycle (KMSLS) – Knowledge Creation and Knowledge Architecture – Nonaka's Model of Knowledge Creation and Transformation, Knowledge Architecture. **Self-Learning Topics:** Case study for KMSLS.	**06**	**CO2**
III	KM Solutions for capture, sharing & applications	KM Processes, KM Systems, Mechanisms & Technologies, Knowledge Capturing Techniques: Brain Storming – Protocol Analysis – Consensus Decision Making – Repertory Grid- Concept Mapping –Blackboarding, Nominal Group Technique, Delphi method. **Self-Learning Topics:** Study various technologies used in KM in industry.	**06**	**CO5**
IV	Knowledge codification	Modes of Knowledge Conversion – Codification Tools and Procedures – Knowledge Developer's Skill Sets – System Testing and Deployment – Knowledge Testing –Approaches to Logical Testing, User Acceptance Testing – KM System Deployment Issues – User Training – Post implementation. **Self-Learning Topics:** Study different tools for testing for KM.	**06**	**CO6**
V	Knowledge transfer and sharing	Transfer Methods – Role of the Internet – Knowledge Transfer in e-world – KM System Tools – Neural Network – Association Rules – Classification Trees – Data Mining and Business Intelligence – Decision Making Architecture – Data Management – Knowledge Management Protocols – Managing Knowledge Workers. **Self-Learning Topics:** Case study for transfer methods in KM.	**06**	**CO3**
VI	KM Impact	Dimensions of KM Impact – People, Processes, Products & Organizational Performance Factors influencing impact – universalistic & contingency views Assessment of KM Impact – Qualitative & quantitative measures, Identification of appropriate KM solutions, Competing with Business Analytics,	**06**	**CO4**

		Caveats for managing Knowledge and Business Intelligence, Corporate social Responsibility, Ethical Legal and Managerial Issues: PAPA, Security and controls. **Self-Learning Topics:** Case study on KM impact.		

Text Books:

1. Irma Becerra-Fernandez, Avelino Gonzalez, Rajiv Sabherwal (2004). Knowledge Management Challenges, Solutions, and Technologies. Prentice Hall. ISBN: 0-13-109931-0.
2. Elias M. Awad, Hassan M. Ghaziri (2004). Knowledge Management. Prentice Hall. ISBN: 0-13- 034820-1
3. Donald Hislop, Knowledge Management in Organizations, Oxford 2nd Edition. Ian Watson (2002).
4. Shelda Debowski, Knowledge Management, Wiley India Edition
5. Keri E Pearlson, Carol S. Saunders, Strategic Management of Information System, Wiley India Edition
6.

References Books:

1. Madanmohan Rao (2004). Knowledge Management Tools and Techniques: Practitioners and Experts Evaluate KM Solutions. Butterworth-Heinemann. ISBN: 0750678186.
2. Stuart Barnes (Ed.) (2002). Knowledge Management Systems Theory and Practice. Thomson Learning.
3. Kimiz Dalkir, Knowledge Management in Theory and Practice, Elsevier, Butterworth Hinemann.
4. Applying Knowledge Management: Techniques for Building Corporate Memories. Morgan Kaufmann. ISBN: 1558607609.

Online resources:

1. https://onlinecourses.nptel.ac.in/noc19_mg33/preview
2. https://www.udemy.com/course/knowledge-management/
3. https://www.coursehero.com/file/70272191/km-pdf-imppdf/
4. http://cs.unibo.it/~gaspari/www/teaching/slides_KM6.pdf

Assessment:

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- **Question paper format**

  - Question Paper will comprise of a total of **six questions each carrying 20 marks Q.1** will be **compulsory** and should **cover maximum contents of the syllabus**

  - **Remaining questions** will be **mixed in nature** (part (a) and part (b) of each question must be from different modules. For example, if Q.2 has part (a) from Module 3 then part (b) must be from any other Module randomly selected from all the modules)

A total of **four questions** need to be answered.

Course Code	Course Name	Theory	Practical	Tutorial	Theory	Practical /Oral	Tutorial	Total
ITDO8021	User Interface Design	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test1	Test 2	Avg. of 2 Tests					
ITDO8021	User Interface Design	20	20	20	80	--	--	--	100

Course Objectives:

Sr.No	Course Objectives
1	To stress the importance of good interface design.
2	To understand the importance of human psychology as well as social and emotional aspect in designing good interfaces.
3	To learn the techniques of data gathering, establishing requirements, analysis and data interpretation.
4	To learn the techniques for prototyping and evaluating user experiences.
5	To understand interaction design process and evaluate design.
6	To bring out the creativity in each student – build innovative applications that are usable, effective and efficient for intended users.

Course Outcomes:

Sr. No	Course Outcomes	Cognitive levels of attainment as per Bloom's Taxonomy
On successful completion, of course, learner/student will be able to:		
1	Identify and criticize bad features of interface designs.	L1,L2,L3
2	Predict good features of interface designs.	L1,L2,L3
3	Illustrate and analyze user needs and formulate user design specifications.	L1,L2,L3
4	Interpret and evaluate the data collected during the process.	L1,L2,L3
5	Evaluate designs based on theoretical frameworks and methodological approaches.	L1,L2,L3,L4,L5
6	Apply better techniques to improve the user interaction design interfaces.	L1,L2,L3

Prerequisite: Software Engineering.

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours	CO Mapping
0	Prerequisite	Software Engineering concepts and any programming Language **Self-learning Topics:** Web design languages	**02**	NA
I	Introduction to Interaction Design	Good and Poor Design, What is Interaction Design, The User Experience, The Process Of Interaction Design, Interaction Design and the User Experience, Necessity of UI/UX **Self-learning Topics:** Study of Various interactive day to day application	**05**	CO1
II	Understanding and Conceptualizing Interaction Cognitive aspects and Social, Emotional Interaction	Understanding the Problem Space and Conceptualizing Design, Conceptual Model, Interface Types, Cognitive aspects, Social Interaction and the Emerging Social Phenomena, Emotions and the User Experience, Expressive and Frustrating Interfaces, Persuasive Technologies **Self-learning Topics:** Study of Various interactive Interface Types	**05**	CO2
III	Data Gathering, Establishing Requirements, Analysis, Interpretation and Presentation	Establishing Requirements, Five Key Issues, Techniques for Data Gathering, Data Analysis Interpretation and Presentation, Task Description and Task Analysis **Self-learning Topics:** Any case study of how to gather requirements .(eq.BE Project)	**08**	CO3
IV	Process of Interaction Design, Prototyping, Construction.	Interaction Design Process, Prototyping and Conceptual Design, Interface Metaphors and Analogies **Self-learning Topics:** Study of two websites with usability concepts.	**07**	CO4 / CO5
V	Design rules and Industry standards	Design principles, Principles to support Usability, Standards and Guidelines, Golden rules and Heuristics, ISO/IEC standards .The 15 Rules Every UI/UX Designer Should Know . **Self-learning Topics:** Study experiments on industry standards and design principles. principles.https://xd.adobe.com/ideas/career-tips/15-rules-every-ux-designer-know/	**07**	CO5

VI	Evaluation Techniques and Framework	The Why, What, Where and When of Evaluation, Types of Evaluation, case studies, DECIDE Framework, Usability Testing, conducting experiments, Field studies, Heuristic Evaluation and walkthroughs, Predictive models. **Self-learning Topics:** Evaluation of any GUI with usability principles.	**05**	CO5/ CO6

Text Books:

1. Interaction Design, by J. Preece, Y. Rogers and H. Sharp. ISBN 0-471-49278-7.
2. Human Computer Interaction, by Alan Dix, Janet Finlay, Gregory D Abowd, Russell Beale
3. Alan Cooper, Robert Reimann, David Cronin, "About Face3: Essentials of Interaction design", Wiley publication.
4. Wilbert O. Galitz, "The Essential Guide to User Interface Design", Wiley publication.

References Books:

1. The UX Book, by Rex Hartson and Pardha S Pyla
2 . Donald A. Norman, "The design of everyday things", Basic books.
3. Jeff Johnson, "Designing with the mind in mind", Morgan Kaufmann Publication.
4. UI Design: Key to captivate User Understanding, by Nilakshi Jain, Dhananjay Kalbande

Online References:

1. https://onlinecourses.nptel.ac.in/noc21_ar05/preview
2. https://nptel.ac.in/courses/124/107/124107008/
3. https://nptel.ac.in/noc/courses/noc19/SEM1/noc19-ar10/
4. https://nptel.ac.in/courses/107/103/107103083/
5. https://www.youtube.com/watch?v=6C2Ye1makdY&list=PLW-zSkCnZ-gD5TDfs1eL5EnH2mQ0f9g6B
6. https://xd.adobe.com/ideas/process/

Assessment:
Internal Assessment (IA) for 20 marks:

- IA will consist of Two Compulsory Internal Assessment Tests. Approximately 40% to 50% of syllabus content must be covered in First IA Test and remaining 40% to 50% of syllabus content must be covered in Second IA Test

- **Question paper format**

  - Question Paper will comprise of a total of **six questions each carrying 20 marks Q.1** will be **compulsory** and should **cover maximum contents of the syllabus**

  - **Remaining questions** will be **mixed in nature** (part (a) and part (b) of each question must be from different modules. For example, if Q.2 has part (a) from Module 3 then part (b) must be from any other Module randomly selected from all the modules)

A total of **four questions** need to be answered.

Course Code	Course Name	Theory	Practical	Tutorial	Theory	Practical/ Oral	Tutorial	Total
ITDO8022	Robotics	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test1	Test 2	Avg. of 2 Tests					
ITDO8022	Robotics	20	20	20	80	--	--	--	100

Course Objectives:

Sr. No.	Course Objectives
1	Learn the basic concepts of Robot.
2	Learn the concepts of Kinematics of Robotics.
3	Learn the different types of Actuators and Sensors in Robot Designing.
4	Learn the concepts of Motions, Velocities and Dynamic Analysis of Force.
5	Learn the concepts of Trajectory and Motion Planning.
6	Learn the different Programming Languages to program Robot.

Course Outcomes:

Sr. No	Course Outcomes	Cognitive levels of attainment as per Bloom's Taxonomy
On successful completion, of course, learner/student will be able to:		
1	Understand different types of robot, its characteristics and applications.	L1,L2
2	Analyse kinematics parameters of robotic manipulator.	L1,L2,L3,L4
3	Identify actuators, sensors and control of a robot for different applications.	L1,L2,L3
4	Apply the differential relationships of motion, velocities and dynamic analysis of force.	L1,L2,L3
5	Apply the concept of trajectory and motion planning in robot programming.	L1,L2,L3
6	Use robot programming languages and acquire skills to program robots.	L1,L2,L3

Prerequisite: Mathematical concepts of Geometry, Linear Algebra, Calculus, Basic Electronics

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours	CO Mapping
0	Prerequisite	Homogenous Coordinate System, Matrix Representation and its Operations, Vector Algebra: Dot and Cross Products, Orthogonal and	**02**	--

		Orthonormal Vectors		
I	Introduction and Fundamentals of Robotics	Automation and its types, definition of Robotics and a Robot, History of Robotics, Advantages and Disadvantages of Robot, Robotic Manipulators, Robot Motions, Robot Anatomy, Links and Joints, Classification of Robots, Specification of Robot, Applications of Robots **Self-learning Topics:** Robot Coordinate System, Economic and Social Aspects of Robotics	**04**	CO1
II	Direct and Inverse Kinematics	Homogeneous transformation matrices, Inverse transformation matrices, Forward and inverse kinematic equations for position and orientation, Denavit-Hartenberg Representation of Forward Kinematic Equations of Robots, The Inverse Kinematic Solution of Robots, Case Studies: Three Axes Planar Articulated Robot Arm (Mini-Drafter) and Four Axes Adept-1 SCARA robot **Self-learning Topics:** Study of Five Axes Rhino XR- Robot Arm and Six Axes Articulated Intelledex 660 Robot Arm	**08**	CO2
III	Actuators and Sensors	Characteristics of Actuating Systems, Comparison of Actuating Systems, Hydraulic Devices, Pneumatic Devices, Electric Motors, Magnetostrictive Actuators, Sensor Characteristics, Position Sensors, Velocity Sensors, Acceleration Sensors, Force and Pressure Sensors, Torque Sensors, Light and Infrared Sensors, Touch and Tactile Sensors, Proximity Sensors, Sniff Sensors, Vision Systems, Voice Synthesizer **Self-learning Topics:** Microprocessor Control of Electric Motors, Microswitches, Range Finders, Voice Recognition Devices	**06**	CO3
IV	Motions, velocities and dynamic analysis of force	Differential relationship, Jacobian, Differential motions of a frame and robot, Inverse Jacobian, Lagrangian mechanics, Moments of Inertia, Dynamic equations of robots, Transformation of forces and moment between coordinate frames **Self-learning Topics:** Static Force Analysis of Robots	**08**	CO4
V	Trajectory and Motion Planning	Trajectory planning, Joint-space trajectory planning, Cartesian-space trajectories, Concept of motion planning, Bug Algorithms – Bug1, Bug2, Tangent Bug **Self-learning Topics:** Case Study based on real life application of motion planning (eg. Chess Game, Robotic Race, etc.)	**05**	CO5
VI	Introduction to Robot Programming	Definition of Robot Program, Robot Programming Techniques like Online programming, Lead-through programming, Walk-through programming, Offline programming, Task programming, Motion Programming, Robotic Programming Language: Overview, Requirements for Standard Robot Language, Introduction to Robot Languages like AL, AML, RAIL, RPL,	**06**	CO6

		VAL, etc. **Self-learning Topics:** Example of Robot Program using VAL.		

Text Books:

1. Robert Shilling, "Fundamentals of Robotics-Analysis and control", PHI, 2003.
2. Saeed B. Niku, "Introduction to Robotics Analysis, Systems, Applications",3rd Edition, Wiley, 2019.
3. Saha, S.K., "Introduction to Robotics", 2nd Edition, McGraw-Hill Higher Education, New Delhi, 2014.
4. Ashitava Ghoshal, "Robotics-Fundamental Concepts and Analysis", Oxford University Press, Sixth impression, 2010
5. Mukherjee S., "Robotics Process Automation", 1st Edition, Khanna Publishing House, New Delhi, 2020.

References Books:

1. John J. Craig, "Introduction to Robotics – Mechanics & Control", 3rd Edition, Pearson Education, India, 2009
2. Mark W. Spong & M. Vidyasagar, "Robot Dynamics & Control", 2nd Wiley India Pvt. Ltd., 2004
3. Aaron Martinez & Enrique Fernandez, "Learning ROS for Robotics Programming", 1st Edition, Shroff Publishers, 2013
4. Howie Choset, Kevin M. Lynch, Seth Hutchinson, George Kantor, Wolfram Burgard, Lydia E. Kavraki and Sebastian Thrun, "Principles of Robot Motion –Theory, Algorithms and Implementations", Prentice-Hall of India, 2005
5. Fu, Gonzalez, Lee, "Robotics: Control, Sensing, Vision and Intelligence", 1st Edition, Mc Graw Hill, India.

Online References:

1. https://swayam.gov.in/nc_details/NPTEL
2. https://www.udemy.com/course/robotics-course/
3. https://www.coursera.org/courses?query=robotics

Assessment:
Internal Assessment (IA) for 20 marks:

- IA will consist of Two Compulsory Internal Assessment Tests. Approximately 40% to 50% of syllabus content must be covered in First IA Test and remaining 40% to 50% of syllabus content must be covered in Second IA Test

- **Question paper format**

  - Question Paper will comprise of a total of **six questions each carrying 20 marks Q.1** will be **compulsory** and should **cover maximum contents of the syllabus**

  - **Remaining questions** will be **mixed in nature** (part (a) and part (b) of each question must be from different modules. For example, if Q.2 has part (a) from Module 3 then part (b) must be from any other Module randomly selected from all the modules)

A total of **four questions** need to be answered.

Course Code	Course Name	Theory	Practical	Tutorial	Theory	Practical/ Oral	Tutorial	Total
ITDO8023	ERP	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test1	Test 2	Avg. of 2 Tests					
ITDO8023	ERP	20	20	20	80	--	--	--	100

Course Objectives:

Sr. No.	Course Objectives
1	To learn the basic concepts of ERP.
2	To learn different technologies used in ERP.
3	To learn the concepts of ERP Manufacturing Perspective and ERP Modules.
4	To learn what are the benefits of ERP.
5	To study and understand the ERP life cycle.
6	To learn the different tools used in ERP.

Course Outcomes:

Sr. No	Course Outcomes	Cognitive levels of attainment as per Bloom's Taxonomy
On successful completion, of course, learner/student will be able to:		
1	Understand the basic concepts of ERP.	L1,L2
2	Identify different technologies used in ERP.	L1,L2,L3
3	Understand and apply the concepts of ERP Manufacturing Perspective and ERP Modules.	L1,L2
4	Discuss the benefits of ERP.	L1,L2,L3
5	Understand and implement the ERP life cycle.	L1,L2
6	Apply different tools used in ERP.	L1,L2,L3

Prerequisite: Basics of software**.**

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours	CO Mapping
0	Prerequisite	Basics of software.	**02**	--

I	Introduction to ERP	Enterprise – An Overview Integrated Management Information, Business Modeling, Integrated Data Model **Self-Learning Topics:** Study of advantages of ERP.	**04**	CO1
II	ERP Technologies	Business Processing Reengineering(BPR), Data Warehousing, Data Mining, On-line Analytical Processing(OLAP), Supply Chain Management (SCM), Customer Relationship Management(CRM), MIS - Management Information System, DSS - Decision Support System, EIS - Executive Information System **Self-Learning Topics:** Study different ERP technologies.	**06**	CO2
III	ERP Manufacturing Perspective and ERP Modules	MRP - Material Requirement Planning, BOM - Bill Of Material, MRP - Manufacturing Resource Planning, DRP – Distributed Requirement Planning, PDM - Product Data Management. Finance, Plant Maintenance, Quality Management, Materials Management. **Self-Learning Topics:** Study different ERP modules.	**08**	CO3
IV	Benefits of ERP	Reduction of Lead-Time, On-time Shipment, Reduction in Cycle Time, Improved Resource Utilization, Better Customer Satisfaction, Improved Supplier Performance, Increased Flexibility, Reduced Quality, Costs, Improved Information Accuracy and Design-making Capability. **Self-Learning Topics:** Study of benefits of ERP for real time application.	**08**	CO4
V	ERP Life cycle	Pre-evaluation Screening, Package Evaluation, Project Planning Phase, Gap Analysis, Reengineering, Configuration, Implementation Team Training, Testing, Going Live, End-user Training, Post- implementation (Maintenance mode). **Self-Learning Topics:** ERP testing tools.	**05**	CO5
VI	E-Commerce to E-business	E-Business structural transformation, Flexible Business Design, Customer Experience, Create the new techo enterprise, New generation e-business leaders, memo to CEO, Empower your customer, Integrate Sales and Service, Integrated Enterprise applications. Enterprise resource planning the E-business Backbone Enterprise architecture, planning, ERP usage in Real world, ERP Implementation. **Self-Learning Topics:** ERP Applications.	**06**	CO6

Text Books:

1. Enterprise Resource Planning - Alexis Leon, Tata McGraw Hill.
2. Enterprise Resource Planning – Diversified by Alexis Leon, TMH.
3. Enterprise Resource Planning - Ravi Shankar & S. Jaiswal , Galgotia.

References Books:

1. Guide to Planning ERP Application, Annetta Clewwto and Dane Franklin, McGRaw-Hill, 1997
2. The SAP R/3 Handbook, Jose Antonio, McGraw – Hill
3. E-Business Network Resource planning using SAP R/3 Baan and Peoplesoft : A Practical Roadmap For Success By Dr. Ravi Kalakota

Online References:

1. https://www.udemy.com/
2. https://www.sap.com/
3. www.oracle.com

Assessment:
Internal Assessment (IA) for 20 marks:

- IA will consist of Two Compulsory Internal Assessment Tests. Approximately 40% to 50% of syllabus content must be covered in First IA Test and remaining 40% to 50% of syllabus content must be covered in Second IA Test

➢ **Question paper format**

- Question Paper will comprise of a total of **six questions each carrying 20 marks Q.1** will be **compulsory** and should **cover maximum contents of the syllabus**

- **Remaining questions** will be **mixed in nature** (part (a) and part (b) of each question must be from different modules. For example, if Q.2 has part (a) from Module 3 then part (b) must be from any other Module randomly selected from all the modules)

A total of **four questions** need to be answered.

Course Code	Course Name	Theory	Practical	Tutorial	Theory	Practical /Oral	Tutorial	Total
ITDO8024	Cloud Computing and Services	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test1	Test 2	Avg. of 2 Tests					
ITDO8024	Cloud Computing and Services	20	20	20	80	--	--	--	100

Course Objectives:

Sr.No	Course Objectives
1	Understand and analyze the basics of cloud computing, service models, deployment models and architecture.
2	Define and understand the concept of virtualization and related technologies.
3	Understand the different cloud computing services and their relevance's.
4	Describe the various services provided by Amazon Web Services cloud platform.
5	Understand and analyze the functionality of Openstack cloud platform & Severless computing.
6	Describe the aspects of Security & Privacy in cloud computing.

Course Outcomes:

Sr. No	Course Outcomes	Cognitive levels of attainment as per Bloom's Taxonomy
On successful completion, of course, learner/student will be able to:		
1	Explain the basics concepts of cloud computing like service models, deployment models and its architecture.	L1,L2,L3
2	Describe and apply virtualization in cloud computing.	L1,L2,L3
3	Use and Analyze different cloud computing services.	L1,L2,L3,L4
4	Understand and apply various services provided by Amazon Web Services cloud platform.	L1,L2,L3
5	Discuss the functionality of Openstack cloud platform & Severless computing.	L1,L2,L3
6	Recognize and examine the security and privacy concerns in cloud computing.	L1,L2,L3

Prerequisite: Computer Network, Operating System.

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours	CO Mapping
0	Prerequisite	Concepts of Computer Network, Network Security and Operating System.	**02**	
I	Introduction to cloud computing	Introduction to cloud computing, need for cloud computing and its components, cloud & other similar configurations, cloud types: NIST and Cloud Cube Model, characteristics of cloud computing, deployment models, service models, advantages and disadvantages of Cloud Computing. **Self-learning Topics:** Study the recent trends in cloud computing architectures and related technologies.	**06**	**CO 1**
II	Virtualization	Characteristics of virtualized environment, structures of virtualization, implementation levels of virtualization, mechanisms of virtualization, pros and cons of virtualization, virtualization vs cloud computing, Xen and KVM architecture. **Self-learning Topics:** Comparison between different virtualization platforms.	**06**	**CO 2**
III	Cloud Computing Services	SPI Model of Cloud computing, Everything as a Service (XaaS): Database as a Service, Storage as a Service, Security as a Service, Collaboration as a Service, Monitoring as a Service, Network as a Service, Disaster Recovery as a service, Identity management as a Service, Analytics as a Service and Backup as a Service. **Self-learning Topics:** Study of different cloud computing platforms providing XaaS services.	**04**	**CO 3**
IV	Amazon Web Service Cloud Platform	Introduction to the AWS Cloud, AWS core services by categories. Compute Service: Introduction to EC2, EC2 Instances, EC2 Amazon Machine Images, Instance Types, Instance Lifecycle. Storage Service: Introducing S3, working with Buckets, setting bucket security, S3 event and notification, bucket properties, working with Elastic Block Store Volumes, Object Storage Vs Block Storage, Archives versus backups, Introduction to Glacier. Virtual Private Cloud: Introduction, Subnet, Elastic Network Interfaces, Internet Gateways, Route Tables, Security Groups. CloudWatch:Introduction, CloudWatch Metrics, CloudWatch Alarms. Database as a Service: Introduction to Amazon Relational Database Service (RDS), Database Engines, Database Instance Classes, Backup and Recovery, Non-relational (No-SQL) Databases, Types of Non relational Databases, Introduction to DynamoDB, Features, Partition and Hash Keys.	**09**	**CO 4**

		Self-learning Topics: Comparison of AWS services with other cloud service platforms like Azure and GCP.		
V	Openstack Cloud platform & Severless Computing	Open source Cloud Platform: Introduction to Openstack cloud platform, Components and modes of Operations, Architecture of Openstack cloud platform. Mobile Cloud Computing: Definition, architecture, benefits and challenges of mobile cloud computing. Serverless Computing: Introduction, Working with Serverless environment,Basics of severless events and functions, AWS Lambda. **Self-learning Topics:** To study different open source cloud computing platforms and compare them based on different XaaS services provided by them.	**05**	**CO 5**
VI	Cloud Security & Privacy	What is security, why is it required in cloud computing, Different types of security in cloud, attacks, and vulnerabilities, IaaS security, PaaS security, SaaS security, trust boundary, Audit and reporting. Introduction to Identity and access Management (IAM), IAM Challenges, IAM Definition, IAM Architecture and Practice, Relevant IAM Standards and Protocols for Cloud Services. Privacy: What Is Privacy? What Are the Key Privacy Concerns in the Cloud?, Legal and Regulatory Implications: Laws and Regulations, Governance, Risk, and Compliance (GRC). **Self-learning Topics:** To assess and analyze how the security and privacy is maintained in different cloud computing platforms.	**07**	**CO 6**

Text Books:

1. Cloud computing Bible, Barrie Sosinsky, Wiley publication.
2. Cloud Computing Black Book, Kailash Jayaswal, Jagannath Kallalurchi, Donald J. Houde, Dr. Deven Shah, Dreamtech Press
3. Mastering Cloud Computing, Rajkumar Buyya, MGH publication
4. AWS certified solution Architect, Joe Baron et.al, Cybex publication
5. Cloud Security and Privacy, Tim Mather, Subra Kumaraswamy, and Shahed Latif, O'Reilly Publication.
6. Cloud security: A comprehensive guide to secure cloud computing by ronold L Krutz and Russell Dean Vines, Wiley publication.

Reference Books:

1. Distributed and Cloud Computing From Parallel Processing to the Internet of Things, Kai Hwang, Geoffrey C. Fox, Jack Dongarra, Morgan Kaufmann Publication
2. Cloud Computing for Dummies, Judith Hurwitz, Wiley Publication
3. Cloud Application Architectures: Building Applications and Infrastructure in the Cloud, George Reese, O'Reilly Publication.
4. Cloud computing security: foundation and challenges, John R Vecca, CRC Press

Online References:

1. https://www.aws.amazon.com

2. https://www.nttel.ac.in

Assessment:
Internal Assessment (IA) for 20 marks:

- IA will consist of Two Compulsory Internal Assessment Tests. Approximately 40% to 50% of syllabus content must be covered in First IA Test and remaining 40% to 50% of syllabus content must be covered in Second IA Test

- **Question paper format**

  - Question Paper will comprise of a total of **six questions each carrying 20 marks Q.1** will be **compulsory** and should **cover maximum contents of the syllabus**

  - **Remaining questions** will be **mixed in nature** (part (a) and part (b) of each question must be from different modules. For example, if Q.2 has part (a) from Module 3 then part (b) must be from any other Module randomly selected from all the modules)

A total of **four questions** need to be answered.

Course Code	Course Name	Credits
ILO8011	Project Management	03

Objectives:

1. To familiarize the students with the use of a structured methodology/approach for each and every unique project undertaken, including utilizing project management concepts, tools and techniques.
2. To appraise the students with the project management life cycle and make them knowledgeable about the various phases from project initiation through closure.

Outcomes: Learner will be able to…

1. Apply selection criteria and select an appropriate project from different options.
2. Write work break down structure for a project and develop a schedule based on it.
3. Identify opportunities and threats to the project and decide an approach to deal with them strategically.
4. Use Earned value technique and determine & predict status of the project.
5. Capture lessons learned during project phases and document them for future reference

Module	Detailed Contents	Hrs
01	**Project Management Foundation:** Definition of a project, Project Vs Operations, Necessity of project management, Triple constraints, Project life cycles (typical & atypical) Project phases and stage gate process. Role of project manager. Negotiations and resolving conflicts. Project management in various organization structures. PM knowledge areas as per Project Management Institute (PMI).	5
02	**Initiating Projects:** How to get a project started, Selecting project strategically, Project selection models (Numeric /Scoring Models and Non-numeric models), Project portfolio process, Project sponsor and creating charter; Project proposal. Effective project team, Stages of team development & growth (forming, storming, norming & performing), team dynamics.	6
03	**Project Planning and Scheduling:** Work Breakdown structure (WBS) and linear responsibility chart, Interface Co-ordination and concurrent engineering, Project cost estimation and budgeting, Top down and bottoms up budgeting, Networking and Scheduling techniques. PERT, CPM, GANTT chart. Introduction to Project Management Information System (PMIS).	8
04	**Planning Projects:** Crashing project time, Resource loading and leveling, Goldratt's critical chain, Project Stakeholders and Communication plan. Risk Management in projects: Risk management planning, Risk identification and risk register. Qualitative and quantitative risk assessment, Probability and impact matrix. Risk response strategies for positive and negative risks	6

05	**5.1 Executing Projects:** Planning monitoring and controlling cycle. Information needs and reporting,	8

	engaging with all stakeholders of the projects. Team management, communication and project meetings. **Monitoring and Controlling Projects:** Earned Value Management techniques for measuring value of work completed; Using milestones for measurement; change requests and scope creep. Project audit. **Project Contracting** Project procurement management, contracting and outsourcing,	
06	**Project Leadership and Ethics:** Introduction to project leadership, ethics in projects. Multicultural and virtual projects. **Closing the Project:** Customer acceptance; Reasons of project termination, Various types of project terminations (Extinction, Addition, Integration, Starvation), Process of project termination, completing a final report; doing a lessons learned analysis; acknowledging successes and failures; Project management templates and other resources; Managing without authority; Areas of further study.	6

REFERENCES:

1. Jack Meredith & Samuel Mantel, Project Management: A managerial approach, Wiley India, 7thEd.
2. A Guide to the Project Management Body of Knowledge (PMBOK® Guide), 5th Ed,Project Management Institute PA, USA
3. Gido Clements, Project Management, Cengage Learning.
4. Gopalan, Project Management, , Wiley India
5. Dennis Lock, Project Management, Gower Publishing England, 9 th Ed.

Assessment:

Internal:
Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

End Semester Theory Examination:
Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

Course Code	Course Name	Credits
ILO8012	Finance Management	03

Objectives:

1. Overview of Indian financial system, instruments and market
2. Basic concepts of value of money, returns and risks, corporate finance, working capital and its management
3. Knowledge about sources of finance, capital structure, dividend policy

Outcomes: Learner will be able to…

1. Understand Indian finance system and corporate finance
2. Take investment, finance as well as dividend decisions

Module	Detailed Contents	Hrs
01	**Overview of Indian Financial System:** Characteristics, Components and Functions of Financial System. **Financial Instruments:** Meaning, Characteristics and Classification of Basic Financial Instruments — Equity Shares, Preference Shares, Bonds-Debentures, Certificates of Deposit, and Treasury Bills. **Financial Markets:** Meaning, Characteristics and Classification of Financial Markets — Capital Market, Money Market and Foreign Currency Market **Financial Institutions:** Meaning, Characteristics and Classification of Financial Institutions — Commercial Banks, Investment-Merchant Banks and Stock Exchanges	06
02	**Concepts of Returns and Risks:** Measurement of Historical Returns and Expected Returns of a Single Security and a Two-security Portfolio; Measurement of Historical Risk and Expected Risk of a Single Security and a Two-security Portfolio. **Time Value of Money:** Future Value of a Lump Sum, Ordinary Annuity, and Annuity Due; Present Value of a Lump Sum, Ordinary Annuity, and Annuity Due; Continuous Compounding and Continuous Discounting.	06
03	**Overview of Corporate Finance:** Objectives of Corporate Finance; Functions of Corporate Finance—Investment Decision, Financing Decision, and Dividend Decision. **Financial Ratio Analysis:** Overview of Financial Statements—Balance Sheet, Profit and Loss Account, and Cash Flow Statement; Purpose of Financial Ratio Analysis; Liquidity Ratios; Efficiency or Activity Ratios; Profitability Ratios; Capital Structure Ratios; Stock Market Ratios; Limitations of Ratio Analysis.	09
04	**Capital Budgeting:** Meaning and Importance of Capital Budgeting; Inputs for Capital Budgeting Decisions; Investment Appraisal Criterion—Accounting Rate of Return, Payback Period, Discounted Payback Period, Net Present Value(NPV), Profitability Index, Internal Rate of Return (IRR), and Modified Internal Rate of Return (MIRR)	10

	Working Capital Management: Concepts of Meaning Working Capital; Importance of Working Capital Management; Factors Affecting an Entity's Working Capital Needs; Estimation of Working Capital Requirements; Management of Inventories; Management of Receivables; and Management of Cash and Marketable Securities.	
05	**Sources of Finance:** Long Term Sources—Equity, Debt, and Hybrids; Mezzanine Finance; Sources of Short Term Finance—Trade Credit, Bank Finance, Commercial Paper; Project Finance. **Capital Structure:** Factors Affecting an Entity's Capital Structure; Overview of Capital Structure Theories and Approaches— Net Income Approach, Net Operating Income Approach; Traditional Approach, and Modigliani-Miller Approach. Relation between Capital Structure and Corporate Value; Concept of Optimal Capital Structure	05
06	**Dividend Policy:** Meaning and Importance of Dividend Policy; Factors Affecting an Entity's Dividend Decision; Overview of Dividend Policy Theories and Approaches—Gordon's Approach, Walter's Approach, and Modigliani-Miller Approach	03

REFERENCES:

1. Fundamentals of Financial Management, 13th Edition (2015) by Eugene F. Brigham and Joel F. Houston; Publisher: Cengage Publications, New Delhi.
2. Analysis for Financial Management, 10th Edition (2013) by Robert C. Higgins; Publishers: McGraw Hill Education, New Delhi.
3. Indian Financial System, 9th Edition (2015) by M. Y. Khan; Publisher: McGraw Hill Education, New Delhi.
4. Financial Management, 11th Edition (2015) by I. M. Pandey; Publisher: S. Chand (G/L) & Company Limited, New Delhi.

Assessment:

Internal:
Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

End Semester Theory Examination:
Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

Course Code	Course Name	Credits
ILO8013	Enterpreneurship Development and Management	03

Objectives:

1. To acquaint with entrepreneurship and management of business
2. Understand Indian environment for entrepreneurship
3. Idea of EDP, MSME

Outcomes: Learner will be able to…

1. Understand the concept of business plan and ownerships
2. Interpret key regulations and legal aspects of entrepreneurship in India
3. Understand government policies for entrepreneurs

Module	Detailed Contents	Hrs
01	**Overview Of Entrepreneurship:** Definitions, Roles and Functions/Values of Entrepreneurship, History of Entrepreneurship Development, Role of Entrepreneurship in the National Economy, Functions of an Entrepreneur, Entrepreneurship and Forms of Business Ownership Role of Money and Capital Markets in Entrepreneurial Development: Contribution of Government Agencies in Sourcing information for Entrepreneurship	04
02	**Business Plans And Importance Of Capital To Entrepreneurship:** Preliminary and Marketing Plans, Management and Personnel, Start-up Costs and Financing as well as Projected Financial Statements, Legal Section, Insurance, Suppliers and Risks, Assumptions and Conclusion, Capital and its Importance to the Entrepreneur **Entrepreneurship And Business Development:** Starting a New Business, Buying an Existing Business, New Product Development, Business Growth and the Entrepreneur Law and its Relevance to Business Operations	09
03	Women's Entrepreneurship Development, Social entrepreneurship-role and need, EDP cell, role of sustainability and sustainable development for SMEs, case studies, exercises	05
04	**Indian Environment for Entrepreneurship:** key regulations and legal aspects , MSMED Act 2006 and its implications, schemes and policies of the Ministry of MSME, role and responsibilities of various government organisations, departments, banks etc., Role of State governments in terms of infrastructure developments and support etc., Public private partnerships, National Skill development Mission, Credit Guarantee Fund, PMEGP, discussions, group exercises etc	08
05	**Effective Management of Business:** Issues and problems faced by micro and small enterprises and effective management of M and S enterprises (risk management, credit availability, technology innovation, supply chain management, linkage with large industries), exercises, e-Marketing	08
06	**Achieving Success In The Small Business:** Stages of the small business life cycle, four types of firm-level growth strategies, Options – harvesting or closing small business Critical Success factors of small business	05

REFERENCES:

1. Poornima Charantimath, Entrepreneurship development- Small Business Enterprise, Pearson
2. Education Robert D Hisrich, Michael P Peters, Dean A Shapherd, Entrepreneurship, latest edition, The McGrawHill Company
3. Dr TN Chhabra, Entrepreneurship Development, Sun India Publications, New Delhi
4. Dr CN Prasad, Small and Medium Enterprises in Global Perspective, New century Publications, New Delhi
5. Vasant Desai, Entrepreneurial development and management, Himalaya Publishing House
6. Maddhurima Lall, Shikah Sahai, Entrepreneurship, Excel Books
7. Rashmi Bansal, STAY hungry STAY foolish, CIIE, IIM Ahmedabad
8. Law and Practice relating to Micro, Small and Medium enterprises, Taxmann Publication Ltd.
9. Kurakto, Entrepreneurship- Principles and Practices, Thomson Publication
10. Laghu Udyog Samachar
11. www.msme.gov.in
12. www.dcmesme.gov.in
13. www.msmetraining.gov.in

Assessment:

Internal:
Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

End Semester Theory Examination:
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4. Only Four question need to be solved.

Course Code	Course Name	Credits
ILO8014	Human Resource Management	03

Objectives:

1. To introduce the students with basic concepts, techniques and practices of the human resource management.
2. To provide opportunity of learning Human resource management (HRM) processes, related with the functions, and challenges in the emerging perspective of today's organizations.
3. To familiarize the students about the latest developments, trends & different aspects of HRM.
4. To acquaint the student with the importance of inter-personal & inter-group behavioral skills in an organizational setting required for future stable engineers, leaders and managers.

Outcomes: Learner will be able to…

1. Understand the concepts, aspects, techniques and practices of the human resource management.
2. Understand the Human resource management (HRM) processes, functions, changes and challenges in today's emerging organizational perspective.
3. Gain knowledge about the latest developments and trends in HRM.
4. Apply the knowledge of behavioral skills learnt and integrate it with in inter personal and intergroup environment emerging as future stable engineers and managers.

Module	Detailed Contents	Hrs
01	**Introduction to HR** • Human Resource Management- Concept, Scope and Importance, Interdisciplinary Approach Relationship with other Sciences, Competencies of HR Manager, HRM functions. • Human resource development (HRD): changing role of HRM – Human resource Planning, Technological change, Restructuring and rightsizing, Empowerment, TQM, Managing ethical issues.	5
02	**Organizational Behavior (OB)** • Introduction to OB Origin, Nature and Scope of Organizational Behavior, Relevance to Organizational Effectiveness and Contemporary issues • Personality: Meaning and Determinants of Personality, Personality development, Personality Types, Assessment of Personality Traits for Increasing Self Awareness • Perception: Attitude and Value, Effect of perception on Individual Decision-making, Attitude and Behavior. • Motivation: Theories of Motivation and their Applications for Behavioral Change (Maslow, Herzberg, McGregor); • Group Behavior and Group Dynamics: Work groups formal and informal groups and stages of group development. Team Effectiveness: High performing teams, Team Roles, cross functional and self-directed team. • Case study	7
03	**Organizational Structure &Design** • Structure, size, technology, Environment of organization; Organizational Roles & conflicts: Concept of roles; role dynamics; role conflicts and	6

	stress. • Leadership: Concepts and skills of leadership, Leadership and managerial roles, Leadership styles and contemporary issues in leadership. • Power and Politics: Sources and uses of power; Politics at workplace, Tactics and strategies.	
04	**Human resource Planning** • Recruitment and Selection process, Job-enrichment, Empowerment - Job-Satisfaction, employee morale. • Performance Appraisal Systems: Traditional & modern methods, Performance Counseling, Career Planning. • Training & Development: Identification of Training Needs, Training Methods	5
05	**Emerging Trends in HR** • Organizational development; Business Process Re-engineering (BPR), BPR as a tool for organizational development , managing processes & transformation in HR. Organizational Change, Culture, Environment • Cross Cultural Leadership and Decision Making**:** Cross Cultural Communication and diversity at work, Causes of diversity, managing diversity with special reference to handicapped, women and ageing people, intra company cultural difference in employee motivation.	6
06	**HR & MIS** Need, purpose, objective and role of information system in HR, Applications in HRD in various industries (e.g. manufacturing R&D, Public Transport, Hospitals, Hotels and service industries **Strategic HRM** Role of Strategic HRM in the modern business world, Concept of Strategy, Strategic Management Process, Approaches to Strategic Decision Making; Strategic Intent – Corporate Mission, Vision, Objectives and Goals **Labor Laws & Industrial Relations** Evolution of IR, IR issues in organizations, Overview of Labor Laws in India; Industrial Disputes Act, Trade Unions Act, Shops and Establishments Act	10

REFERENCES:

1. Stephen Robbins, Organizational Behavior, 16th Ed, 2013
2. V S P Rao, Human Resource Management, 3rd Ed, 2010, Excel publishing
3. Aswathapa, Human resource management: Text & cases, 6th edition, 2011
4. C. B. Mamoria and S V Gankar, Dynamics of Industrial Relations in India, 15th Ed, 2015, Himalaya Publishing, 15thedition, 2015
5. P. Subba Rao, Essentials of Human Resource management and Industrial relations, 5th Ed, 2013, Himalaya Publishing
6. Laurie Mullins, Management & Organizational Behavior, Latest Ed, 2016, Pearson Publications

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Course Code	Course Name	Credits
ILO8015	Professional Ethics and Corporat Social Responsibility (CSR)	03

Objectives:

1. To understand professional ethics in business
2. To recognized corporate social responsibility

Outcomes: Learner will be able to…

1. Understand rights and duties of business
2. Distinguish different aspects of corporate social responsibility
3. Demonstrate professional ethics
4. Understand legal aspects of corporate social responsibility

Module	Detailed Contents	Hrs
01	**Professional Ethics and Business:** The Nature of Business Ethics; Ethical Issues in Business; Moral Responsibility and Blame; Utilitarianism: Weighing Social Costs and Benefits; Rights and Duties of Business	04
02	**Professional Ethics in the Marketplace:** Perfect Competition; Monopoly Competition; Oligopolistic Competition; Oligopolies and Public Policy **Professional Ethics and the Environment:** Dimensions of Pollution and Resource Depletion; Ethics of Pollution Control; Ethics of Conserving Depletable Resources	08
03	**Professional Ethics of Consumer Protection:** Markets and Consumer Protection; Contract View of Business Firm's Duties to Consumers; Due Care Theory; Advertising Ethics; Consumer Privacy **Professional Ethics of Job Discrimination:** Nature of Job Discrimination; Extent of Discrimination; Reservation of Jobs.	06
04	**Introduction to Corporate Social Responsibility:** Potential Business Benefits—Triple bottom line, Human resources, Risk management, Supplier relations; Criticisms and concerns—Nature of business; Motives; Misdirection. Trajectory of Corporate Social Responsibility in India	05
05	**Corporate Social Responsibility:** Articulation of Gandhian Trusteeship Corporate Social Responsibility and Small and Medium Enterprises (SMEs) in India, Corporate Social Responsibility and Public-Private Partnership (PPP) in India	08
06	**Corporate Social Responsibility in Globalizing India:** Corporate Social Responsibility Voluntary Guidelines, 2009 issued by the Ministry of Corporate Affairs, Government of India, Legal Aspects of Corporate Social Responsibility—Companies Act, 2013.	08

REFERENCES:

1. Business Ethics: Texts and Cases from the Indian Perspective (2013) by Ananda Das Gupta; Publisher: Springer.
2. Corporate Social Responsibility: Readings and Cases in a Global Context (2007) by Andrew Crane, Dirk Matten, Laura Spence; Publisher: Routledge.
3. Business Ethics: Concepts and Cases, 7th Edition (2011) by Manuel G. Velasquez; Publisher: Pearson, New Delhi.
4. Corporate Social Responsibility in India (2015) by BidyutChakrabarty, Routledge, New Delhi.

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Course Code	Course Name	Credits
ILO8016	Research Methodology	03

Objectives:

1. To understand Research and Research Process
2. To acquaint students with identifying problems for research and develop research strategies
3. To familiarize students with the techniques of data collection, analysis of data and interpretation

Outcomes: Learner will be able to…

1. Prepare a preliminary research design for projects in their subject matter areas
2. Accurately collect, analyze and report data
3. Present complex data or situations clearly
4. Review and analyze research findings

Module	Detailed Contents	Hrs
01	**Introduction and Basic Research Concepts** Research – Definition; Concept of Construct, Postulate, Proposition, Thesis, Hypothesis, Law, Principle.Research methods vs Methodology Need of Research in Business and Social Sciences Objectives of Research **Issues** and Problems in Research Characteristics of Research:Systematic, Valid, Verifiable, Empirical and Critical	09
02	**Types of Research** Basic Research Applied Research Descriptive Research Analytical Research Empirical Research **2.6** Qualitative and Quantitative Approaches	07
03	**Research Design and Sample Design** Research Design – Meaning, Types and Significance Sample Design – Meaning and Significance Essentials of a good sampling Stages in Sample Design Sampling methods/techniques Sampling Errors	07
04	**Research Methodology** **4.1** Meaning of Research Methodology **4.2**. Stages in Scientific Research Process: **a.** Identification and Selection of Research Problem **b.** Formulation of Research Problem **c.** Review of Literature **d.** Formulation of Hypothesis **e.** Formulation of research Design **f.** Sample Design **g.** Data Collection **h.** Data Analysis **i.** Hypothesis testing and Interpretation of Data	08

	j. Preparation of Research Report	
05	**Formulating Research Problem** **5.1** Considerations: Relevance, Interest, Data Availability, Choice of data, Analysis of data, Generalization and Interpretation of analysis	**04**
06	**Outcome of Research** Preparation of the report on conclusion reached Validity Testing & Ethical Issues Suggestions and Recommendation	**04**

REFERENCES:

1. Dawson, Catherine, 2002, Practical Research Methods, New Delhi, UBS Publishers Distributors.
2. Kothari, C.R.,1985, Research Methodology-Methods and Techniques, New Delhi, Wiley Eastern Limited.
3. Kumar, Ranjit, 2005, Research Methodology-A Step-by-Step Guide for Beginners, (2nded), Singapore, Pearson Education

Assessment:

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End Semester Theory Examination:
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4. Only Four question need to be solved.

Course Code	Course Name	Credits
ILO8017	IPR and Patenting	03

Objectives:

1. To understand intellectual property rights protection system
2. To promote the knowledge of Intellectual Property Laws of India as well as International treaty procedures
3. To get acquaintance with Patent search and patent filing procedure and applications

Outcomes: Learner will be able to…

1. understand Intellectual Property assets
2. assist individuals and organizations in capacity building
3. work for development, promotion, protection, compliance, and enforcement of Intellectual Property and Patenting

Module	Detailed Contents	Hr
01	**Introduction to Intellectual Property Rights (IPR)**: Meaning of IPR, Different category of IPR instruments - Patents, Trademarks,Copyrights, Industrial Designs, Plant variety protection, Geographical indications,Transfer of technology etc. **Importance of IPR in Modern Global Economic Environment:** Theories of IPR, Philosophical aspects of IPR laws, Need for IPR, IPR as an instrument of development	05
02	**Enforcement of Intellectual Property Rights:** Introduction, Magnitude of problem, Factors that create and sustain counterfeiting/piracy, International agreements, International organizations (e.g. WIPO, WTO) activein IPR enforcement **Indian Scenario of IPR:**Introduction, History of IPR in India, Overview of IP laws in India, Indian IPR, Administrative Machinery, Major international treaties signed by India, Procedure for submitting patent and Enforcement of IPR at national level etc.	07
03	**Emerging Issues in IPR:**Challenges for IP in digital economy, e-commerce, human genome,biodiversity and traditional knowledge etc.	05
04	**Basics of Patents:**Definition of Patents, Conditions of patentability, Patentable and non-patentable inventions, Types of patent applications (e.g. Patent of addition etc), Process Patent and Product Patent, Precautions while patenting, Patent specification Patent claims, Disclosures and non-disclosures, Patent rights and infringement, Method of getting a patent	07
05	**Patent Rules:** Indian patent act, European scenario, US scenario, Australia scenario, Japan scenario, Chinese scenario, Multilateral treaties where India is a member (TRIPS agreement, Paris convention etc.)	08
06	**Procedure for Filing a Patent (National and International):** Legislation and Salient Features, Patent Search, Drafting and Filing Patent Applications, Processing of patent, Patent Litigation, Patent Publicationetc, Time frame and cost, Patent Licensing, Patent Infringement	07

	Patent databases: Important websites, Searching international databases	

REFERENCE BOOKS:

1. Rajkumar S. Adukia, 2007, A Handbook on Laws Relating to Intellectual Property Rights in India, The Institute of Chartered Accountants of India
2. Keayla B K, Patent system and related issues at a glance, Published by National Working Group on Patent Laws
3. T Sengupta, 2011, Intellectual Property Law in India, Kluwer Law International
4. Tzen Wong and Graham Dutfield, 2010, Intellectual Property and Human Development: Current Trends and Future Scenario, Cambridge University Press
5. Cornish, William Rodolph & Llewelyn, David. 2010, Intellectual Property: Patents, Copyrights, Trade Marks and Allied Right, 7th Edition, Sweet & Maxwell
6. Lous Harns, 2012, The enforcement of Intellactual Property Rights: A Case Book, 3rd Edition, WIPO
7. Prabhuddha Ganguli, 2012, Intellectual Property Rights, 1st Edition, TMH
8. R Radha Krishnan & S Balasubramanian, 2012, Intellectual Property Rights, 1st Edition, Excel Books
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10. Kompal Bansal and Praishit Bansal, 2012, Fundamentals of IPR for Engineers, 1st Edition, BS Publications
11. Entrepreneurship Development and IPR Unit, BITS Pilani, 2007, A Manual on Intellectual Property Rights,
12. Mathew Y Maa, 2009, Fundamentals of Patenting and Licensing for Scientists and Engineers, World Scientific Publishing Company
13. N S Rathore, S M Mathur, Priti Mathur, Anshul Rathi**,** IPR: Drafting,Interpretation of Patent Specifications and Claims**,** New India Publishing Agency
14. Vivien Irish, 2005, Intellectual Property Rights for Engineers,IET
15. Howard B Rockman, 2004, Intellectual Property Law for Engineers and scientists, Wiley-IEEE Press

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Course Code	Course Name	Credits
ILO8018	**Digital Business Management**	**03**

Objectives:

1. To familiarize with digital business concept
2. To acquaint with E-commerce
3. To give insights into E-business and its strategies

Outcomes: The learner will be able to …..

1. Identify drivers of digital business
2. Illustrate various approaches and techniques for E-business and management
3. Prepare E-business plan

Module	Detailed content	Hours
1	**Introduction to Digital Business-** Introduction, Background and current status, E-market places, structures, mechanisms, economics and impacts Difference between physical economy and digital economy, **Drivers of digital business**- Big Data & Analytics, Mobile, Cloud Computing, Social media, BYOD, and Internet of Things(digitally intelligent machines/services) Opportunities and Challenges in Digital Business,	09
2	**Overview of E-Commerce** **E-Commerce**- Meaning, Retailing in e-commerce-products and services, consumer behavior, market research and advertisement B2B-E-commerce-selling and buying in private e-markets, public B2B exchanges and support services, e-supply chains, Collaborative Commerce, Intra business EC and Corporate portals Other E-C models and applications, innovative EC System-From E- government and learning to C2C, mobile commerce and pervasive computing EC Strategy and Implementation-EC strategy and global EC, Economics and Justification of EC, Using Affiliate marketing to promote your e- commerce business, Launching a successful online business and EC project, Legal, Ethics and Societal impacts of EC	06

3	**Digital Business Support services**: ERP as e –business backbone, knowledge Tope Apps, Information and referral system **Application Development:** Building Digital business Applications and Infrastructure	06
4	**Managing E-Business**-Managing Knowledge, Management skills for e-business, Managing Risks in e –business Security Threats to e-business -Security Overview, Electronic Commerce Threats, Encryption, Cryptography, Public Key and Private Key Cryptography, Digital Signatures, Digital Certificates, Security Protocols over Public Networks: HTTP, SSL, Firewall as Security Control, Public Key Infrastructure (PKI) for Security, Prominent Cryptographic Applications	06
5	**E-Business Strategy**-E-business Strategic formulation- Analysis of Company's Internal and external environment, Selection of strategy, E-business strategy into Action, challenges and E-Transition (Process of Digital Transformation)	04
6	**Materializing e-business: From Idea to Realization**-Business plan preparation **Case Studies and presentations**	08

References:

1. A textbook on E-commerce, Er Arunrajan Mishra, Dr W K Sarwade,Neha Publishers & Distributors, 2011
2. E-commerce from vision to fulfilment, Elias M. Awad, PHI-Restricted, 2002
3. Digital Business and E-Commerce Management, 6th Ed, Dave Chaffey, Pearson, August 2014
4. Introduction to E-business-Management and Strategy, Colin Combe, ELSVIER, 2006
5. Digital Business Concepts and Strategy, Eloise Coupey, 2nd Edition, Pearson
6. Trend and Challenges in Digital Business Innovation, VinocenzoMorabito, Springer
7. Digital Business Discourse Erika Darics, April 2015, Palgrave Macmillan
8. E-Governance-Challenges and Opportunities in : Proceedings in 2nd International Conference theory and practice of Electronic Governance
9. Perspectives the Digital Enterprise –A framework for Transformation, TCS consulting journal Vol.5
10. Measuring Digital Economy-A new perspective -DOI:10.1787/9789264221796-enOECD Publishing

Assessment:

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Course Code	Course Name	Credits
ILO8019	Environmental Management	03

Objectives:

1. Understand and identify environmental issues relevant to India and global concerns
2. Learn concepts of ecology
3. Familiarise environment related legislations

Outcomes: Learner will be able to…

1. Understand the concept of environmental management
2. Understand ecosystem and interdependence, food chain etc.
3. Understand and interpret environment related legislations

Module	Detailed Contents	Hrs
01	Introduction and Definition of Environment: Significance of Environment Management for contemporary managers, Career opportunities. Environmental issues relevant to India, Sustainable Development, The Energy scenario.	10
02	Global Environmental concerns : Global Warming, Acid Rain, Ozone Depletion, Hazardous Wastes, Endangered life-species, Loss of Biodiversity, Industrial/Man-made disasters, Atomic/Biomedical hazards, etc.	06
03	Concepts of Ecology: Ecosystems and interdependence between living organisms, habitats, limiting factors, carrying capacity, food chain, etc.	05
04	Scope of Environment Management, Role & functions of Government as a planning and regulating agency. Environment Quality Management and Corporate Environmental Responsibility	10
05	Total Quality Environmental Management, ISO-14000, EMS certification.	05
06	General overview of major legislations like Environment Protection Act, Air (P & CP) Act, Water (P & CP) Act, Wildlife Protection Act, Forest Act, Factories Act, etc.	03

REFERENCES:

1. Environmental Management: Principles and Practice, C J Barrow, Routledge Publishers London, 1999
2. A Handbook of Environmental Management Edited by Jon C. Lovett and David G. Ockwell, Edward Elgar Publishing
3. Environmental Management,**T V Ramachandra and Vijay Kulkarni, TERI Press**
4. Indian Standard Environmental Management Systems — Requirements With Guidance For Use, Bureau Of Indian Standards, February 2005
5. Environmental Management: An Indian Perspective, S N Chary and Vinod Vyasulu, Maclillan India, 2000

6. Introduction to Environmental Management, Mary K Theodore and Louise Theodore, CRC Press
7. Environment and Ecology, Majid Hussain, 3rd Ed. Access Publishing.2015

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