

**COURSE STRUCTURE**  
**&**  
**DETAILED SYLLABUS**  
(R23 Regulation)  
For  
Bachelor of Technology  
II B.Tech. (IT)  
(Applicable for Batches Admitted from 2023-2024)

Department of  
**INFORMATION TECHNOLOGY**  
(Applicable for Batches Admitted from 2023-2024)



**DEPARTMENT OF INFORMATION TECHNOLOGY**  
COLLEGE OF ENGINEERING, VIZIANAGARAM  
JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY GURAJADA VIZIANAGARAM  
ANDHRA PRADESH-535003, INDIA

**PROPOSED COURSE STRUCTURE-B.TECH (I.T.) -R23**

(Applicable from the academic year 2023-24 onwards)

<b>II-B.Tech I-Semester</b>						
<b>S. No.</b>	<b>Category</b>	<b>Title</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>Credits</b>
1.	BS & H	Mathematical Foundations of Computer Science	3	0	0	3
2.	BS & H	Universal Human Values - Understanding Harmony	2		0	3
3.	Engineering Science	Digital Logic & Computer Organization	3	0	0	3
4.	Professional Core	Software Engineering	3	0	0	3
5.	Professional Core	Object Oriented Programming Through Java	3	0	0	3
6.	Professional Core	CASE Tools Lab	0	0	3	1.5
7.	Professional Core	Object Oriented Programming Through Java Lab	0	0	3	1.5
8.	Skill Enhancement course	Python Programming	0	1	2	2
9.	Audit Course	Environmental Science	2	0	0	–
		<b>Total</b>	<b>16</b>	<b>2</b>	<b>8</b>	<b>20</b>

<b>B.Tech. - II - Year II Semester</b>						
<b>S. No.</b>	<b>Category</b>	<b>Title</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>Credits</b>
1.	Management Course-I	Managerial Economics and Financial Analysis	2	0	0	2
2.	Engineering Science/ Basic Science	Probability & Statistics	3	0	0	3
3.	Professional Core	Operating Systems	3	0	0	3
4.	Professional Core	Database Management Systems	3	0	0	3
5.	Professional Core	Design and Analysis of Algorithms	3	0	0	3
6.	Professional Core	Operating Systems Lab	0	0	3	1.5
7.	Professional Core	Database Management Systems Lab	0	0	3	1.5
8.	Skill Enhancement course	Django Framework	0	1	2	2
9.	BS & H	Design Thinking & Innovation	1	0	2	2
		<b>Total</b>	<b>15</b>	<b>1</b>	<b>10</b>	<b>21</b>

<b>II Year I Semester</b>	<b>Mathematical Foundations of Computer Science</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
		<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>

**COURSE OBJECTIVES:**

- CO1: To understand mathematical arguments using logical connectives and quantifiers and verify the validity of logical flow of arguments using propositional, predicate logic, and truth tables.
- CO2: To understand about elementary of combinatorics, the principle of inclusion and exclusion and the pigeonhole principle.
- CO3: To expose the students to Binary relations, posets, Hasse diagram, lattice, and discuss various properties of relations.
- CO4: To understand Algebraic structures like groups, semigroups, monoids.
- CO5: To introduce generating functions and recurrence relations.

**COURSE OUTCOMES:**

1. Recall the concepts of Mathematical logic and statement & predicate calculus
2. Recall the concepts of combinatorics, set theory, posets and lattices
3. Recall the concepts of algebraic structures, recurrence relations and generating functions
4. Use and interpret the concepts of Mathematical logic and statement & predicate calculus
5. Use and interpret the concepts of combinatorics, set theory, posets and lattices
6. Use and interpret the concepts of algebraic structures, recurrence relations and generating functions
7. Apply the concepts of discrete mathematical structures to computer science and engineering

**Unit-I: Mathematical Logic****10 hrs**

Propositional Calculus: Statements and Notations, Connectives, Well Formed Formulas, Truth Tables, Tautologies, and Equivalence of Formulas, Duality Law, Tautological Implications, and Normal Forms, Theory of Inference for Statement Calculus, Consistency of Premises and Indirect Method of Proof.

Predicate Calculus: Predicative Logic, Statement Functions, Variables and Quantifiers, Free and Bound Variables, Inference Theory for Predicate Calculus.

**Unit-II: Functions & Relations****10 hrs**

Set Theory: Introduction, Operations on Binary Sets, Principle of Inclusion and Exclusion, Relations: Properties of Binary Relations, Relation Matrix and Digraph, Operations on Relations, Partition and Covering, Transitive Closure, Equivalence, Compatibility and Partial Ordering Relations, Hassie Diagrams,

Functions: Bijective Functions, Composition of Functions, Inverse Functions, Permutation Functions, Recursive Functions, Lattice and its Properties

**Unit-III: Algebraic Structures and Number Theory****10 hrs**

Algebraic Structures: Algebraic Systems, Examples, General Properties, Semi Groups and Monoids, Homomorphism of Semi Groups and Monoids, Group, Subgroup, Abelian Group, Homomorphism, Isomorphism

Number Theory: Properties of Integers, Division Theorem, The Greatest Common Divisor, Euclidean Algorithm, Least Common Multiple, Testing for Prime Numbers, The Fundamental Theorem of Arithmetic, Modular Arithmetic (Fermat's Theorem and Euler's Theorem without Proof)

**Unit-IV: Recurrence Relations****8 hrs**

Generating Functions, Function of Sequences, Partial Fractions, Calculating Coefficient of Generating Functions, Recurrence Relations, Formulation as Recurrence Relations, Solving Recurrence Relations by Substitution and Generating Functions, Method of Characteristic Roots,

## Solving Inhomogeneous Recurrence Relations

**Unit-V: Graph Theory****10 hrs**

Basic Concepts of Graphs, Sub graphs, Matrix Representation of Graphs: Adjacency Matrices, Incidence Matrices, Isomorphic Graphs, Paths and Circuits, Eulerian and Hamiltonian Graphs, Multigraphs, Planar Graphs, Euler's Formula, Graph Colouring and Covering, Chromatic Number, Spanning Trees, Algorithms for Spanning Trees (Problems Only and Theorems without Proofs)

**Text Books:**

1. J. P. Tremblay and R. Manohar, Discrete Mathematical Structures with Applications to C Sc, Tata McGraw Hill, 1997
2. C. L. Liu and ,Elements of Discrete Mathematics-A Computer Oriented Approach

**Reference Books:**

1. Kenneth. H. Rosen, Discrete Mathematics and its Applications, 6/e, Tata McGraw-Hill, 2009.
2. Discrete Mathematics for Computer Scientists and Mathematicians, J.L.Mott,A. Kandel, T. P. Baker, 2ndEdition, Prentice Hall of India.
3. Dr. D S Chandrasekharaiah, Mathematical Foundations of Computer Science, Prism Book Pvt Ltd.
4. S. K. Chakraborty and B.K. Sarkar ,Discrete Mathematics, Oxford,2011

II Year-I Semester	UNIVERSAL HUMAN VALUES – UNDERSTANDING HARMONY AND ETHICAL HUMAN CONDUCT	L	T	P	C
		2	1	0	3

**Course Objectives:**

- To help the students appreciate the essential complementary between 'VALUES' and 'SKILLS' to ensure sustained happiness and prosperity which are the core aspirations of all human beings.
- To facilitate the development of a Holistic perspective among students towards life and profession as well as towards happiness and prosperity based on a correct understanding of the Human reality and the rest of existence. Such holistic perspective forms the basis of Universal Human Values and movement towards value-based living in a natural way.
- To highlight plausible implications of such a Holistic understanding in terms of ethical human conduct, trustful and mutually fulfilling human behaviour and mutually enriching interaction with Nature.

**Course Outcomes:**

- Define the terms like Natural Acceptance, Happiness and Prosperity (L1, L2)
- Identify one's self, and one's surroundings (family, society nature) (L1, L2)
- Apply what they have learnt to their own self in different day-to-day settings in real life (L3)
- Relate human values with human relationship and human society. (L4)
- Justify the need for universal human values and harmonious existence (L5)
- Develop as socially and ecologically responsible engineers (L3, L6)

**Course Topics**

The course has 28 lectures and 14 tutorials in 5 modules. The lectures and tutorials are of 1-hour duration. Tutorial sessions are to be used to explore and practice what has been proposed during the lecture sessions.

The Teacher's Manual provides the outline for lectures as well as practice sessions. The teacher is expected to present the issues to be discussed as propositions and encourage the students to have a dialogue.

**UNIT I** Introduction to Value Education (6 lectures and 3 tutorials for practice session)  
 Lecture 1: Right Understanding, Relationship and Physical Facility (Holistic Development and the Role of Education)  
 Lecture 2: Understanding Value Education  
 Tutorial 1: Practice Session PS1 Sharing about Oneself  
 Lecture 3: self-exploration as the Process for Value Education  
 Lecture 4: Continuous Happiness and Prosperity – the Basic Human Aspirations  
 Tutorial 2: Practice Session PS2 Exploring Human Consciousness  
 Lecture 5: Happiness and Prosperity – Current Scenario  
 Lecture 6: Method to Fulfill the Basic Human Aspirations  
 Tutorial 3: Practice Session PS3 Exploring Natural Acceptance

**UNIT II** Harmony in the Human Being (6 lectures and 3 tutorials for practice session)  
 Lecture 7: Understanding Human being as the Co-existence of the self and the body.  
 Lecture 8: Distinguishing between the Needs of the self and the body  
 Tutorial 4: Practice Session PS4 Exploring the difference of Needs of self and body.  
 Lecture 9: The body as an Instrument of the self  
 Lecture 10: Understanding Harmony in the self

Tutorial 5: Practice Session PS5 Exploring Sources of Imagination in the self  
 Lecture 11: Harmony of the self with the body  
 Lecture 12: Programme to ensure self-regulation and Health  
 Tutorial 6: Practice Session PS6 Exploring Harmony of self with the body

**UNIT III** Harmony in the Family and Society (6 lectures and 3 tutorials for practice session)

Lecture 13: Harmony in the Family – the Basic Unit of Human Interaction  
 Lecture 14: 'Trust' – the Foundational Value in Relationship  
 Tutorial 7: Practice Session PS7 Exploring the Feeling of Trust  
 Lecture 15: 'Respect' – as the Right Evaluation  
 Tutorial 8: Practice Session PS8 Exploring the Feeling of Respect  
 Lecture 16: Other Feelings, Justice in Human-to-Human Relationship  
 Lecture 17: Understanding Harmony in the Society  
 Lecture 18: Vision for the Universal Human Order  
 Tutorial 9: Practice Session PS9 Exploring Systems to fulfil Human Goal

**UNIT IV** Harmony in the Nature/Existence (4 lectures and 2 tutorials for practice session)

Lecture 19: Understanding Harmony in the Nature  
 Lecture 20: Interconnectedness, self-regulation and Mutual Fulfilment among the Four Orders of Nature  
 Tutorial 10: Practice Session PS10 Exploring the Four Orders of Nature  
 Lecture 21: Realizing Existence as Co-existence at All Levels  
 Lecture 22: The Holistic Perception of Harmony in Existence  
 Tutorial 11: Practice Session PS11 Exploring Co-existence in Existence.

**UNIT V** Implications of the Holistic Understanding – a Look at Professional Ethics (6 lectures and 3 tutorials for practice session)

Lecture 23: Natural Acceptance of Human Values  
 Lecture 24: Definitiveness of (Ethical) Human Conduct  
 Tutorial 12: Practice Session PS12 Exploring Ethical Human Conduct  
 Lecture 25: A Basis for Humanistic Education, Humanistic Constitution and Universal Human Order  
 Lecture 26: Competence in Professional Ethics  
 Tutorial 13: Practice Session PS13 Exploring Humanistic Models in Education  
 Lecture 27: Holistic Technologies, Production Systems and Management Models-Typical Case Studies  
 Lecture 28: Strategies for Transition towards Value-based Life and Profession  
 Tutorial 14: Practice Session PS14 Exploring Steps of Transition towards Universal Human Order

Practice Sessions for UNIT I – Introduction to Value Education

PS1 Sharing about Oneself  
 PS2 Exploring Human Consciousness  
 PS3 Exploring Natural Acceptance

Practice Sessions for UNIT II – Harmony in the Human Being

PS4 Exploring the difference of Needs of self and body  
 PS5 Exploring Sources of Imagination in the self  
 PS6 Exploring Harmony of self with the body

Practice Sessions for UNIT III – Harmony in the Family and Society

PS7 Exploring the Feeling of Trust  
 PS8 Exploring the Feeling of Respect  
 PS9 Exploring Systems to fulfil Human Goal

Practice Sessions for UNIT IV – Harmony in the Nature (Existence)

PS10 Exploring the Four Orders of Nature

PS11 Exploring Co-existence in Existence

Practice Sessions for UNIT V – Implications of the Holistic Understanding – a Look at Professional Ethics

PS12 Exploring Ethical Human Conduct

PS13 Exploring Humanistic Models in Education

PS14 Exploring Steps of Transition towards Universal Human Order

### READINGS:

#### Textbook and Teachers Manual

a. The Textbook

R R Gaur, R Asthana, G P Bagaria, *A Foundation Course in Human Values and Professional Ethics*, 2nd Revised Edition, Excel Books, New Delhi, 2019. ISBN 978-93-87034-47-1

b. The Teacher's Manual

R R Gaur, R Asthana, G P Bagaria, *Teachers' Manual for A Foundation Course in Human Values and Professional Ethics*, 2nd Revised Edition, Excel Books, New Delhi, 2019. ISBN 978-93-87034-53-2

#### Reference Books

1. *Jeevan Vidya: Ek Parichaya*, A Nagaraj, Jeevan Vidya Prakashan, Amarkantak, 1999.
2. *Human Values*, A.N. Tripathi, New Age Intl. Publishers, New Delhi, 2004.
3. *The Story of Stuff* (Book).
4. *The Story of My Experiments with Truth* - by Mohandas Karamchand Gandhi
5. *Small is Beautiful* - E. F Schumacher.
6. *Slow is Beautiful* - Cecile Andrews
7. *Economy of Permanence* - J C Kumarappa
8. *Bharat Mein Angreji Raj* – Pandit Sunderlal
9. *Rediscovering India* - by Dharampal
10. *Hind Swaraj or Indian Home Rule* - by Mohandas K. Gandhi
11. *India Wins Freedom* - Maulana Abdul Kalam Azad
12. *Vivekananda* - Romain Rolland (English)
13. *Gandhi* - Romain Rolland (English)

#### Mode of Conduct:

Lecture hours are to be used for interactive discussion, placing the proposals about the topics at hand and motivating students to reflect, explore and verify them.

Tutorial hours are to be used for practice sessions.

While analyzing and discussing the topic, the faculty mentor's role is in pointing to essential elements to help in sorting them out from the surface elements. In other words, help the students explore the important or critical elements.

In the discussions, particularly during practice sessions (tutorials), the mentor encourages the student to connect with one's own self and do self-observation, self-reflection and self-exploration.

Scenarios may be used to initiate discussion. The student is encouraged to take up "ordinary" situations rather than "extra-ordinary" situations. Such observations and their analyses are shared and discussed with other students and faculty mentor, in a group sitting.

Tutorials (experiments or practical) are important for the course. The difference is that the laboratory is everyday life, and practical are how you behave and work in real life. Depending on the nature of topics, worksheets, home assignment and/or activity are included. The practice sessions (tutorials) would also provide support to a student in performing actions commensurate to his/her beliefs. It is intended that this would lead to development of commitment, namely behaving and working based on basic human values.

It is recommended that this content be placed before the student as it is, in the form of a basic foundation course, without including anything else or excluding any part of this content. Additional content may be offered in separate, higher courses. This course is to be taught by faculty from every teaching department, not exclusively by any one department.

Teacher preparation with a minimum exposure to at least one 8-day Faculty Development Program on Universal Human Values is deemed essential.

#### Online Resources:

1. <https://fdp-si.aicte-india.org/UHV-II%20Class%20Notes%20&%20Handouts/UHV%20Handout%201->

Introduction%20to%20Value%20Education.pdf

2. <https://fdp-si.aicte-india.org/UHV-II%20Class%20Notes%20&%20Handouts/UHV%20Handout%202-Harmony%20in%20the%20Human%20Being.pdf>
3. <https://fdp-si.aicte-india.org/UHV-II%20Class%20Notes%20&%20Handouts/UHV%20Handout%203-Harmony%20in%20the%20Family.pdf>
4. <https://fdp-si.aicte-india.org/UHV%201%20Teaching%20Material/D3-S2%20Respect%20July%2023.pdf>
5. <https://fdp-si.aicte-india.org/UHV-II%20Class%20Notes%20&%20Handouts/UHV%20Handout%205-Harmony%20in%20the%20Nature%20and%20Existence.pdf>
6. <https://fdp-si.aicte-india.org/download/FDPTeachingMaterial/3-days%20FDP-SI%20UHV%20Teaching%20Material/Day%203%20Handouts/UHV%203D%20D3-S2A%20Und%20Nature-Existence.pdf>
7. <https://fdp-si.aicte-india.org/UHV%20II%20Teaching%20Material/UHV%20II%20Lecture%2023-25%20Ethics%20v1.pdf>
8. <https://www.studocu.com/in/document/kiet-group-of-institutions/universal-human-values/chapter-5-holistic-understanding-of-harmony-on-professional-ethics/62490385>
9. [https://onlinecourses.swayam2.ac.in/aic22\\_ge23/preview](https://onlinecourses.swayam2.ac.in/aic22_ge23/preview)



<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>

## DIGITAL LOGIC & COMPUTER ORGANIZATION

### Course Objectives:

The main objectives of the course is to

- Provide students with a comprehensive understanding of digital logic design principles and computer organization fundamentals
- Describe memory hierarchy concepts
- Explain input/output (I/O) systems and their interaction with the CPU, memory, and peripheral devices

### UNIT-I:

**Data Representation:** Binary Numbers, Fixed Point Representation. Floating Point Representation. Number base conversions, Octal and Hexadecimal Numbers, components, Signed binary numbers, Binary codes.

**Digital Logic Circuits-I:** Basic Logic Functions, Logic gates, universal logic gates, Minimization of Logic expressions. K-Map Simplification, Combinational Circuits, Decoders, Multiplexers

### UNIT-II:

**Digital Logic Circuits-II:** Sequential Circuits, Flip-Flops, Binary counters, Registers, Shift Registers, Ripple counters

**Basic Structure of Computers:** Computer Types, Functional units, Basic operational concepts, Bus structures, Software, Performance, multiprocessors and multi computers, Computer Generations, Von- Neumann Architecture

### UNIT-III:

**Computer Arithmetic:** Addition and Subtraction of Signed Numbers, Design of Fast Adders, Multiplication of Positive Numbers, Signed-operand Multiplication, Fast Multiplication, Integer Division, Floating-Point Numbers and Operations

**Processor Organization:** Fundamental Concepts, Execution of a Complete Instruction, Multiple-Bus Organization, Hardwired Control and Multi programmed Contra I

### UNIT-IV:

**The Memory Organization:** Basic Concepts, Semiconductor RAM Memories, Read-Only Memories, Speed, Size and Cost, Cache Memories, Performance Considerations, Virtual Memories, Memory Management Requirements, Secondary Storage.

### UNIT-V:

Input/Output Organization: Accessing I/O Devices, Interrupts, Processor Examples, Direct Memory Access, Buses, Interface Circuits, Standard I/O Interfaces

### Textbooks:

1. Computer Organization and Embedded Systems, Carl Hamacher, Zvonko Vranesic, Safwat Zaky, 6th edition, McGraw Hill
2. Digital Design, 6th Edition, M. Morris Mano, Pearson Education.
3. Computer Organization and Architecture, William Stallings, 11th Edition, Pearson.

### Reference Books:

1. Computer Systems Architecture, M. Morris Mano, 3<sup>rd</sup> Edition, Pearson
2. Computer Organization and Design, David A. Paterson, John L. Hennessy, Elsevier
3. Fundamentals of Logic Design, Roth, 5<sup>th</sup> Edition, Thomson

### Online Learning Resources:

1. <https://nptel.ac.in/courses/106/103/106103068/>

## II Year-I Semester

L	T	P	C
3	0	0	3

## SOFTWARE ENGINEERING

### Course Objectives:

The objectives of this course are to introduce

- Software life cycle models, Software requirements and SRS document.
- Project Planning, quality control and ensuring good quality software.
- Software Testing strategies, use of CASE tools, Implementation issues, validation & verification procedures.

### UNIT I:

**Introduction:** Evolution, Software development projects, Exploratory style of software developments, Emergence of software engineering, Notable changes in software development practices, Computer system engineering.

**Software Life Cycle Models:** Basic concepts, Waterfall model and its extensions, Rapid application development, Agile development model, Spiral model.

### UNIT II:

**Software Project Management:** Software project management complexities, Responsibilities of a software project manager, Metrics for project size estimation, Project estimation techniques, Empirical Estimation techniques, Software Cost Estimation: COCOMO, Halstead's software science, risk management.

**Requirements Analysis and Specification:** Requirements gathering and analysis, Software Requirements Specification (SRS), Formal system specification, Axiomatic specification, Algebraic specification, Executable specification and 4GL.

### UNIT III:

**Software Design:** Overview of the design process, how to characterize a good software design? Layered arrangement of modules, Cohesion and Coupling. Approaches to software design.

**Agility:** Agility and the Cost of Change, Agile Process, Extreme Programming (XP), Other Agile Process Models, Tool Set for the Agile Process (Text Book 2).

**Function-Oriented Software Design:** Overview of SA/SD methodology, structured analysis, Developing the DFD model of a system, Structured design, Detailed design, and Design Review.

**User Interface Design:** Characteristics of a good user interface, Basic concepts, Types of user interfaces, Fundamentals of component-based GUI development, and user interface design methodology.

### UNIT IV:

**Coding And Testing:** Coding, Code review, Software documentation, Testing, Black-box testing, White-Box testing, Debugging, Program analysis tools, Integration testing, testing object-oriented programs, Smoke testing, and some general issues associated with testing.

**Software Reliability and Quality Management:** Software reliability. Statistical testing, Software quality, Software quality management system, ISO 9000. SEI Capability maturity model. Few other important quality standards, and Six Sigma.

**UNIT V:**

**Computer-Aided Software Engineering (Case):** CASE and its scope, CASE environment, CASE support in the software life cycle, other characteristics of CASE tools, Towards second generation CASE Tool, and Architecture of a CASE Environment.

**Software Maintenance:** Characteristics of software maintenance, Software reverse engineering, Software maintenance process models and Estimation of maintenance cost.

**Software Reuse:** reuse- definition, introduction, reason behind no reuse so far, Basic issues in any reuse program, A reuse approach, and Reuse at organization level.

**Text Books:**

1. Fundamentals of Software Engineering, Rajib Mall, 5th Edition, PHI.
2. Software Engineering A Practitioner's Approach, Roger S. Pressman, 9<sup>th</sup> Edition, McGraw Hill International Edition.

**Reference Books:**

1. Software Engineering, Ian Sommerville, 10<sup>th</sup> Edition, Pearson.
2. Software Engineering, Principles and Practices, Deepak Jain, Oxford University Press.

**e-Resources:**

- 1) <https://nptel.ac.in/courses/I06/105/106105182/>
- 2) [https://infyspringboard.onwingspan.com/web/en/app/toc/lex\\_auth\\_01260589506387148827\\_shared/overview](https://infyspringboard.onwingspan.com/web/en/app/toc/lex_auth_01260589506387148827_shared/overview)
- 3) [https://infyspringboard.onwingspan.com/web/en/app/toc/lex\\_auth\\_013382690411003904735\\_shared/overview](https://infyspringboard.onwingspan.com/web/en/app/toc/lex_auth_013382690411003904735_shared/overview)

II Year - I Semester

L	T	P	C
3	0	0	3

## OBJECT ORIENTED PROGRAMMING THROUGH JAVA

### Course Objectives:

The learning objectives of this course are to:

- Identify Java language components and how they work together in applications.
- Learn the fundamentals of object-oriented programming in Java, including defining classes, invoking methods, using class libraries.
- Learn how to extend Java classes with inheritance and dynamic binding and how to use exception handling in Java applications
- Understand how to design applications with threads in Java.
- Understand how to use Java APIs for program development.

### UNIT-I

**Object Oriented Programming:** Basic concepts, Principles, Program Structure in Java: Introduction, Writing Simple Java Programs, Elements or Tokens in Java Programs, Java Statements, Command Line Arguments, User Input to Programs, Escape Sequences Comments, Programming Style.

**Data Types, Variables, and Operators:** Introduction, Data Types in Java, Declaration of Variables, Data Types, Type Casting, Scope of Variable Identifier, Literal Constants, Symbolic Constants, Formatted Output with printf() Method, Static Variables and Methods, Attribute Final, Introduction to Operators, Precedence and Associativity of Operators, Assignment Operator ( = ), Basic Arithmetic Operators, Increment (++) and Decrement (- -) Operators, Ternary Operator, Relational Operators, Boolean Logical Operators, Bitwise Logical Operators.

**Control Statements:** Introduction, if Expression, Nested if Expressions, if- else Expressions, Ternary Operator?:, Switch Statement, Iteration Statements, while Expression, do-while Loop, for Loop, Nested for Loop, For- Each for Loop, Break Statement, Continue Statement.

### UNIT II

**Classes and Objects:** Introduction, Class Declaration and Modifiers, Class Members, Declaration of Class Objects, Assigning One Object to Another, Access Control for Class Members, Accessing Private Members of Class, Constructor Methods for Class, Overloaded Constructor Methods, Nested Classes, Final Class and Methods, Passing Arguments by Value and by Reference, Keyword this.

**Methods:** Introduction, Defining Methods, Overloaded Methods, Overloaded Constructor Methods, Class Objects as Parameters in Methods, Access Control, Recursive Methods, Nesting of Methods, Overriding Methods, Attributes Final and Static.

### UNIT III

**Arrays:** Introduction, Declaration and Initialization of Arrays, Storage of Array in Computer Memory, Accessing Elements of Arrays, Operations on Array Elements, Assigning Array to Another Array, Dynamic Change of Array Size, Sorting of Arrays, Search for Values in Arrays, Class Arrays, Two-dimensional Arrays, Arrays of Varying Lengths, Three-dimensional Arrays, Arrays as Vectors.

**Inheritance:** Introduction, Process of Inheritance, Types of Inheritances, Universal Super

Class-Object Class, Inhibiting Inheritance of Class Using Final, Access Control and Inheritance, Multilevel Inheritance, Application of Keyword Super, Constructor Method and Inheritance, Method Overriding, Dynamic Method Dispatch, Abstract Classes, Interfaces and Inheritance.

**Interfaces:** Introduction, Declaration of Interface, Implementation of Interface, Multiple Interfaces, Nested Interfaces, Inheritance of Interfaces, Default Methods in Interfaces, Static Methods in Interface, Functional Interfaces, Annotations.

## UNIT IV

**Packages and Java Library:** Introduction, Defining Package, Importing Packages and Classes into Programs, Path and Class Path, Access Control, Packages in Java SE, Java.lang Package and its Classes, Class Object, Enumeration, class Math, Wrapper Classes, Auto-boxing and Auto-unboxing, Java util Classes and Interfaces, Formatter Class, Random Class, Time Package, Class Instant (java.time.Instant), Formatting for Date/Time in Java, Temporal Adjusters Class, Temporal Adjusters Class.

**Exception Handling:** Introduction, Hierarchy of Standard Exception Classes, Keywords throws and throw, try, catch, and finally Blocks, Multiple Catch Clauses, Class Throw able, Unchecked Exceptions, Checked Exceptions.

**Java I/O and File:** Java I/O API, standard I/O streams, types, Byte streams, Character streams, Scanner class, Files in Java (Text Book 2)

## UNIT V

**String Handling in Java:** Introduction, Interface Char Sequence, Class String, Methods for Extracting Characters from Strings, Comparison, Modifying, Searching; Class String Buffer.

**Multithreaded Programming:** Introduction, Need for Multiple Threads Multithreaded Programming for Multi-core Processor, Thread Class, Main Thread-Creation of New Threads, Thread States, Thread Priority- Synchronization, Deadlock and Race Situations, Inter-thread Communication - Suspending, Resuming, and Stopping of Threads.

**Java FX GUI:** Java FX Scene Builder, Java FX App Window Structure, displaying text and image, event handling, laying out nodes in scene graph, mouse events (Text Book 3)

### Text Books:

- 1) JAVA one step ahead, Anitha Seth, B.L.Juneja, Oxford.
- 2) Joy with JAVA, Fundamentals of Object Oriented Programming, Debasis Samanta, Monalisa Sarma, Cambridge, 2023.
- 3) JAVA 9 for Programmers, Paul Deitel, Harvey Deitel, 4<sup>th</sup> Edition, Pearson.

### References Books:

- 1) The complete Reference Java, 11<sup>th</sup> edition, Herbert Schildt, TMH
- 2) Introduction to Java programming, 7<sup>th</sup> Edition, Y Daniel Liang, Pearson

### Online Resources:

- 1) <https://nptel.ac.in/courses/106/105/106105191/>
- 2) [https://infyspringboard.onwingspan.com/web/en/app/toc/lex\\_auth\\_012880464547618816347\\_shared/overview](https://infyspringboard.onwingspan.com/web/en/app/toc/lex_auth_012880464547618816347_shared/overview)

## II Year - I Semester

L	T	P	C
0	0	3	1.5

## CASE TOOLS LAB

### COURSE LEVEL LEARNING OUTCOMES (COS)

Students will be able to achieve & demonstrate the following COs on completion of course based learning

#### Course Objectives

To have hands on experience in developing a software project by using various software engineering principles and methods in each of the phases of software development.

#### Course Outcomes

1. Ability to translate end-user requirements into system and software requirements
2. Ability to generate a high-level design of the system from the software requirements
3. Will have experience and/or awareness of testing problems and will be able to develop a simple testing report

#### List of Experiments

Do the following g 8 exercises for any two projects given in the list of sample projects or any other projects:

- 1) Development of problem statement.
- 2) Preparation of Software Requirement Specification Document, Design Documents and Testing Phase related documents.
- 3) Preparation of Software Configuration Management and Risk Management related documents.
- 4) Study and usage of any Design phase CASE tool
- 5) Performing the Design by using any Design phase CASE tools.
- 6) Develop test cases for unit testing and integration testing
- 7) Develop test cases for various white box and black box testing techniques.

#### Sample Projects:

- 1) Passport automation System
- 2) Book Bank
- 3) Online Exam Registration
- 4) Stock Maintenance System
- 5) Online course reservation system
- 6) E-ticketing
- 7) Software Personnel Management System
- 8) Credit Card Processing
- 9) E-book management System.
- 10) Recruitment system

#### Text Books:

- 1) Software Engineering, A practitioner's Approach- Roger S. Pressman, 6th edition, Mc Graw Hill International Edition.
- 2) Software Engineering- Sommerville, 7th edition, Pearson Education.
- 3) The unified modeling language user guide Grady Booch, James Rumbaugh, Ivar Jacobson, Pearson Education.

## II Year - I Semester

L	T	P	C
0	0	3	1.5

**OBJECT ORIENTED PROGRAMMING THROUGH JAVA LAB****Course Objectives:**

The aim of this course is to

- Practice object oriented programming in the Java programming language
- implement Classes, Objects, Methods, Inheritance, Exception, Runtime Polymorphism, User defined Exception handling mechanism
- Illustrate inheritance, Exception handling mechanism, JDBC connectivity
- Construct Threads, Event Handling, implement packages, Java FX GUI

**Experiments covering the Topics:**

- Object Oriented Programming fundamentals- data types, control structures
- Classes, methods, objects, Inheritance, polymorphism,
- Exception handling, Threads, Packages, Interfaces
- Files, I/O streams, JavaFX GUI

**Sample Experiments:****Exercise – 1:**

- Write a JAVA program to display default value of all primitive data type of JAVA
- Write a java program that display the roots of a quadratic equation  $ax^2+bx=0$ . Calculate the discriminate D and basing on value of D, describe the nature of root.

**Exercise - 2**

- Write a JAVA program to search for an element in a given list of elements using binary search mechanism.
- Write a JAVA program to sort for an element in each list of elements using bubble sort
- Write a JAVA program using String Buffer to delete, remove character.

**Exercise - 3**

- Write a JAVA program to implement class mechanism. Create a class, methods and invoke them inside main method.
- Write a JAVA program implement method overloading.
- Write a JAVA program to implement constructor.
- Write a JAVA program to implement constructor overloading.

**Exercise - 4**

- Write a JAVA program to implement Single Inheritance
- Write a JAVA program to implement multi level Inheritance
- Write a JAVA program for abstract class to find areas of different shapes

**Exercise - 5**

- Write a JAVA program give example for “super” keyword.
- Write a JAVA program to implement Interface. What kind of Inheritance can be achieved?

- c) Write a JAVA program that implements Runtime polymorphism

**Exercise - 6**

- a) Write a JAVA program that describes exception handling mechanism  
b) Write a JAVA program Illustrating Multiple catch clauses  
c) Write a JAVA program for creation of Java Built-in Exceptions  
d) Write a JAVA program for creation of User Defined Exception

**Exercise - 7**

- a) Write a JAVA program that creates threads by extending Thread class. First thread display “Good Morning “every 1 sec, the second thread displays “Hello “every 2 seconds and the third display “Welcome” every 3 seconds, (Repeat the same by implementing Runnable)  
b) Write a program illustrating is Alive and join ()  
c) Write a Program illustrating Daemon Threads.  
d) Write a JAVA program Producer Consumer Problem

**Exercise – 8**

- a) Write a JAVA program that import and use the user defined packages  
b) Without writing any code, build a GUI that display text in label and image in an ImageView (use JavaFX)  
c) Build a Tip Calculator app using several JavaFX components and learn how to respond to user interactions with the GUI

**Exercise – 9**

- a) Write a java program that connects to a database using JDBC  
b) Write a java program to connect to a database using JDBC and insert values into it.  
c) Write a java program to connect to a database using JDBC and delete values from it



II Year - I Semester

<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>0</b>	<b>1</b>	<b>2</b>	<b>2</b>

## PYTHON PROGRAMMING (Skill Enhancement Course)

### Course Objectives:

- The main objectives of the course are to Introduce core programming concepts of Python programming language.
- Demonstrate about Python data structures like Lists, Tuples, Sets and dictionaries
- Implement Functions, Modules and Regular Expressions in Python Programming and to create practical and contemporary applications using these

### UNIT-I:

History of Python Programming Language, Thrust Areas of Python, Installing Anaconda Python Distribution, Installing and Using Jupyter Notebook.

Parts of Python Programming Language: Identifiers, Keywords, Statements and Expressions, Variables, Operators, Precedence and Associativity, Data Types, Indentation, Comments, Reading Input, Print Output, Type Conversions, the type () Function and Is Operator, Dynamic and Strongly Typed Language.

Control Flow Statements: if statement, if-else statement, if...elif...else, Nested if statement, while Loop, for Loop, continue and break Statements, Catching Exceptions Using try and except Statement.

### Sample Experiments:

1. Write a program to find the largest element among three Numbers.
2. Write a Program to display all prime numbers within an interval
3. Write a program to swap two numbers without using a temporary variable.
4. Demonstrate the following Operators in Python with suitable examples.
  - i) Arithmetic Operators ii) Relational Operators iii) Assignment Operators iv) Logical Operators v) Bit wise Operators vi) Ternary Operator vii) Membership Operators viii) Identity Operators
5. Write a program to add and multiply complex numbers
6. Write a program to print multiplication table of a given number.

### UNIT-II:

Functions: Built-In Functions, Commonly Used Modules, Function Definition and Calling the function, return Statement and void Function, Scope and Lifetime of Variables, Default Parameters, Keyword Arguments, \*args and \*\*kwargs, Command Line Arguments.

**Strings:** Creating and Storing Strings, Basic String Operations, Accessing Characters in String by Index Number, String Slicing and Joining, String Methods, Formatting Strings.

**Lists:** Creating Lists, Basic List Operations, Indexing and Slicing in Lists, Built-In Functions Used on Lists, List Methods, del Statement.

### Sample Experiments:

7. Write a program to define a function with multiple return values.
8. Write a program to define a function using default arguments.
9. Write a program to find the length of the string without using any library functions.

10. Write a program to check if the substring is present in a given string or not.
11. Write a program to perform the given operations on a list:
  - i. addition
  - ii. Insertion
  - iii. slicing
12. Write a program to perform any 5 built-in functions by taking any list.

### UNIT-III:

**Dictionaries:** Creating Dictionary, Accessing and Modifying key:value Pairs in Dictionaries, Built-In Functions Used on Dictionaries, Dictionary Methods, del Statement.

**Tuples and Sets:** Creating Tuples, Basic Tuple Operations, tuple() Function, Indexing and Slicing in Tuples, Built-In Functions Used on Tuples, Relation between Tuples and Lists, Relation between Tuples and Dictionaries, Using zip() Function, Sets, Set Methods, Frozenset.

#### Sample Experiments:

13. Write a program to create tuples (name, age, address, college) for at least two members and concatenate the tuples and print the concatenated tuples.
14. Write a program to count the number of vowels in a string (No control flow allowed).
15. Write a program to check if a given key exists in a dictionary or not.
16. Write a program to add a new key-value pair to an existing dictionary.
17. Write a program to sum all the items in a given dictionary.

### UNIT-IV:

**Files:** Types of Files, Creating and Reading Text Data, File Methods to Read and Write Data, Reading and Writing Binary Files, Pickle Module, Reading and Writing CSV Files, Python os and os.path Modules.

**Object-Oriented Programming:** Classes and Objects, Creating Classes in Python, Creating Objects in Python, Constructor Method, Classes with Multiple Objects, Class Attributes Vs Data Attributes, Encapsulation, Inheritance, Polymorphism.

#### Sample Experiments:

18. Write a program to sort words in a file and put them in another file. The output file should have only lower-case words, so any upper-case words from source must be lowered.
19. Python program to print each line of a file in reverse order.
20. Python program to compute the number of characters, words and lines in a file.
21. Write a program to create, display, append, insert and reverse the order of the items in the array.
22. Write a program to add, transpose and multiply two matrices.
23. Write a Python program to create a class that represents a shape. Include methods to calculate its area and perimeter. Implement subclasses for different shapes like circle, triangle, and square.

### UNIT-V:

Introduction to Data Science: Functional Programming, JSON and XML in Python, NumPy with Python, Pandas.

#### Sample Experiments:

24. Python program to check whether a JSON string contains complex object or not.
25. Python Program to demonstrate NumPy arrays creation using array () function.
26. Python program to demonstrate use of ndim, shape, size, dtype.
27. Python program to demonstrate basic slicing, integer and Boolean indexing.
28. Python program to find min, max, sum, cumulative sum of array

29. Create a dictionary with at least five keys and each key represent value as a list where this list contains at least ten values and convert this dictionary as a pandas data frame and explore the data through the data frame as follows:
- Apply head () function to the pandas data frame
  - Perform various data selection operations on Data Frame
30. Select any two columns from the above data frame, and observe the change in one attribute with respect to other attribute with scatter and plot operations in matplotlib

**Reference Books:**

- Gowri shankar S, Veena A., Introduction to Python Programming, CRCPress.
- Python Programming, S Sridhar, J Indumathi, V M Hariharan, 2<sup>nd</sup> Edition, Pearson, 2024
- Introduction to Programming Using Python, Y. Daniel Liang, Pearson.

**Online Learning Resources/Virtual Labs:**

- <https://www.coursera.org/learn/python-for-applied-data-science-ai>
- <https://www.coursera.org/learn/python?specialization=python#syllabus>

II Year-I Semester	ENVIRONMENTAL SCIENCE	L	T	P	C
		2	0	0	-

**Course Objectives:**

- To make the students to get awareness on environment.
- To understand the importance of protecting natural resources, ecosystems for future generations and pollution causes due to the day to day activities of human life
- To save earth from the inventions by the engineers.

**UNIT I****7h**

**Multidisciplinary Nature of Environmental Studies:** – Definition, Scope and Importance – Need for Public Awareness.

**Natural Resources:** Renewable and non-renewable resources – Natural resources and associated problems – Forest resources – Water resources – Mineral resources- Food resources–Land resources and Energy resources - Use and over exploitation, case studies.

**UNIT II****7h**

**Ecosystems:** Concept of an ecosystem. – Structure and function of an ecosystem (Producers, consumers and decomposers), Energy flow in the ecosystem and ecological pyramids – Introduction, types, characteristic features of the following ecosystem:

- Forest ecosystem.
- Grassland ecosystem
- Desert ecosystem.
- Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries)

**Biodiversity and its Conservation:** Introduction - Definition: genetic, species and ecosystem diversity – Bio-geographical classification of India – Biodiversity at global, National and local levels – India as a mega-diversity nation – Hot-spots of biodiversity – Threats to biodiversity – Endangered and endemic species of India – Conservation of biodiversity: In-situ and Ex-situ conservation of biodiversity.

**UNIT III****6h**

**Environmental Pollution:** Definition, Cause, effects and control measures of:

- Air Pollution.
- Water pollution
- Soil pollution
- Marine pollution
- Noise pollution
- Thermal pollution
- Nuclear hazards

**Solid Waste Management:** Causes, effects and control measures of urban and industrial wastes – Role of an individual in prevention of pollution – Pollution case studies – Disaster management: floods, earthquake, cyclone and landslides.

**UNIT IV****6h**

**Social Issues and the Environment:** From Unsustainable to Sustainable development – Water conservation, rain water harvesting, watershed management – Environmental ethics: Issues and possible solutions – Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust. Case Studies – Environment Protection Act. – Air (Prevention and Control of Pollution) Act. – Water (Prevention and control of Pollution) Act – Wildlife Protection Act – Forest Conservation Act.

**Human Population and the Environment:** Population growth, variation among nations. Population explosion – Family Welfare Programmes. – Environment and human health – Human Rights – Value Education – HIV/AIDS – Women and Child Welfare – Role of information Technology in Environment and human health – Case studies.  
**Field Work:** Visit to a local area to document environmental assets River/forest grassland/hill/mountain – Visit to a local polluted site-Urban/Rural/Industrial/Agricultural Study of common plants, insects, and birds – river, hill slopes, etc.

**Textbooks:**

1. Textbook of Environmental Studies for Undergraduate Courses Erach Bharucha for University Grants Commission, Universities Press.
2. Palaniswamy, “Environmental Studies”, Pearson education
3. S.Azeem Unnisa, “Environmental Studies” Academic Publishing Company
4. K.Raghavan Nambiar, “Text book of Environmental Studies for Undergraduate Courses as per UGC model syllabus”, Scitech Publications (India), Pvt. Ltd.

**References:**

1. Deeksha Dave and E.Sai Baba Reddy, “Textbook of Environmental Science”, Cengage Publications.
2. M.Anji Reddy, “Text book of Environmental Sciences and Technology”, BS Publication.
3. J.P.Sharma, Comprehensive Environmental studies, Laxmi publications.
4. J. Glynn Henry and Gary W. Heinke, “Environmental Sciences and Engineering”, Prentice hall of India Private limited
5. G.R.Chatwal, “A Text Book of Environmental Studies” Himalaya Publishing House
6. Gilbert M. Masters and Wendell P. Ela, “Introduction to Environmental Engineering and Science, Prentice hall of India Private limited.

II Year-II Semester	MANAGERIAL ECONOMICS AND FINANCIAL ANALYSIS	L	T	P	C
		2	0	0	2

**Course Objectives:**

- To inculcate the basic knowledge of microeconomics and financial accounting
- To make the students learn how demand is estimated for different products, input-output relationship for optimizing production and cost
- To Know the Various types of market structure and pricing methods and strategy
- To give an overview on investment appraisal methods to promote the students to learn how to plan long-term investment decisions.
- To provide fundamental skills on accounting and to explain the process of preparing financial statements.

**Course Outcomes:**

- Define the concepts related to Managerial Economics, financial accounting and management(L2)
- Understand the fundamentals of Economics viz., Demand, Production, cost, revenue and markets (L2)
- Apply the Concept of Production cost and revenues for effective Business decision (L3)
- Analyze how to invest their capital and maximize returns (L4)
- Evaluate the capital budgeting techniques. (L5)
- Develop the accounting statements and evaluate the financial performance of business entity (L5)

**UNIT - I Managerial Economics 6h**

Introduction – Nature, meaning, significance, functions, and advantages. Demand-Concept, Function, Law of Demand - Demand Elasticity- Types – Measurement. Demand Forecasting- Factors governing Forecasting, Methods. Managerial Economics and Financial Accounting and Management.

**UNIT - II Production and Cost Analysis 4h**

Introduction – Nature, meaning, significance, functions and advantages. Production Function– Least-cost combination– Short run and long run Production Function- Isoquants and Is costs, Cost & Break-Even Analysis - Cost concepts and Cost behaviour- Break-Even Analysis (BEA) - Determination of Break-Even Point (Simple Problems).

**UNIT - III Business Organizations and Markets 4h**

Introduction – Forms of Business Organizations- Sole Proprietary - Partnership - Joint Stock Companies - Public Sector Enterprises. Types of Markets - Perfect and Imperfect Competition - Features of Perfect Competition Monopoly- Monopolistic Competition–Oligopoly-Price-Output Determination - Pricing Methods and Strategies

**UNIT - IV Capital Budgeting 8h**

Introduction – Nature, meaning, significance. Types of Working Capital, Components, Sources of Short-term and Long-term Capital, Estimating Working capital requirements. Capital Budgeting– Features, Proposals, Methods and Evaluation. Projects – Pay Back Method, Accounting Rate of Return (ARR) Net Present Value (NPV) Internal Rate Return (IRR) Method (sample problems)

**UNIT - V Financial Accounting and Analysis 10h**

Introduction – Concepts and Conventions- Double-Entry Bookkeeping, Journal, Ledger, Trial Balance-Final Accounts (Trading Account, Profit and Loss Account and Balance Sheet with simple adjustments). Introduction to Financial Analysis - Analysis and Interpretation of Liquidity Ratios, Activity Ratios, and

## Capital structure Ratios and Profitability.

**Textbooks:**

1. Varshney & Maheswari: Managerial Economics, Sultan Chand.
2. Aryasri: Business Economics and Financial Analysis, 4/e, MGH.

**Reference Books:**

1. Ahuja Hl Managerial economics Schand.
2. S.A. Siddiqui and A.S. Siddiqui: Managerial Economics and Financial Analysis, New Age International.
3. Joseph G. Nellis and David Parker: Principles of Business Economics, Pearson, 2/e, New Delhi.
4. Domnick Salvatore: Managerial Economics in a Global Economy, Cengage.

**Online Learning Resources:**

<https://www.slideshare.net/123ps/managerial-economics-ppt>

<https://www.slideshare.net/rossanz/production-and-cost-45827016>

<https://www.slideshare.net/darkyla/business-organizations-19917607>

<https://www.slideshare.net/balarajbl/market-and-classification-of-market>

<https://www.slideshare.net/ruchi101/capital-budgeting-ppt-59565396>

<https://www.slideshare.net/ashu1983/financial-accounting>

<b>II Year IISemester</b>	<b>PROBABILITY &amp; STATISTICS</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
		<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>

**Course Outcomes:**

After successful completion of this course, the students should be able to:

COs	Statements	Blooms level
CO1	Acquire knowledge in finding the analysis of the data quantitatively or categorically and various statistical elementary tools.	L2, L3
CO2	Develop skills in designing mathematical models involving probability, random variables and the critical thinking in the theory of probability and its applications in real life problems.	L3, L5
CO3	Apply the theoretical probability distributions like binomial, Poisson, and Normal in the relevant application areas.	L3
CO4	Analyze to test various hypotheses included in theory and types of errors for large samples.	L2, L3
CO5	Apply the different testing tools like t-test, F-test, chi-square test to analyze the relevant real-life problems.	L3, L5

**UNITI:Descriptive statistics and methods for data science: 10 hrs**

Data science – Statistics Introduction – Population vs Sample – Collection of data – primary and secondary data – Type of variable: dependent and independent Categorical and Continuous variables– Data visualization – Measures of Central tendency – Measures of Variability (spread or variance) –Skewness Kurtosis.

**UNITII:Probability & Distributions: 10 hrs**

Probability – Conditional probability and Baye’s theorem – Random variables – Discrete and Continuous random variables – Distribution function – Mathematical Expectation and Variance –Binomial, Poisson, Uniform and Normal distributions.

**UNITIII:SamplingTheory: 10 hrs**

Introduction – Population and samples – Sampling distribution of Means and Variance (definition only) – Central limit theorem (without proof) – Introduction to t, chi-square and F-distributions – Point and Interval estimations – Standard error and Maximum error of estimate.

**UNITIV:Tests of Hypothesis: 10 hrs**

Introduction – Hypothesis – Null and Alternative Hypothesis – Type I and Type II errors – Level of significance-Confidence limits-Test of significance for large samples-single and two means – single and two proportions-Student’s t- distribution- significance test of a sample mean – significance test of difference between sample means.F-test, chi-square test and test of goodness of fit.

**UNITV :Regression analysis: 8 hrs**

Method of least squares – Straight line – Parabola – Exponential – Power curves. Regression -Regression coefficients and properties – Curvilinear Regression, Multiple Regression - Correlation –Correlation coefficient – Rank correlation

**Textbooks:**

1. Miller and Freunds, Probability and Statistics for Engineers,7/e, Pearson, 2008.
2. S.C. Gupta and V.K. Kapoor, Fundamentals of Mathematical Statistics, 11/e, Sultan Chand & Sons Publications, 2012.

**Reference Books:**

1. Shron L. Myers, Keying Ye, Ronald E Walpole, Probability and Statistics Engineers and the Scientists,8th Edition, Pearson 2007.
2. S. Ross, a First Course in Probability, Pearson Education India, 2002.
3. W. Feller, an Introduction to Probability Theory and its Applications, 1/e, Wiley, 1968.

**Online Learning Sources:**



- [https://onlinecourses.nptel.ac.in/noc21\\_ma74/preview](https://onlinecourses.nptel.ac.in/noc21_ma74/preview)
- [https://onlinecourses.nptel.ac.in/noc22\\_mg31/preview](https://onlinecourses.nptel.ac.in/noc22_mg31/preview)

## II Year - II Semester

L	T	P	C
3	0	0	3

## OPERATING SYSTEMS

### Course Objectives:

The main objectives of the course is to make student

- Understand the basic concepts and principles of operating systems, including process management, memory management, file systems, and Protection
- Make use of process scheduling algorithms and synchronization techniques to achieve better performance of a computer system.
- Illustrate different conditions for deadlock and their possible solutions.

### UNIT - I

**Operating Systems Overview:** Introduction, Operating system functions, Operating systems operations, Computing environments, Free and Open-Source Operating Systems

**System Structures:** Operating System Services, User and Operating-System Interface, system calls, Types of System Calls, system programs, Operating system Design and Implementation, Operating system structure, Building and Booting an Operating System, Operating system debugging

### UNIT - II

**Processes:** Process Concept, Process scheduling, Operations on processes, Inter-process communication.

**Threads and Concurrency:** Multithreading models, Thread libraries, Threading issues.

**CPU Scheduling:** Basic concepts, Scheduling criteria, Scheduling algorithms, Multiple processor scheduling.

### UNIT – III

**Synchronization Tools:** The Critical Section Problem, Peterson’s Solution, Mutex Locks, Semaphores, Monitors, Classic problems of Synchronization. Deadlocks: system Model, Deadlock characterization, Methods for handling Deadlocks, Deadlock prevention, Deadlock avoidance, Deadlock detection, Recovery from Deadlock.

### UNIT - IV

**Memory-Management Strategies:** Introduction, Contiguous memory allocation, Paging, Structure of the Page Table, Swapping.

**Virtual Memory Management:** Introduction, Demand paging, Copy-on-write, Page replacement, Allocation of frames, Thrashing Storage Management: Overview of Mass Storage Structure, HDD Scheduling.

### UNIT - V

**File System:** File System Interface: File concept, Access methods, Directory Structure; File system Implementation: File-system structure, File-system Operations, Directory implementation, Allocation method, Free space management; File-System Internals: File-System Mounting, Partitions and Mounting, File Sharing.

**Protection:** Goals of protection, Principles of protection, Protection Rings, Domain of protection, Access matrix.

**Text Books:**

1. Operating System Concepts, Silberschatz A, Galvin P B, Gagne G, 10<sup>th</sup> Edition, Wiley, 2018.
2. Modern Operating Systems, Tanenbaum A S, 4<sup>th</sup> Edition, Pearson ,2016

**Reference Books:**

1. Operating Systems -Internals and Design Principles, Stallings W, 9<sup>th</sup> edition, Pearson, 2018
2. Operating Systems: A Concept Based Approach, D.M Dhamdhere, 3<sup>rd</sup> Edition, McGraw- Hill, 2013

**Online Learning Resources:**

1. <https://nptel.ac.in/courses/106/106/106106144/>
2. <http://peterindia.net/OperatingSystems.html>

II Year - II Semester

L	T	P	C
3	0	0	3

## DATABASE MANAGEMENT SYSTEMS

### Course Objectives:

- The main objectives of the course is to Introduce database management systems and to give a good formal foundation on the relational model of data and usage of Relational Algebra
- Introduce the concepts of basic SQL as a universal Database language
- Demonstrate the principles behind systematic database design approaches by covering conceptual design, logical design through normalization
- Provide an overview of physical design of a database system, by discussing Database indexing techniques and storage techniques

### UNIT I:

**Introduction:** Database system, Characteristics (Database Vs File System), Database Users, Advantages of Database systems, Database applications. Brief introduction of different Data Models; Concepts of Schema, Instance and data independence; Three tier schema architecture for data independence; Database system structure, environment, Centralized and Client Server architecture for the database.

**Entity Relationship Model:** Introduction, Representation of entities, attributes, entity set, relationship, relationship set, constraints, sub classes, super class, inheritance, specialization, generalization using ER Diagrams.

### UNIT II:

**Relational Model:** Introduction to relational model, concepts of domain, attribute, tuple, relation, importance of null values, constraints (Domain, Key constraints, integrity constraints) and their importance, Relational Algebra - Selection and Projection, Set Operations, Renaming, Joins, Division, More Examples of Relational Algebra Queries , Relational Calculus- Tuple Relational Calculus, Domain Relational Calculus, Expressive. Power of Algebra and Calculus. BASIC SQL: Simple Database schema, data types, table definitions - DDL (Data Definition Language) - create, alter, different DML operations (insert, delete, update).

### UNIT III:

**SQL:** Basic SQL querying (select and project) using where clause, arithmetic & logical operations, SQL functions(Date and Time, Numeric, String conversion).Creating tables with relationship, implementation of key and integrity constraints, nested queries, sub queries, grouping, aggregation, ordering, implementation of different types of joins, view (updatable and non- updatable), relational set operations.

### UNIT IV:

**Schema Refinement (Normalization):** Purpose of Normalization or schema refinement, concept of functional dependency, normal forms based on functional dependency Lossless join and dependency preserving decomposition, (1NF, 2NF and 3 NF), concept of surrogate key, Boyce-Codd normal form(BCNF), MVD, Fourth normal form(4NF), Fifth Normal Form (5NF).

**UNIT V:**

**Transaction Concept:** Transaction State, ACID properties, Concurrent Executions, Serializability, Recoverability, Implementation of Isolation, Testing for Serializability, lock based, time stamp based, optimistic, concurrency protocols, Deadlocks, Failure Classification, Storage, Recovery and Atomicity, Recovery algorithm.

**Introduction to Indexing Techniques:** B+ Trees, operations on B+ Trees, Hash Based Indexing.

**Text Books:**

- 1) Database Management Systems, 3<sup>rd</sup> edition, Raghurama Krishnan, Johannes Gehrke, TMH (For Chapters 2, 3, 4)
- 2) Database System Concepts, 5<sup>th</sup> edition, Silberschatz, Korth, Sudarsan, TMH (For Chapter 1 and Chapter 5)

**Reference Books:**

- 1) Introduction to Database Systems, 8<sup>th</sup> edition, C J Date, Pearson.
- 2) Database Management System, 6<sup>th</sup> edition, Ramez Elmasri, Shamkant B. Navathe, Pearson
- 3) Database Principles Fundamentals of Design Implementation and Management, Corlos Coronel, Steven Morris, Peter Robb, Cengage Learning.

**Web-Resources:**

- 1) <https://nptel.ac.in/courses/106/105/106105175/>
- 2) [https://infyspringboard.onwingspan.com/web/en/app/toc/lex\\_auth\\_01275806667282022456\\_shared/overview](https://infyspringboard.onwingspan.com/web/en/app/toc/lex_auth_01275806667282022456_shared/overview)

II Year - II Semester

L	T	P	C
3	0	0	3

## DESIGN & ANALYSIS OF ALGORITHMS

### Course Objectives:

The main objectives of the course is to

- Provide knowledge on advance data structures frequently used in Computer Science domain
- Develop skills in algorithm design techniques popularly used
- Understand the use of various data structures in the algorithm design

### Course Outcomes:

After completion of the course, students will be able to

1. Illustrate the working of the advanced tree data structures and their applications (L2)
2. Understand the Graph data structure, traversals and apply them in various contexts. (L2)
3. Use various data structures in the design of algorithms (L3)
4. Recommend appropriate data structures based on the problem being solved (L5)
5. Analyze algorithms with respect to space and time complexities (L4)

### UNIT – I:

Introduction to Algorithm Analysis, Space and Time Complexity analysis, Asymptotic Notations.

SETS and DISJOINT SETS – Union and Find Operations.

Heap Trees (Priority Queues) – Min and Max Heaps, Operations and Applications

### UNIT – II:

Graphs – Terminology, Representations, Basic Search and Traversals, Connected Components and Biconnected Components, applications

**Divide and Conquer:** The General Method, Quick Sort, Merge Sort, Strassen's matrix multiplication, Convex Hull

### UNIT – III:

Greedy Method: General Method, Job Sequencing with deadlines, Knapsack Problem, Minimum cost spanning trees, Single Source Shortest Paths

### UNIT – IV:

**Dynamic Programming:** General Method, applications-Matrix chain multiplication, optimal binary search trees,0/1 Knapsack problem, all pairs shortest paths, Travelling Salesperson problem, Reliability Design.

### UNIT – V:

**Backtracking:** General Method, Applications – N-Queens Problem, Sum of Subsets problem, Graph Coloring, Hamiltonian Cycle.

**Branch and Bound:** The General Method, applications-Travelling Salesperson problem, 0/1 Knapsack Problem, LC Branch and Bound solution, FIFO Branch and Bound solution.

**NP Hard and NP Complete Problems: Basic concepts, non-deterministic algorithms, NP Hard and NP Complete classes, Cook's theorem.**

**Textbooks:**

1. Fundamentals of Computer Algorithms, Ellis Horowitz, Satraj Sahni and Rajasekharam, Universities Press.
2. Introduction to Algorithms, second edition, T.H. Cormen, C.E.Leiserson, R.L.Rivest and C.Stein, PHI Pvt.Ltd.
3. Introduction to the Design and Analysis of Algorithms, Anany Levitin, PEA.
4. Algorithm Design, Jon Kleinberg and Eva Tardos. 1<sup>st</sup> Edition.
5. Data Structures and Algorithms in Python. Roberto Tamassia, Michael H. Goldwasser, Michael T. Goodrich. Wiley.1<sup>st</sup> Edition.
6. Problem Solving with Algorithms and Data Structures Using Python. Release 3.0. Bradley N Miller. Franklin Beedle & Assoc

**Reference Books:**

1. Data Structures and program design in C, Robert Kruse, Pearson Education Asia
2. An introduction to Data Structures with applications, Trembley & Sorenson, McGraw Hill
3. The Art of Computer Programming, Vol.1: Fundamental Algorithms, Donald E Knuth, Addison-Wesley, 1997.
4. Data Structures using C & C++: Langsam, Augenstein & Tanenbaum, Pearson, 1995
5. Algorithms + Data Structures & Programs:, N.Wirth, PHI
6. Fundamentals of Data Structures in C++: Horowitz Sahni & Mehta, Galgottia Pub.
7. Data structures in Java:, Thomas Standish, Pearson Education Asia

**Online Learning Resources:**

1. [https://www.tutorialspoint.com/advanced\\_data\\_structures/index.asp](https://www.tutorialspoint.com/advanced_data_structures/index.asp)
2. <http://peterindia.net/Algorithms.html>
3. [https://www.youtube.com/playlist?list=PLDN4rrl48XKpZkf03iYFl-O29szjTrs\\_O](https://www.youtube.com/playlist?list=PLDN4rrl48XKpZkf03iYFl-O29szjTrs_O)

## II Year - II Semester

L	T	P	C
0	0	3	1.5

## OPERATING SYSTEMS LAB

### Course Objectives:

The main objectives of the course are to

- Provide insights into system calls, file systems, semaphores,
- Develop and debug CPU Scheduling algorithms, page replacement algorithms, thread implementation
- Implement Bankers Algorithms to Avoid the Dead Lock

### Course Outcomes:

After completion of the course, students will be able to

1. Trace different CPU Scheduling algorithms (L2).
2. Implement Bankers Algorithms to Avoid the Dead Lock (L3).
3. Evaluate Page replacement algorithms (L5).
4. Illustrate the file organization techniques (L4).
5. Illustrate Inter process Communication and concurrent execution of threads (L4)

### Experiments covering the Topics:

- UNIX fundamentals, commands & system calls
- CPU Scheduling algorithms, thread processing
- IPC, semaphores, monitors, deadlocks
- Page replacement algorithms, file allocation strategies
- Memory allocation strategies

### Sample Experiments:

1. Practicing of Basic UNIX Commands.
2. Write programs using the following UNIX operating system calls fork, exec, getpid, exit, wait, close, stat, opendir and readdir
3. Simulate UNIX commands like cp, ls, grep, etc.,
4. Simulate the following CPU scheduling algorithms
  - a) FCFS b) SJF c) Priority d) Round Robin
5. Control the number of ports opened by the operating system with
  - a) Semaphore b) Monitors.
6. Write a program to illustrate concurrent execution of threads using pthreads library.
7. Write a program to solve producer-consumer problem using Semaphores.
8. Implement the following memory allocation methods for fixed partition
  - a) First fit b) Worst fit c) Best fit
9. Simulate the following page replacement algorithms
  - a) FIFO b) LRU c) LFU



10. Simulate Paging Technique of memory management.
11. Implement Bankers Algorithm for Dead Lock avoidance and prevention
12. Simulate the following file allocation strategies
  - a) Sequential
  - b) Indexed
  - c) Linked
13. Android Experiments:
  - a) Installation of Android studio.
  - b) Development of Hello World Application.
  - c) Create an application that takes the name from a text box and shows hello message along with the name entered in text box, when the user clicks the OK button.

**Reference Books:**

1. Operating System Concepts, Silberschatz A, Galvin P B, Gagne G, 10<sup>th</sup> Edition, Wiley, 2018.
2. Modern Operating Systems, Tanenbaum A S, 4<sup>th</sup> Edition, Pearson, 2016
3. Operating Systems -Internals and Design Principles, Stallings W, 9<sup>th</sup> edition, Pearson, 2018
4. Operating Systems: A Concept Based Approach, D.M Dhamdhere, 3<sup>rd</sup> Edition, McGraw- Hill, 2013

**Online Learning Resources:**

1. <https://www.cse.iitb.ac.in/~mythili/os/>
2. <http://peterindia.net/OperatingSystems.html>

## II Year - II Semester

L	T	P	C
0	0	3	1.5

## DATABASE MANAGEMENT SYSTEMS LAB

### Course Objectives:

This course will enable students to

- Implement SQL queries using MySQL/HSQL.
- Populate and query a database using SQL DDL/DML Commands
- Declare and enforce integrity constraints on a database
- Writing Queries using advanced concepts of SQL
- Programming PL/SQL including procedures, functions, cursors and triggers

### Experiments covering the topics:

- DDL, DML, DCL commands
- Queries, nested queries, built-in functions,
- PL/SQL programming- control structures
- Procedures, Functions, Cursors, Triggers,
- Database connectivity- ODBC/JDBC

### Sample Experiments:

1. Creation, altering and dropping of tables and inserting rows into a table (use constraints while creating tables) examples using SELECT command.
2. Queries (along with sub Queries) using ANY, ALL, IN, EXISTS, NOT EXISTS, UNION, INTERSECT, Constraints. Example:- Select the roll number and name of the student who secured fourth rank in the class.
3. Queries using Aggregate functions (COUNT, SUM, AVG, MAX and MIN), GROUP BY, HAVING and Creation and dropping of Views.
4. Queries using Conversion functions (to\_char, to\_number and to\_date), string functions (Concatenation, lpad, rpad, ltrim, rtrim, lower, upper, initcap, length, substr and instr), date functions (Sysdate, next\_day, add\_months, last\_day, months\_between, least, greatest, trunc, round, to\_char, to\_date)
5.
  - i. Create a simple PL/SQL program which includes declaration section, executable section and exception –Handling section (Ex. Student marks can be selected from the table and printed for those who secured first class and an exception can be raised if no records were found)
  - ii. Insert data into student table and use COMMIT, ROLLBACK and SAVEPOINT in PL/SQL block.
6. Develop queries by using NESTED queries concept.
7. Develop a program that includes the features NESTED IF, CASE and CASE expression. The program can be extended using the NULLIF and COALESCE functions.
8. Program development using WHILE LOOPS, numeric FOR LOOPS, nested loops using ERROR Handling, BUILT –IN Exceptions, USE defined Exceptions, RAISE- APPLICATION ERROR.
9. Programs development using creation of procedures, passing parameters IN and OUT of PROCEDURES.

10. Program development using creation of stored functions, invoke functions in SQL Statements and write complex functions.
11. Develop programs using features parameters in a CURSOR, FOR UPDATE CURSOR, WHERE CURRENT of clause and CURSOR variables.
12. Develop Programs using BEFORE and AFTER Triggers, Row and Statement Triggers and INSTEAD OF Triggers
13. Create a table and perform the search operation on table using indexing and non-indexing techniques.
14. Write a Java program that connects to a database using JDBC
15. Write a Java program to connect to a database using JDBC and insert values into it
16. Write a Java program to connect to a database using JDBC and delete values from it

**Text Books/Suggested Reading:**

1. High Performance MySQL: Proven Strategies for Operating at Scale. Author(s): Silvia Botros, Jeremy Tinley. Publisher: O'Reilly Media, Year: 2021
2. Rick F Vander Lans, "Introduction to SQL", Fourth Edition, Pearson Education, 2007

**E-Resource:**

Online resource: <https://hsqldb.org/>

II Year - II Semester

<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>0</b>	<b>1</b>	<b>2</b>	<b>2</b>

## **DJANGO FRAMEWORK (Skill Enhancement Course)**

### **Course Objectives:**

The main objectives of the course are to

- Design and build static as well as dynamic web pages and interactive web-based applications
- Web development using Django framework.
- Analyze and create functional website in Django and deploy Django Web Application on Cloud

### **UNIT-I:**

**Python libraries for web development:** Collections-Container datatypes, Tkinter-GUI applications, Requests-HTTP requests, BeautifulSoup4-web scraping, Scrapy, Zappa, Dash, CherryPy, Turbo Gears, Flask, Web2Py, Bottle, Falcon, Cubic Web, Quixote, Pyramid.

### **Sample Experiments:**

1. Write a Python GUI program to import Tkinter package and create a window. Set its title and add a label to the window.
2. Write a Python program that designs a simple login form with labels and Entry widgets, arranging them in a grid using the Grid geometry manager.
3. Write a program using BeautifulSoup4 library for web scraping for a given URL
4. Develop a sample Hello World page using Flask framework
5. Develop a sample web page using CherryPy / Web2Py / BottleFramework

### **UNIT-II:**

**Introduction to Django Framework:** Understanding Django environment, Features of Django and Django architecture, MVC and MTV, Urls and Views, Mapping the views to URLs, Django Template, Template inheritance Django Models, creating model for site, Converting the model into a table, Fields in Models, Integrating Bootstrap into Django, Creating tables, Creating grids, Creating carousels.

### **Sample Experiments:**

1. Create a Sample “Hello World” Application using Django
2. Create a Login and Registration Page using MVC architecture in Django Framework
3. Create a sample page in Django by integrating Bootstrap.
4. Create an application with Tables, grids in Django
5. Create a Django App with Carousels feature.

### **UNIT-III:**

**Integrating Accounts & Authentication on Django:** Introduction to Django Authentication System, Security Problem &

Solution with Django Creating Registration Form using Django, Adding Email Field in Forms, configuring email settings, sending emails with Django, Adding Grid Layout on Registration Page, Adding Page Restrictions, Login Functionality Test and Logout.

#### Sample Experiments:

1. Create a registration page using Authentication System
2. Create an application in Django to send emails using email settings and Grid Layout
3. Create an application in Django using page restriction / authentication with Login and Logout Functionality
4. Create a sample form using Django Forms

#### UNIT-IV:

**Connecting SQLite with Django:** Database Migrations, Fetch Data From Database, Displaying Data On Templates, Adding Condition On Data, Sending data from url to view, Sending data from view to template, Saving objects into database, Sorting objects, Filtering objects, Deleting objects, Difference between session and cookie, Creating sessions and cookies in Django.

#### Sample Experiments:

1. Create an app in Django which fetches data from database and show as list and also save objects in database
2. Create an app in Django for performing CRUD operations on records in a database
3. Create an app in Django which uses session management and cookies to store and manage user sessions.

#### UNIT-V:

**Deploying Django Web Application on Cloud:** Creating a functional website in Django, Four Important Pillars to Deploy, registering on Heroku and GitHub, Push project from Local System to GitHub, working with Django Heroku, Working with Static Root, Handling WSGI with gunicorn, setting up Database & adding users.

#### Sample Experiments:

1. Create a website in Django with login, and registration page.
2. Register on GitHub, and Heroku and deploy the website on Heroku with all the functionalities developed.
3. Configure Django to handle static files.

#### Optional Experiments:

1. Setting Up a Django Project with Fast API Integration.
2. Creating a CRUD API with Fast API in a Django Project.
3. Implementing Authentication with Django and Fast API

#### Text books:

1. Martin C. Brown, "Python: The Complete Reference Paper back", 4<sup>th</sup> Edition 2018, McGraw Hill Education.
2. Reema Thareja, "Python Programming: Using Problem Solving Approach", 3<sup>rd</sup> Edition 2017, Oxford.
3. Daniel Rubio, A., press, "Beginning Django Web Application Development and Deployment with Python", 2<sup>nd</sup> Edition 2017, Apress.

#### Reference Books:

1. Tom Aratyn, "Building Django 2.0 Web Applications: Create enterprise-grade, scalable Python web applications easily with Django 2.0", 2<sup>nd</sup> Edition 2018, Packt Publishing.
2. Harry Percival, "Test-Driven Development with Python: Obey the Testing Goat: Using Django, Selenium and JavaScript", 2<sup>nd</sup> Edition 2019, Kindle Edition.

#### E-Resources:

1. <https://medium.com/@mohanishp1/building-web-applications-with-django-and-fastapi-combining-the-best-of-both-worlds-1892719a8b9d>.
2. <https://sunscrapers.com/blog/fastapi-and-django-a-guide-to-elegant-integration/>

II Year-II Semester	DESIGN THINKING & INNOVATION	L	T	P	C
		1	0	2	2

**Course Objectives:**

The objective of this course is to familiarize students with design thinking process as a tool for breakthrough innovation. It aims to equip students with design thinking skills and ignite the minds to create innovative ideas, develop solutions for real-time problems.

**Course Outcomes:**

- Define the concepts related to design thinking. (L1, L2)
- Explain the fundamentals of Design Thinking and innovation (L1, L2)
- Apply the design thinking techniques for solving problems in various sectors. (L3)
- Analyse to work in a multidisciplinary environment (L4)
- Evaluate the value of creativity (L5)
- Formulate specific problem statements of real time issues (L3, L6)

**UNIT I Introduction to Design Thinking****10h**

Introduction to elements and principles of Design, basics of design-dot, line, shape, form as fundamental design components. Principles of design. Introduction to design thinking, history of Design Thinking, New materials in Industry.

**UNIT II Design Thinking Process****10h**

Design thinking process (empathize, analyze, idea & prototype), implementing the process in driving inventions, design thinking in social innovations. Tools of design thinking - person, customer, journey map, brainstorming, product development

**Activity:** Every student presents their idea in three minutes, Every student can present design process in the form of flow diagram or flow chart etc. Every student should explain about product development.

**UNIT III Innovation****10h**

Art of innovation, Difference between innovation and creativity, role of creativity and innovation in organizations- Creativity to Innovation- Teams for innovation- Measuring the impact and value of creativity.

**Activity:** Debate on innovation and creativity, Flow and planning from idea to innovation, Debate on value-based innovation.

**UNIT IV Product Design****8h**

Problem formation, introduction to product design, Product strategies, Product value, Product planning, product specifications- Innovation towards product design- Case studies

**Activity:** Importance of modelling, how to set specifications, Explaining their own product design.

**UNIT V Design Thinking in Business Processes****10h**

Design Thinking applied in Business & Strategic Innovation, Design Thinking principles that redefine business – Business challenges: Growth, Predictability, Change, Maintaining Relevance, Extreme competition, Standardization. Design thinking to meet corporate needs- Design thinking for Startups- Defining and testing Business Models and Business Cases- Developing & testing prototypes.

**Activity:** How to market our own product, About maintenance, Reliability and plan for startup.

**Textbooks:**

1. Tim Brown, Change by design, Harper Bollins (2009)
2. Idris Mootee, Design Thinking for Strategic Innovation, 2013, John Wiley & Sons.

**Reference Books:**

1. David Lee, Design Thinking in the Classroom, Ulysses press

2. Shrutin N Shetty, Design the Future, Norton Press
3. William Lidwell, Universal Principles of Design- Kritinaholden, Jill Butter.
4. Chesbrough. H, The Era of Open Innovation – 2013

**Online Learning Resources:**

- <https://nptel.ac.in/courses/110/106/110106124/>
- <https://nptel.ac.in/courses/109/104/109104109/>
- [https://swayam.gov.in/nd1\\_noc19\\_mg60/preview](https://swayam.gov.in/nd1_noc19_mg60/preview)