TECHNO INDIA UNIVERSITY

WEST BENGAL

Syllabus

for

4-Years B.Tech.

in

Computer Science and Business Systems

Academic Year: 2024-2025

SEMESTER 1

Discrete Mathematics (TIU-UCBMA-T101)

Program: B. Tech. in CSBS	**Year, Semester:** 1st Yr., 1st Sem.
Course Title: Discrete Mathematics	**Subject Code:** TIU-UCBMA-T101
Contact Hours/Week: 3–1–0 (L–T–P)	**Credit:** 4

COURSE OBJECTIVE:

Enable the student to:

1. To develop the basic ideas of abstract algebra.
2. To analyze the fundamental concepts of graphs.
3. To solve problems using combinatorics.

COURSE OUTCOME:

On completion of the course, the student will be able to:

CO-1:	To practice the principle of mathematical induction.	K4
CO-2:	To analyse the concepts of group with examples.	K4
CO-3:	To apply combinatorics to solve real time problems	K4
CO-4:	To develop knowledge of graph theory.	K4
CO-5:	To relate logical connectives to represent propositions.	K4
CO-6:	To examine if algebraic structures are ring or field.	K4

COURSE CONTENT:

MODULE 1:	**INTRODUCTION**	**5 Hours**
Set Theory, Principle of mathematical induction		
MODULE 2:	**Abstract algebra**	**10 Hours**
Binary operation, semigroup, monoid, group, abelian group, ring, field.		
MODULE 3:	**Combinatorics**	**10 Hours**
Basic counting, balls and bins problems, generalized permutations and combinations, pigeonhole principle.		
MODULE 4:	**Graph Theory**	**10 Hours**
Graphs and digraphs, isomorphism, connectedness and reachability, adjacency matrix, Eulerian paths and circuits in graphs and digraphs, Hamiltonian paths and circuits in graphs and digraphs, trees and forests, Planar graphs, chromatic number, statement of Four-color theorem.		

MODULE 5:	**Logic**	**10 Hours**
Propositional calculus - propositions and connectives, syntax; Semantics –truth assignments and truth tables, validity and satisfiability, tautology; Adequate set of connectives; Equivalence and normal forms; Compactness and resolution; Formal reducibility - natural deduction system and axiom system; Soundness and completeness, Proof techniques.		
TOTAL LECTURES		**45 Hours**

Text Books:

1. I.N. Herstein, —Topics in Algebra||, John Wiley and Sons.
2. M. Morris Mano, —Digital Logic & Computer Design||, Pearson
3. B. S. Grewal, —Higher Engineering Mathematics||, Khanna Publication, Delhi.
4. Gilbert Strang, Introduction to linear algebra
5. Peter V. O'Neil, Advanced Engineering Mathematics, Seventh Edition, Thomson Learning.
6. M. D. Greenberg, Advanced Engineering Mathematics, Second Edition, Pearson Education.
7. P. N. Wartikar and J. N. Wartikar, Applied Mathematics. Vol. I & II, VidyarthiPrakashan.

Introductory topics in Statistics, Probability and Calculus (TIU-UCBMA-T103)

Program: B. Tech. in CSBS	**Year, Semester:** 1st Yr., 1st Sem.
Course Title: Introductory topics in Statistics, Probability and Calculus	**Subject Code:** TIU-UCBMA-T103
Contact Hours/Week: 3–0–0 (L–T–P)	**Credit:** 3

COURSE OBJECTIVE:

Enable the student to:

1. learn the basics of probabilistic and statistical analysis.
2. understand the concepts of probability and probability distribution.
3. have an understanding of the fundamental concepts of differential and integral calculus.
4. To be able to solve double and triple integrals.

COURSE OUTCOME:

On completion of the course, the student will be able to:

CO-1:	Apply concepts of probability to real life problems.	K4
CO-2:	Learn discrete and continuous random variables and their applications.	K4
CO-3:	Formulate and analyze probability distributions like binomial, Poisson, uniform, normal etc.	K4

CO-4:	Develop basic idea about statistics, data, sample, population, regression etc.	K4
CO-5:	Calculate, compare and differentiate between different mean, variance, mode and median of statistics.	K4
CO-6:	Develop basic idea of differential and integral calculus and to compute double and triple integrals.	K4

COURSE CONTENT:

MODULE 1:	**BASIC PROBABILITY**	**5 Hours**
Concept of experiments, sample space, event. Definition of Combinatorial Probability. Conditional Probability, Bayes Theorem.		
MODULE 2:	**RANDOM VARIABLES**	**9 Hours**
Discrete and continuous Random variables; Expected values and moments: mathematical expectation and its properties, Moments (including variance) and their properties, interpretation, Moment generating function.		
MODULE 3:	**PROBABILITY DISTRIBUTIONS**	**7 Hours**
Discrete & continuous distributions, Binomial, Poisson and Geometric distributions, Uniform, Exponential, Normal, Chi-square, t, F distributions.		
MODULE 4:	**INTRODUCTORY STATISTICS**	**8 Hours**
Definition of Statistics. Basic objectives. Applications in various branches of science with examples. Collection of Data: Internal and external data, Primary and secondary Data. Population and sample, Representative sample. Descriptive Statistics: Classification and tabulation of univariate data, graphical representation, Frequency curves, Regression.		
MODULE 5:	**MEASURES OF STATISTICS**	**6 Hours**
Descriptive measures - central tendency and dispersion. Bivariate data. Summarization, marginal and conditional frequency distribution.		
MODULE 6:	**CALCULUS**	**10 Hours**
Basic concepts of differential and integral calculus, partial derivatives, application of double and triple integral.		
TOTAL LECTURES		**45 Hours**

Books:

1. S. M. Ross, —Introduction of Probability Models, Academic Press, N.Y.
2. Higher Engineering Mathematics, B. S. Grewal.
3. Thomas' Calculus Early Transcendentals, 13th Edition, Pearson, George B. Thomas Jr.
4. S. M. Ross, —A first course in Probability, Prentice Hall.

5. Advanced Engineering Mathematics, 2nd Edition, Michael. D. Greenberg.
6. Advanced Engineering Mathematics, 7th Edition, Peter V. O'Neil.

Fundamentals of Computer Science + Lab (TIU-UBCS-C101)

Program: B.Tech in CSBS	**Year, Semester: 1st** Yr., 1st Sem.
Course Title: Fundamentals of Computer Science + Lab	**Subject Code:** TIU-UBCS-C101
Contact Hours/Week: 3-1-2 (L-T-P)	**Credit:** 5

Course Objectives:

CO-1:	Ability to design algorithmic solution to problems	K2
CO-2:	Ability to convert algorithms to C programs	K2
CO-3:	Ability to design modular C programs using functions including recursion.	K4
CO-4:	Ability to design programs with Interactive Input and Output, utilizing arithmetic expression repetitions, decision making, arrays	K3
CO-5:	Ability to design programs using file Input and Output	K3
CO-6:	Ability to design and develop programs using Structure, Union, Pointers and understand the concept of linked lists	K3

Course Content:

MODULE 1:	**INTRODUCTION**	**7 Hours**
General Problem-Solving concepts: Algorithm, and Flowchart for problem solving with Sequential Logic Structure, Decisions and Loops.		
MODULE 2:	**IMPERATIVE LANGUAGE**	**7 Hours**
Introduction to imperative language; syntax and constructs of a specific language (ANSI C) Types Operator and Expressions with discussion of variable naming and Hungarian Notation: Variable Names, Data Type and Sizes (Little Endian Big Endian), Constants, Declarations, Arithmetic Operators, Relational Operators, Logical Operators, Type Conversion, Increment Decrement Operators, Bitwise Operators, Assignment Operators and Expressions, Precedence and Order of Evaluation, proper variable naming and Hungarian Notation.		
MODULE 3:	**CONTROL FLOW**	**7 Hours**
Control Flow with discussion on structured and unstructured programming: Statements and Blocks, If-Else-If, Switch, Loops – while, do, for, break and continue, go-to-labels, structured		

and un- structured programming		
MODULE 4:	**FUNCTIONS**	**8 Hours**
Functions and Program Structure with discussion on standard library: Basics of functions, parameter passing and returning type, C main return as integer, External, Auto, Local, Static, Register Variables, Scope Rules, Block structure, Initialisation, Recursion, Pre-processor, Standard Library Functions and return types.		
MODULE 5:	**POINTERS AND ARRAY**	**8 Hours**
Pointers and Arrays: Pointers and address, Pointers and Function Arguments, Pointers and Arrays, Address Arithmetic, character Pointers and Functions, Pointer Arrays, Pointer to Pointer, Multi-dimensional array and Row/column major formats, Initialisation of Pointer Arrays, Command line arguments, Pointer to functions, complicated declarations and how they are evaluated		
MODULE 6:	**STRUCTURES, INPUT/OUTPUT AND UNIX BASICS**	**10 Hours**
Structures: Basic Structures, Structures and Functions, Array of structures, Pointer of structures, Self-referral structures, Table look up, typedef, unions, Bit-fields Input and Output: Standard I/O, Formatted Output – printf, Formated Input – scanf, Variable length argument list, file access including FILE structure, fopen, stdin, sdtout and stderr, Error Handling including exit, error and error.h, Line I/O, related miscellaneous functions. Unix system Interface: File Descriptor, Low level I/O – read and write, open, create, close and unlink, Random access – seek, Discussions on Listing Directory, Storage allocator. **Programming Method:** Debugging, Macro, User Defined Header, User Defined Library Function, makefile utility		
TOTAL LECTURES		**47 Hours**

Laboratory		
MODULE-1:	**Problem Solving with Algorithms & Flowcharts**	**4 Hours**

Algorithm & Flowchart Design: Introduction to **Algorithm & Flowchart** for problem-solving Develop flowcharts for simple problems (e.g., finding the largest number, summing numbers) **Sequential Logic Structure:** Implement **basic I/O operations** in C. Write a C program to calculate the area of a circle.
Decisions & Loops: Develop a **C program using If-Else** for even/odd number detection. Write a **C program using loops** to find the factorial of a number.

MODULE-2:	**Imperative Language & Operators**	**4 Hours**

Data Types, Operators & Expressions: Implement **Arithmetic, Relational, Logical, and Bitwise operators.** Demonstrate **Increment/Decrement, Type Conversion, Assignment Operators**
Variable Naming & Hungarian Notation: Write a program using **proper variable naming** following Hungarian Notation. Demonstrate **Little Endian vs. Big Endian** memory representation
Expressions & Precedence: Develop a program to **evaluate expressions** considering precedence and associativity.
Swapping Variables & ASCII Values: Swap two numbers **with and without using a third variable.** Write a program to **print the ASCII value of a character.**

MODULE-3:	**Control Flow**	**6 Hours**

If-Else & Switch Statements: Write a program to **determine leap year,** Implement a **calculator using Switch-Case.**
Loops – While, Do-While, For: Implement **Fibonacci series using different loops**
Break, Continue & Goto Statements: Develop a program using **break & continue in loops**
Armstrong & Reverse Number: Write a program to **check if a number is an Armstrong number.** Reverse a number using loops.
Structured vs. Unstructured Programming: Implement the same logic **with and without Goto statements**

MODULE-4:	**Functions**	**6 Hours**

Basics of Functions: Implement **a simple function to calculate the sum of two numbers.**
Parameter Passing & Return Types: Write a program to **swap two numbers using functions.**
Recursion: Implement a **recursive function for factorial calculation.**
Standard Library Functions: Use **math.h functions** to calculate square root, power, and absolute values
Preprocessor & Header Files: Demonstrate **#define, #include, and user-defined headers**

MODULE-5:	**Pointers & Arrays**	**5 Hours**

Introduction to Pointers: Write a program to demonstrate pointer arithmetic **Pointer & Function Arguments:** Implement call-by-reference using pointers **Arrays & Pointers:** Write a program to sort an array using pointers **Multi-Dimensional Arrays:** Implement Matrix Multiplication (2×4 matrix) **Command-Line Arguments:** Create a program to read arguments from the command line **Pointer to Function:** Write a program to demonstrate pointer to function concepts		
MODULE-6:	**Structures, File Handling**	**5 Hours**
Structures & Unions: Create a structure for storing student records, Demonstrate use of typedef **Structures & Pointers:** Implement self-referential structures **String Manipulation:** Implement string comparison without using string.h. Extract a substring from a string **File Handling Basics:** Implement file read, write operations using fopen, fclose, fprintf, fscanf **Low-Level File Operations:** Use open(), read(), write(), close() system calls in UNIX **Error Handling & Storage Allocator:** Implement error handling using stderr &error.h **Debugging &Makefile Utility:** Demonstrate debugging using gdb. Create a Makefile for compiling multi-file projects		
TOTAL PRACTICAL		**30 Hours**

Recommended Books:

Text Book:

1. **"Programming in ANSI C"** – E. Balagurusamy
2. **"Let Us C"** – Yashavant Kanetkar

Reference Book:

3. **"Computer Science: An Overview"** – J. Glenn Brookshear & Dennis Brylow
4. **"How to Solve It by Computer"** – R.G. Dromey

Principles of Electrical Engineering + Lab(TIU-UCBEE-C101)

Program: B. Tech CSBS	**Year, Semester: 1ST YEAR ,1ST SEMESTER**
Course Title: Principles of Electrical Engineering + Lab	**Subject Code:**TIU-UCBEE-C101
Contact Hours/Week: L-T-P (2-0-2)	**Credit: 3**

COURSE OBJECTIVE:

- Understand the basic principles of electrical engineering, including voltage, current, and power.
- Develop skills to analyze and solve electrical circuits using fundamental techniques.
- Gain knowledge of digital and analog circuits and their applications in computing.
- Acquire hands-on experience in building, testing, and troubleshooting electrical circuits.
- Learn how electrical engineering principles apply to computing hardware, embedded systems, and network infrastructure.

COURSE OUTCOME:

On completion of the course, the student will be able to:

CO No.	Outcome	Knowledge Level
CO-1	Define the fundamentals of electrical engineering, including voltage, current, resistance, and power.	K1
CO-2	Analyze and solve electrical circuits using Ohm's Law, Kirchhoff's Laws, and network theorems.	K2
CO-3	Understand the functioning of digital and analog circuits and their applications in electrical and computing systems.	K3
CO-4	Develop hands-on skills in building, testing, and troubleshooting electrical circuits through laboratory-based experiments.	K2, K3
CO-5	Explain the role of electrical engineering principles in computing hardware, embedded systems, and network infrastructure.	K4

COURSE CONTENT:

MODULE 1:	**Electrical Fundamentals**	**6 Hours**
Basic electrical quantities: Voltage, current, resistance, and power, Ohm's Law and Kirchhoff's Laws, Series and parallel circuits. Energy sources and conversion.		
MODULE 2:	**Electrical Circuit Analysis**	**6 Hours**
Network theorems: Thevenin's and Norton's theorems, Superposition theorem, Maximum Power Transfer theorem, Mesh and nodal analysis, AC circuit fundamentals: Phasors, impedance, reactance, resonance		
MODULE 3:	**Digital and Analog Circuits**	**6 Hours**
Basics of digital logic: Boolean algebra, logic gates, combinational and sequential circuits, Analog circuits: Amplifiers, operational amplifiers, filters, Application of digital and analog circuits in electrical engineering		

MODULE 4:	Laboratory Experiments (6 Hours)	6 Hours
Hands-on experiments with resistors, capacitors, and inductors, Verification of Kirchhoff's Laws, Study of Thevenin's and Norton's theorems, Testing and troubleshooting electrical circuits		
MODULE 5:	**Application in Computing and Embedded Systems**	**6 Hours**
Role of electrical circuits in computing devices, Introduction to embedded systems and microcontrollers, Network infrastructure and power systems for computing applications.		
TOTAL LECTURES		**30 Hours**

Laboratory		
MODULE-1:	**Basic Electrical Circuits & Laws**	**7 Hours**
Verification of Ohm's Law: Measure voltage and current for a resistor and verify Ohm's Law. **Verification of Kirchhoff's Voltage and Current Laws (KVL & KCL):** Apply Kirchhoff's Laws in a given DC circuit and validate results. **Superposition Theorem:** Verify the **Superposition Theorem** using a two-source DC circuit. **Thevenin's & Norton's Theorem:** Find Thevenin/Norton equivalent circuits and compare experimental vs. theoretical results.		
MODULE-2:	**AC Circuits & Resonance**	**8 Hours**
Resonance in Series RLC Circuit: Study **series resonance** and measure resonance frequency & impedance. **Resonance in Parallel RLC Circuit:** Measure impedance and resonance frequency of a **parallel RLC circuit**. **Measurement of Power & Power Factor in a Single-Phase AC Circuit:** Use **wattmeter & power factor meter** to analyze an AC circuit. **Measurement of Three-Phase Power by Two-Wattmeter Method:** Use the **two-wattmeter method** to measure power in a three-phase system.		
MODULE-3:	**Electrical Machines & Transformers**	**8 Hours**
Open-Circuit and Short-Circuit Test on a Single-Phase Transformer: Determine **efficiency & voltage regulation** using OC & SC tests. **Load Test on a Single-Phase Transformer:** Study the **efficiency & voltage regulation** under different loads. **Speed Control of DC Motor:** Experiment on **armature & field control methods** for a DC motor. **No-Load and Blocked Rotor Tests on a Three-Phase Induction Motor:** Find **parameters**		

of an equivalent circuit of an induction motor.		
MODULE-4:	**Measurement & Instrumentation**	**7 Hours**
Calibration of Voltmeter and Ammeter using DC Potentiometer: Perform a **DC potentiometer experiment** to calibrate measuring instruments. **Measurement of Low & High Resistance using a Wheatstone Bridge:** Use **Kelvin's Bridge & Megger** for low & high resistance measurement. **Study of CRO & Measurement of AC Signals:** Learn **Cathode Ray Oscilloscope (CRO) basics** and measure **waveforms, frequency, and phase angle**.		
TOTAL PRACTICAL		**30 Hours**

REFERENCES:

1. **"Basic Electrical Engineering"** – V.K. Mehta & Rohit Mehta
   Covers electrical fundamentals, circuit analysis, and basic analog circuits.
   ISBN: 978-8121925372
2. **"A Textbook of Electrical Technology" (Volume 1) – Basic Electrical Engineering** – B.L. Theraja& A.K. Theraja
   Provides clear explanations on electrical principles and network theorems.
   ISBN: 978-8121924405
3. **"Digital Electronics: Principles and Integrated Circuits"** – Anil K. Maini
   Simplifies digital logic concepts, logic gates, and circuits.
   ISBN: 978-8126518951
4. **"Electric Circuits"** – James W. Nilsson & Susan A. Riedel
   User-friendly book with step-by-step explanations of circuit analysis techniques.
   ISBN: 978-0133760033
5. **"Embedded Systems: An Integrated Approach"** – Lyla B. Das
   Introduces embedded systems, microcontrollers, and their applications.
   ISBN: 978-9332540690

Physics for Computing Science+ Lab (TIU-UCBPH-C101)

Program: B. Tech in CSBS	**Year, Semester:** 1st Yr., 1st Sem
Course Title: Physics for Computing Science+ Lab	**Subject Code:** TIU-UCBPH-C101
Contact Hours/Week: 2–0–2 (L–T–P)	**Credit:** 3

COURSE OBJECTIVE:

This course aims to:

1. provide a foundational understanding of basic concepts of physics.
2. To develop analytical and problem-solving skills and apply the basic concepts of physics to real-world engineering and computing applications.
3. To enhance experimental skills by conducting practical investigations in optics, electromagnetism, quantum mechanics, and thermal physics

COURSE OUTCOME:

On completion of the course, the student will be able to:

CO-1:	Understand and analyze the fundamental concepts of oscillations, including simple harmonic motion, damped and forced oscillations, resonance, and their applications in mechanical and electrical	K4
CO-2:	Explain and apply the principles of wave optics, including interference, diffraction, and polarization, to analyze various optical phenomena and their engineering applications.	K3
CO-3:	Comprehend the basics of electromagnetism, quantum mechanics, crystallography, and semiconductor physics, and apply these principles to solve related physical problems.	K2
CO-4:	Explore the principles of laser and fiber optics, thermodynamics, and their applications in engineering, communication, and energy systems.	K4
CO-5:	Understand and apply fundamental physics principles related to oscillations, optics, electromagnetism, quantum mechanics, and semiconductor physics in computing science applications.	K3
CO-6:	Develop experimental skills by performing laboratory experiments on magnetic fields, semiconductor properties, quantum mechanics, optics, and thermodynamics, enabling accurate data analysis and interpretation of physical phenomena.	K3

COURSE CONTENT:

MODULE 1:	**OSCILLATIONS**	**4 Hours**
Periodic motion-simple harmonic motion-characteristics of simple harmonic motion-vibration of simple spring mass system. Resonance-definition, damped harmonic oscillator – heavy, critical and light damping, energy decay in a damped harmonic oscillator, quality factor, forced mechanical and electrical oscillators.		
MODULE 2:	**INTERFERENCE-PRINCIPLE OF SUPERPOSITION – YOUNG'S EXPERIMENT**	**5 Hours**
Theory of interference fringes-types of interference - Fresnel's prism - Newton's rings, Diffraction - Two kinds of diffraction - Difference between interference and diffraction - Fresnel's half period zone and zone plate - Fraunhofer diffraction at single slit - plane diffraction grating. Temporal and Spatial Coherence.		
MODULE 3:	**POLARIZATION OF LIGHT**	**2 Hours**

Polarization - Concept of production of polarized beam of light from two SHM acting at right angle; plane, elliptical and circularly polarized light, Brewster's law, double refraction.		
MODULE 4:	**BASIC IDEA OF ELECTROMAGNETISMS**	**2 Hours**
Continuity equation for current densities, Maxwell's equation in vacuum and non-conducting medium.		
MODULE 5:	**QUANTUM MECHANICS**	**5 Hours**
Introduction - Planck's quantum theory - Matter waves, de-Broglie wavelength, Heisenberg's Uncertainty principle, time independent and time dependent Schrödinger's wave equation, Physical significance of wave function, Particle in a one-dimensional potential box, Heisenberg Picture.		
MODULE 6:	**CRYSTALLOGRAPHY**	**3 Hours**
Basic terms-types of crystal systems, Bravais lattices, miller indices,dspacing,Atomic packing factor for SC, BCC, FCC and HCP structures, X-ray diffraction		
MODULE 7:	**SEMICONDUCTOR PHYSICS**	**2 Hours**
Conductor, Semiconductor and Insulator; Basic concept of Band theory.		
MODULE 8:	**LASER AND FIBER OPTICS**	**3 Hours**
Einstein's theory of matter radiation interaction and A and B coefficients; amplification of light by population inversion, different types of lasers: Ruby Laser, CO2 and Neodymium lasers; Properties of laser beams: mono-chromaticity, coherence, directionality and brightness, laser speckles, applications of lasers in engineering. Fiber optics and Applications, Types of optical fibers.		
MODULE 9:	**THERMODYNAMICS**	**4 Hours**
Zeroth law of thermodynamics, first law of thermodynamics, brief discussion on application of 1st law, second law of thermodynamics and concept of Engine, entropy, change in entropy in reversible and irreversible processes.		
TOTAL LECTURES		**30 Hours****

Books:

1. Introduction to Electrodynamics, David J. Griffiths, Pearson Education India Learning Private Limited
2. Introduction to Classical Mechanics, R Takwale, P Puranik, McGraw Hill Education private limited
3. Engineering Physics ,Dattuprasad Ramanlal Joshi, McGraw Hill Education private limited
4. Quantum Physics of Atoms, Molecules, Solids, Nuclei and Particles,Robert Eisberg, Robert Resnick, Wiley
5. Statistical Physics, L.D. Landau, E M.Lifshitz, Butterworth-Heinemann
6. Optics,Ghatak, McGrawHill Education India Private Limited
7. Engineering Physics , Hitendra K Malik & A K Sing, McGraw Hill Education private limited
8. Advanced Acoustics, Dr. D.P. Raychaudhuri, The new bookstall, Revised Ninth Edition, 2009
9. Concepts of Modern Physics (Sixth Edition) by Arthur Beiser (Published by McGraw-Hill).
10. Introduction to Solid State Physics (January2019) by Charles Kittel (Published by Wiley)

Business Communication and Value Science I(TIU-UCBEN-S101)

Program: Btech in CSBS	**Year, Semester:** 1st Yr., 1st Sem.
Course Title: Business Communication and Value Science-I	**Subject Code:** TIU-UCBEN-C101
Contact Hours/Week: 2–0–0 (L–T–P)	**Credit:** 2

COURSE OBJECTIVE:

Enable the student to:

1. Understand the importance of life skills and values in professional and personal life.
2. Develop self-awareness, confidence, and effective communication skills.
3. Learn the fundamentals of business communication and its practical applications.

COURSE OUTCOME:

On completion of the course, the student will be able to:

CO-1:	Recognize the need for life skills and values in personal and professional growth.	K1
CO-2:	Develop self-awareness and confidence through practical exercises.	K2
CO-3:	Apply life skills in various professional and social situations.	K3
CO-4:	Understand and implement basic communication principles.	K4
CO-5:	Effectively communicate in different business scenarios.	K5
CO-6:	Work in teams, exhibit leadership, and make impactful presentations.	K6

COURSE CONTENT :

MODULE 1:	**Introduction to Communication**	**5 Hours**
Definition, importance, and elements of communication - Barriers to effective communication and strategies to overcome them. - Forms and types of communication in professional and personal contexts.		
MODULE 2:	**Language and Grammar Skills**	**5 Hours**
Fundamentals of grammar and sentence formation. - Building vocabulary and understanding word usage. - Punctuation, spelling rules, and error correction.		
MODULE 3:	**Speaking and Conversational Skills**	**5 Hours**
Principles of effective speaking and pronunciation drills. - Verbal and non-verbal communication techniques. - Role-playing and conversational exercises. - Public speaking fundamentals and confidence-building activities.		
MODULE 4:	**Writing Skills and Professional Documentation**	**5 Hours**
The writing process: prewriting, drafting, revising, and editing. - Writing structured paragraphs and linking ideas effectively. - Business writing: emails, reports, and formal		

letters. - Summary writing and storytelling techniques.		
MODULE 5:	**Business Communication and Ethics**	**5 Hours**
Understanding business communication in corporate environments. - Ethical considerations in communication and professional etiquette. - Case studies on effective business communication.		
MODULE 6:	**Life Skills and Practical Applications**	**5 Hours**
Personal presentation skills and self-awareness activities. - Immersion activity: interviewing people from different backgrounds. - Resume building and career communication. - Teamwork, leadership, and managing stress. - Project: Creating a postcard on a college-relevant topic.		
TOTAL LECTURES		**30 Hours**

Books:

Textbooks:

1. Alan McCarthy & O'Dell, *English Vocabulary in Use*, Cambridge University Press, ISBN: 978-0521126739.
2. Dr. Saroj Hiremath, *Business Communication*, Nirali Prakashan, ISBN: 978-8185790324.

Reference Books:

1. *APAART: Speak Well 1 & 2* – English Language and Communication, APAART Publications, ISBN: 978-9381234567.
2. Simon Sinek, *Train Your Mind to Perform Under Pressure*, Penguin Books, ISBN: 978-0670923172.
3. *Will Smith's Top Ten Rules for Success* (Video Lectures), Available on YouTube and other streaming platforms.
4. Coursera Course: *Effective Business Communication*, Online Course by University of California, Irvine.

SEMESTER 2

Linear Algebra(TIU-UCBMA-T102)

Program: B. Tech. in CSBS	**Year, Semester:** 1st Yr., 2nd Sem.
Course Title: Linear Algebra	**Subject Code:** TIU-UCBMA-T102
Contact Hours/Week: 3–1–0 (L–T–P)	**Credit:** 4

COURSE OBJECTIVE:

Enable the student to:

1. be able to solve system of linear equations using matrices.
2. understand algebraic and geometric representations of vectors and vector spaces
3. understand algebraic and geometric representations of linear transformations, eigen vectors.

COURSE OUTCOME:

On completion of the course, the student will be able to:

CO-1:	Develop basic concepts of matrices and determinants.	K4
CO-2:	Investigate the solutions of a system of linear equations using matrices.	K4
CO-3:	Establish the concepts of vector spaces and its substructure.	K4
CO-4:	Establish the concepts of linear transformations and to understand its applications.	K4
CO-5:	Evaluate Eigen values and Eigen vectors of a matrix.	K4
CO-6:	Develop the idea of Singular value decomposition, principal component analysis and interpret their applications.	K4

COURSE CONTENT:

MODULE 1:	**MARIX AND DETERMINANT**	**5 Hours**
Introduction to Matrices and Determinants; Solution of Linear Equations; Cramer's rule; Inverse of a Matrix; Hermitian and unitary matrices.		
MODULE 2:	**SOLUTION OF LINEAR EQUATIONS**	**7 Hours**
Rank of a matrix; Gaussian elimination; LU Decomposition; Solving Systems of Linear Equations using the tools of Matrices.		
MODULE 3:	**VECTOR SPACES**	**10 Hours**
Vectors and linear combinations; Vector space; Dimension; Basis; Orthogonality; Projections; Gram-Schmidt orthogonalization and QR decomposition.		
MODULE 4:	**LINEAR TRANSFORMATIONS**	**7 Hours**
Linear transformations; Image and Kernel of linear maps; Geometric interpretations.		
MODULE 5:	**EIGEN VALUES AND EIGEN VECTORS**	**7 Hours**
Eigenvalues and Eigenvectors of a matrix; Positive definite matrices; Diagonalization of a square matrix.		

MODULE 6:	SVD AND PCA	9 Hours
Singular value decomposition and Principal component analysis; Introduction to their applications in Image Processing and Machine Learning.		
TOTAL LECTURES		**45 Hours**

Books:

1. Elementary Linear Algebra A Matrix Approach, 2nd Edition, L. Spence, A. Insel, S. Friedberg.
2. Higher Engineering Mathematics, B. S. Grewal.
3. Introduction to linear algebra, 5th Edition, Gilbert Strang.
4. Digital Image Processing, R C Gonzalez and R E Woods.
5. Advanced Engineering Mathematics, 7th Edition, Peter V. O'Neil.
6. Advanced Engineering Mathematics, 2nd Edition, Michael. D. Greenberg.
7. https://machinelearningmastery.com/introduction-matrices-machine-learning/

Statistical Methods + LAB (TIU-UCBCS-C102)

Program: B. Tech. in CSBS	**Year, Semester:** 1st Yr., 2nd Sem.
Course Title: Statistical Methods + LAB	**Subject Code:** TIU-UCBCS-C102
Contact Hours/Week: 3–0–2 (L–T–P)	**Credit:** 4

COURSE OBJECTIVE:

Enable the student to:

1. Apply advanced sampling techniques develop and interpret linear statistical models.
2. Implement Robust Estimation methods and utilize sufficient statistics in inference.
3. Conduct rigorous hypothesis testing and employ Non-Parametric Inference Techniques.
4. Analyze and forecast time series data and develop proficiency in R for statistical computing.

COURSE OUTCOME:

The student will be able to:

CO-1:	explore the underlying master sampling techniques and their applications, develop and Interpret Linear Statistical Models.
CO-2:	Apply estimation techniques in statistical inference and perform rigorous hypothesis testing.
CO-3:	Implement non-parametric inference methods, analyze and forecast time series data.
CO-4:	Leverage R for Statistical Analysis and Data Visualization.
CO-5:	Integrate theoretical concepts with practical applications.

COURSE CONTENT:

MODULE 1:	**SAMPLING TECHNIQUES**	**7 Hours**
Random sampling- Sampling from finite and infinite populations. Estimates and standard error (sampling with replacement and sampling without replacement), Sampling distribution of sample mean, stratified random sampling.		
MODULE 2:	**LINEAR STATISTICAL MODELS**	**7 Hours**
Scatter diagram. Linear regression and correlation. Least squares method. Rank correlation. Multiple regression & multiple correlation, Analysis of variance (one way, two way with as well as without interaction).		
MODULE 3:	**ESTIMATION**	**7 Hours**
Point estimation, criteria for good estimates (un-biasedness, consistency), Methods of estimation including maximum likelihood estimation.		
MODULE 4:	**SUFFICIENT STATISTICS AND TEST OF HYPOTHESIS**	**8 Hours**
Concept & examples, complete sufficiency, their application in estimation. Test of hypothesis: Concept & formulation, Type I and Type II errors, Neyman Pearson lemma, Procedures of testing.		
MODULE 5:	**NON-PARAMETRIC INFERENCE**	**8 Hours**
Comparison with parametric inference, Use of order statistics. Sign test, Wilcoxon signed rank test, Mann-Whitney test, Run test, Kolmogorov-Smirnov test. Spearman's and Kendall's test. Tolerance region.		
MODULE 6:	**BASICS OF TIME SERIES ANALYSIS & FORECASTING**	**8 Hours**
Stationary, ARIMA Models: Identification, Estimation and Forecasting.		
TOTAL LECTURES		**45 Hours**

Laboratory		
MODULE 1 :	**Introduction to R & RStudio**	**6 Hours**
Basic syntax, variables, data types, Introduction to R, Functions,		
MODULE 2 :	**Vectors and Lists**	**6 Hours**
Creating vectors, Operations on vectors, List creation and manipulation		
MODULE 3 :	**Matrices and Arrays and Data Frames**	**6 Hours**
Creating and manipulating matrices, performing matrix operations Creating data frames, Accessing and modifying elements, Filtering and sorting		
MODULE 4 :	**Control Structures and Functions & Data Analysis and Visualization**	**6 Hours**

Conditional Statements and Loops, if, if-else, switch, for, while, repeat loops. User-defined Functions, Creating and calling functions, Function arguments and return values. Data Import and Export, Reading CSV, Excel, and text files, Writing data to files		
MODULE 5 :	**Exploratory Data Analysis (EDA) & Data Visualization**	**6 Hours**
Summary statistics, Descriptive analysis using summary(), str(), etc. Data Visualization, Basic plots: histograms, boxplots, scatter plots		

Text Books:

1. Probability and Statistics for Engineers (Fourth Edition), I.R. Miller, J.E. Freund and R. Johnson, Prentice Hall India Learning Private Limited.
2. Fundamentals of Statistics (vol. I & vol. II), A. Goon, M. Gupta and B. Dasgupta, World Press.
3. The Analysis of Time Series: An Introduction, Chris Chatfield, Chapman & Hall/CRC.

Reference Books:

1. Introduction to Linear Regression Analysis, D.C. Montgomery and E. Peck, Wiley Interscience.
2. Introduction to the Theory of Statistics, A.M. Mood, F. A. Graybill and D.C. Boes, McGraw Hill.
3. Applied Regression Analysis, N. Draper and H. Smith, Wiley-Interscience.
4. Hands-on Programming with R, Garrett Grolemund, O'Reilly.
5. R for Everyone: Advanced Analytics and Graphics, Jared P. Lander, Addison-Wesley Professional.

Data Structures & Algorithms + LAB(TIU-UCBCS-C104)

Program: B. Tech. in CSBS	**Year, Semester:** 1st Year 2nd Sem
Course Title: Data Structures & Algorithms + LAB	**Subject Code:** TIU-UCBCS-C104
Contact Hours/Week: 3–1–2 (L–T–P)	**Credit: 5**

COURSE OBJECTIVE:

Enable the student to:

1. Introduce fundamental data structures, including linear and nonlinear structures, and their real-world applications to help students understand their significance in problem-solving.
2. Enable students to develop and implement various data structures and algorithms efficiently using programming techniques.
3. Equip students with the ability to analyze the time and space complexity of algorithms and make informed trade-offs for optimizing performance.
4. Encourage students to apply data structures and algorithmic principles to design and develop efficient solutions for real-world computational problems.

COURSE OUTCOME:

The student will be able to:

CO-1:	Be able to understand the concepts and applications of different types of data structures.
CO-2:	Be able to develop programs to implement linear and nonlinear data structures.
CO-3:	Be able to learn various algorithms and their implementations
CO-4:	Analyze algorithms to do efficiency tradeoffs
CO-5:	Apply the concepts of data structures and algorithms to find efficient solutions for real-world problems
CO-6:	Understand the concepts of complex data structures and algorithms.

COURSE CONTENT:

Theory		
MODULE 1:	**Fundamentals of DSA**	**6 Hours**
Algorithm specification, Recursion, Performance analysis, Asymptotic Notation - The Big-O, Omega and Theta notation, Programming Style, Refinement of Coding - Time-Space Trade-Off, Testing, Data Abstraction		
MODULE 2:	**Linear Data Structure**	**11 Hours**
Array, Stack, Queue, Linked-list and its types, Various Representations, Operations & Applications of Linear Data Structures.		
MODULE 3:	**Non-linear Data Structure**	**12 Hours**
Trees (Binary Tree, Threaded Binary Tree, Binary Search Tree, B & B+ Tree, AVL Tree, Splay Tree) and Graphs (Directed, Undirected), Various Representations, Operations & Applications of Non-Linear Data Structures		
MODULE 4:	**Searching and Sorting on Various Data Structures**	**11 Hours**
Sequential Search, Binary Search, Comparison Trees, Breadth First Search, Depth First Search Insertion Sort, Selection Sort, Shell Sort, Divide and Conquer Sort, Merge Sort, Quick Sort, Heapsort, Introduction to Hashing		
MODULE 5:	**File Processing**	**9 Hours**
Organization (Sequential, Direct, Indexed Sequential, Hashed) and various types of accessing schemes.		
MODULE 6	**Graph**	**9 Hours**
Basic Terminologies and Representations, Graph search and traversal algorithms and complexity analysis.		
	TOTAL LECTURE	**45 Hours**

Laboratory		
MODULE-1:	**Sorting, Searching in Array**	**12 Hours**

Overview of the linear data structure Array, dynamic and static array creation, array element access, insertion, deletion, shifting. Implementation of searching algorithms like linear search, binary search. Implementation of sorting algorithms like bubble sort, selection sort, insertion sort, counting sort, merge sort, quick sort and heap sort. Understanding the concept of 2D array, polynomial representation using array, Matrix representation and operations on matrix.		
MODULE-2:	**Stack and Queue**	**6 Hours**
Implementation of Stack and Queue data structure. Optimization of queue data structure using the concept of circular queue. Infix to post fix conversion and post fix notation evaluation using stack data structure.		
MODULE-3:	**Linked List**	**6 Hours**
Understanding the concept of singly LinkedList and doubly linked list. Stack and Queue implementation using linked list. Polynomial representation using linked list.		
MODULE-4:	**Tree**	**6 Hours**
Realization of binary search tree data structure. Implementation of tree traversal algorithms with recursion and without recursion. Understanding the concept of threaded binary search tree.		
	TOTAL PRACTICAL	**30 Hours**

Books:

1. Fundamentals of Data Structures, E. Horowitz, S. Sahni, S. A-Freed, Universities Press.

2. Data Structures and Algorithms, A. V.Aho, J. E.Hopperoft, J. D.UIlman, Pearson.

Reference Books:

1. The Art of Computer Programming: Volume 1: Fundamental Algorithms, Donald E. Knuth.

2. Introduction to Algorithms, Thomas, H. Cormen, Charles E. Leiserson, Ronald L. Rivest, Clifford Stein, The MIT Press.

3. Open Data Structures: An Introduction (Open Paths to Enriched Learning), (Thirty First Edition), Pat Morin, UBC Press.

Principles of Electronics + Lab (TIU-UCBEC-C102)

Program: B. Tech. in CSBS	**Year, Semester:** 1ST YR. 2nd SEMESTER
Course Title: Principles of Electronics + Lab	**Subject Code:**TIU-UCBEC-C102
Contact Hours/Week: 2–0–2 (L–T–P)	**Credit:** 3

COURSE OBJECTIVE:

Enable the student to:

1. To understand the basics of semiconductors and based on that acquire functioning knowledge of diodes and diode circuits, bipolar junction transistor and field effect transistor.
2. Acquiring knowledge of the components mentioned above, working knowledge of feedback amplifiers and operational amplifiers are to be gained.
3. Lastly digital electronics fundamentals are to be gained.

COURSE OUTCOME:

On completion of the course, the student will be able to:

CO-1:	Fundamentals of Electronics: Provide students with a foundational understanding of electronic components
CO-2:	Circuit Analysis and Design: Enable students to analyze, design, and troubleshoot basic electronic circuits for
CO-3:	Digital and Analog Systems: Familiarize students with the principles of both analog and digital electronics,
CO-4:	Hands-on Experimentation: Develop practical skills through lab exercises where students assemble, test, and
CO-5:	Application of Electronics in Computing: Equip students with the knowledge to apply electronic principles incomputer science contexts, such as microprocessors and hardware interfacing**.**

COURSE CONTENT:

MODULE 1:	**Semiconductors:**	**4 Hours**
Semiconductors: Crystalline material: Mechanical properties, Energy band theory, Fermi levels; Conductors, Semiconductors & Insulators: electrical properties, band diagrams. Semiconductors: intrinsic & extrinsic, energy band diagram, P&N-type semiconductors, drift & diffusion carriers.		
MODULE 2:	**Diodes and Diode Circuits:**	**6 Hours**
Formation of P-N junction, energy band diagram, built-in-potential, forward and reverse biased P-N junction, formation of depletion zone, V-I characteristics, Zener breakdown, Avalanche breakdown and its reverse characteristics; Junction capacitance. Linear piecewise model; Rectifier circuits: half wave, full wave, PIV, DC voltage and current, ripple factor, efficiency, idea of regulation.		
MODULE 3:	**Bipolar Junction Transistors:**	**5 Hours**

Formation of PNP / NPN junctions; transistor mechanism and principle of transistors, CE, CB, CC configuration, transistor characteristics: cut-off active and saturation mode, transistor action, injection efficiency, base transport factor and current amplification factors for CB and CE modes. Biasing and Bias stability: calculation of stability factor		
MODULE 4:	**Field Effect Transistors:**	**5 Hours**
Concept of Field Effect Transistors (channel width modulation), Gate isolation types, JFET Structure and characteristics, MOSFET Structure and characteristics, depletion and enhancement type; CS, CG, CD configurations; CMOS: Basic Principles		
MODULE 5:	**Feed Back Amplifier, and Operational Amplifiers**	**8 Hours**
Concept (Block diagram), properties, positive and negative feedback, loop gain, open loop gain, feedback factors; topologies of feedback amplifier; effect of feedback on gain, output impedance, input impedance, sensitivities (qualitative), bandwidth stability. Introduction to integrated circuits, operational amplified and its terminal properties; Application of operational amplifier; inverting and non-inverting mode of operation, Adders, Subtractors, Constant-gain multiplier, Voltage follower, Comparator, Integrator, Differentiato		
MODULE 6:	**Digital Electronics Fundamentals:**	**8 Hours**
Difference between analog and digital signals, Boolean algebra, Basic and Universal Gates, Symbols, Truth tables, logic expressions, Logic simplification using K- map, Logic ICs, half and full adder/subtractor, multiplexers, demultiplexers, flip-flops, shift registers, counte		
TOTAL LECTURES		**41 Hours**

Fundamentals of Economics (TIU-UCBEM-T102)

Program: B. Tech. in CSBS	**Year, Semester:** 1stYr., 2nd Sem.
Course Title: Fundamentals of Economics	**Subject Code:**TIU-UCBEM-T102
Contact Hours/Week: 2–0–0 (L–T–P)	**Credit:** 2

COURSE OBJECTIVE :

Enable the student to:

1. understand the fundamentals of supply and demand, elasticity, consumer behavior, and market structures like perfect competition, monopoly, and monopolistic competition.
2. analyze the national income accounting (GDP, GNP, NNP, etc.), the Keynesian multiplier, and macroeconomic equilibrium using models like IS-LM.
3. Explore the roles of government policies, taxes, subsidies, and international trade on economic outcomes.
4. Apply economic theory to real-world problems and critically assess the impact of fiscal and monetary policies on economic stability and growth.

COURSE OUTCOME :

The student will be able to:

CO-1:	Introduce students to core economic principles, including supply, demand, and market equilibrium, to understand how economies function.	K2
CO-2:	Teach students how microeconomic concepts apply to individual and business decision-making processes in various markets.	K3
CO-3:	Equip students with knowledge of macroeconomic indicators, such as GDP, inflation, and unemployment, and their impact on the business environment.	K3
CO-4:	Provide insights into different economic systems and policy-making, preparing students to analyze how policies influence business and technology sectors.	K4
CO-5:	Help students apply economic principles to understand the economic forces shaping technology markets, innovation, and business strategy.	K3

COURSE CONTENT :

MODULE 1:	**INTRODUCTION**	**3 Hours**
Reason of studying economics, The scope and method of economics: Wants, Scarcity and Choice, Basic economic questions, Normative and Positive economics, comparison of Microeconomics and Macroeconomics		
MODULE 2:	**Consumer Behaviour**	**5 Hours**
Utility theory – Cardinal and Ordinal approach. Utility under Cardinal Approach- Utility and Choice, Total and Marginal Utility, choice maximization, Utility under Ordinal Approach- axioms of preference, indifference curve, marginal rate of substitution and convexity of IC, budget constraint, consumer's equilibrium-interior and corner, Derivation of Demand Curves from ICs, composite good convention.		

MODULE 3:	**Demand and Supply Analysis: How markets work**	**6 Hours**
Theory of Demand, demand schedule, law of demand, ceteris paribus assumption, determinants of demand, individual demand and market demand, movement along the demand curve and shift of the demand curve. Theory of supply, supply curve, influencing factors of supply, movement along shift in the supply curve. Determination of equilibrium price under competitive market, stability of equilibrium.Different types of elasticity- Price , Income and Cross price elasticity of demand, elasticity for liner demand curve, price elasticity of supply. Elasticity and revenue		
MODULE 4:	**Cost of Production**	**4 Hours**
Cost- Concept of implicit cost, explicit cost, accounting cost, sunk cost, economic cost, fixed cost, variable cost, total cost, average cost, marginal cost. Short run cost curves, cost minimization, expansion path, long run cost curves and comparison with short run cost curves, economies of scale.		
MODULE 5:	**Market Structure**	**5 Hours**
Equilibrium of a Firm Under Perfect Competition; Monopoly and Monopolistic Competition		
MODULE 6:	**Macroeconomics Indicators**	**7 Hours**
National Income and its Components- GNP, NNP, GDP, NDP; Consumption Function; Investment; Simple Keynesian Model of Income Determination and the Keynesian Multiplier; Government Sector- Taxes and Subsidies; External Sector- Exports and Imports; Money- Definitions; Demand for Money-Transactionary and Speculative Demand; Supply of Money- Bank's Credit Creation Multiplier; Integrating Money and Commodity Markets- IS, LM Model; Business Cycles and Stabilization- Monetary and Fiscal Policy - Central Bank and the Government; The Classical Paradigm- Price and Wage Rigidities - Voluntary and Involuntary Unemployment		
TOTAL LECTURES		**45 Hours**

Text Books:

T1. Mankiw, N. G. (2021). Principles of Economics (9th ed.). Cengage Learning.
T2. T2. Samuelson, P. A., & Nordhaus, W. D. (2010).Economics (19th ed.). McGraw-Hill Education.

Reference Books:

T3. R1. Krugman, P., & Wells, R. (2018).Microeconomics (5th ed.). Worth Publishers.
T4. R2.Blanchard, O., & Johnson, D. R. (2013). Macroeconomics (6th ed.). Pearson.

Business Communication and Value Science II (TIU-UCBEN-C102)

Program: Btech in CSBS	**Year, Semester:** 1st Yr., 2nd Sem.
Course Title: Business Communication and Value Science II	**Subject Code:** TIU-UCBEN-C102
Contact Hours/Week: 1–0–2 (L–T–P)	**Credit:** 2

COURSE OBJECTIVE :

Enable the student to:

1. Develop effective writing, reading, presentation, and group discussion skills.
2. Help students identify personality traits and evolve as better team players
3. Introduce key concepts of morality, behavior, beliefs, and diversity & inclusion.

COURSE OUTCOME :

On completion of the course, the student will be able to:

CO-1:	Demonstrate proficiency in written and verbal communication	K2
CO-2:	Apply effective reading strategies, including skimming and scanning.	K3
CO-3:	Utilize digital and social media for structured communication	K4
CO-4:	Develop teamwork and leadership skills through personality analysis	K5
CO-5:	Understand and apply ethical principles in communication	K4
CO-6:	Organize and present communication-based projects with real-world applications.	K6

COURSE CONTENT :

MODULE 1:	**Fundamentals of Written Communication**	**5 Hours**
Identification of common errors in written communication and ways of rectification. Understanding tools for structured written communication		
MODULE 2:	**Effective Reading Techniques**	**5 Hours**
Speed reading techniques – Skimming and Scanning. Tools for quick reading and comprehension		
MODULE 3:	**Application of Reading and Writing Skills**	**5 Hours**
Use of electronic/social media for communication. Developing structured materials for professional communication.		
MODULE 4:	**Personality Development and Team Dynamics**	**5 Hours**
Analyzing personality traits and team player styles. Understanding outward behavior and internal behavior.		
MODULE 5:	**Morality, Diversity, and Inclusion**	**5 Hours**

Understanding the concepts of morality, diversity, and inclusion. Application of these concepts in professional and social scenarios.		
MODULE 6:	**Practical Communication and Awareness Activities**	**5 Hours**
Creation of communication material for a social cause. Organizing events to support inclusion and diversity.		
TOTAL LECTURES		**30 Hours****

Books:

1. Alan McCarthy & O'Dell, *English Vocabulary in Use*, Cambridge University Press, ISBN: 978-0521126739.
2. Dr. Saroj Hiremath, *Business Communication*, Nirali Prakashan, ISBN: 978-8185790324.
3. Dale Carnegie, *The Art of Public Speaking*, Simon & Schuster, ISBN: 978-0671724009.
4. Daniel Goleman, *Emotional Intelligence: Why It Can Matter More Than IQ*, Bantam, ISBN: 978-0553383713.
5. Stephen R. Covey, *The 7 Habits of Highly Effective People*, Simon & Schuster, ISBN: 978-1982137274.
6. Edward de Bono, *Six Thinking Hats*, Back Bay Books, ISBN: 978-0316178310.
7. Harvard Business Review, *HBR Guide to Persuasive Presentations*, Harvard Business Review Press, ISBN: 978-1422187104.

Environmental Science (TIU-UCBOG- T102)

Program: B. Tech in CSBS	**Year, Semester:** 1st Year., 2nd Sem
Course Title: Environmental Science	**Subject Code:** TIU-UCBOG- T102
Contact Hours/Week: 2–0–0(L–T–P)	**Credit:** 0

COURSE OBJECTIVE:

1. Understand the fundamentals of environmental pollution from chemical processes, including characterization of emissions and effluents, and relevant environmental regulations.
2. Apply pollution prevention strategies through process modification, resource recovery, and waste minimization techniques.
3. Analyze and design air and water pollution control systems, including particulate and gaseous emission control, and physical water treatment processes.
4. Evaluate and implement biological treatment methods for wastewater and appropriate solid waste disposal techniques.

COURSE OUTCOME:

The students will be able to:

CO-1:	Describe the sources and types of environmental pollution fromchemical process industries, Characterize industrial emissions and effluents, Explain relevant environmental laws, rules, and standards.	Understand (BT Level 2)
CO-2:	Apply process modification and alternative raw material selection for pollution prevention, Develop strategies for recovery, recycle, and reuse of industrial waste, Perform material and energy balance calculations for pollution minimization, Implement water use minimization and fugitive emission/effluent control measures.	Apply (BT Level 3)
CO-3:	Select and design appropriate particulate emission control systems (cyclones, ESP, fabric filters), Select and design gaseous emission control systems (absorbers), Analyze the performance of air pollution control equipment.	Analyze (BT Level 4)
CO-4:	Explain the principles of physical and pre-treatment methods for wastewater, Design and evaluate solids removal processes (sedimentation, filtration, centrifugation, coagulation, flocculation).	Evaluate (BT Level 5)
CO-5:	Describe the principles of anaerobic and aerobic biological treatment, Apply biochemical kinetics to design biological treatment systems, Select and design aeration systems and sludge separation/drying processes.	Create (BT Level 6)
CO-6:	Evaluate different solid waste disposal methods (composting, landfill, incineration), Explain the processes of briquetting and gasification of solid waste.	Evaluate (BT Level 5)

COURSE CONTENT:

MODULE 1:	**Introduction**	**10 Hours**
Environment and environmental pollution from chemical process industries, characterization of emission and effluents, environmental Laws and rules, standards for ambient air, noise emission and effluents.		
MODULE 2:	**Pollution Prevention**	**8 Hours**
Process modification, alternative raw material, recovery of by co-product from industrial emission effluents, recycle and reuse of waste, energy recovery and waste utilization. Material and energy balance for pollution minimization. Water use minimization, Fugitive emission/effluents and leakages and their control-housekeeping and maintenance.		
MODULE 3:	**Air Pollution Control**	**9 Hours**
Particulate emission control by mechanical separation and electrostatic precipitation, wet gas scrubbing, gaseous emission control by absorption and adsorption, Design of cyclones, ESP, fabric filters and absorbers		

MODULE 4:	**Water Pollution Control**	**9 Hours**
Physical treatment, pre-treatment, solids removal by setting and sedimentation, filtration centrifugation, coagulation and flocculation.		
MODULE 5:	**Biological Treatment**	**5 Hours**
Anaerobic and aerobic treatment biochemical kinetics, trickling filter, activated sludge and lagoons, aeration systems, sludge separation and drying.		
MODULE 6:	**Solid Disposal**	**4 Hours**
Solids waste disposal - composting, landfill, briquetting / gasification and incineration.		
TOTAL LECTURES		**45 Hours**

Recommended Textbooks:-**

1. A. K. De, "Environmental Chemistry", New Age
2. G. M. Masters, "Introduction to Environmental Engineering and Science", Pearson
3. G. S. Sodhi, "Fundamental Concepts of Environmental Chemistry", Narosa
4. E. Odum, M. Barrick& G. W. Barrett, "Fundamentals of Ecology", Brooks

SEMESTER 3

Formal Language and Automata Theory (TIU-UCBCS-T201)

Program: B. Tech. in CSBS	**Year, Semester:** 2nd Year, 3rd Sem
Course Title: Formal Language and Automata Theory	**Subject Code:** TIU-UCBCS-T201
Contact Hours/Week: 3–0–0 (L–T–P)	**Credit:** 3

COURSE OBJECTIVE:

1. To make the student aware about the basic concepts of different abstract computing methods.
2. To make the student aware about regular languages, regular grammar, regular expression, DFA, NFA, their relationship and closure properties of regular languages,
3. To make the students aware about context free languages (CFL), context free grammar, push down automata, closure properties of CFL, Chomsky normal form (CNF), Greibach normal Form (GNF)
4. To make the student aware about context sensitive grammar

COURSE OUTCOME:

After Completion of the course, the students will be able to:

CO1:	Describe the concepts of formal theory of language, the meaning of computing and algorithms	K2
CO2:	Describe and analyze different models of computing such as FA, CFG/PDA, TM	K4
CO3:	Design above models for problem solving	K3
CO4:	Analyze and identify the strengths and shortcomings of the above computing models	K4
CO5:	Describe basic concepts of complexity theory: solvable and unsolvable problems, complexity classes, etc.	K2
CO6:	Apply formal language and automata theory concepts to real-world computing problems.	K3

COURSE CONTENT:

MODULE 1:	**Regular Languages and Finite Automata**	**15 Hours**
Introduction, Alphabet, Language, and Grammar. Regular Expressions and Languages, Deterministic Finite Automata (DFA) and Equivalence with Regular Expressions, Nondeterministic Finite Automata (NFA) and Equivalence with DFA, Regular Grammars and Equivalence with Finite Automata, Properties of Regular Languages, Pumping Lemma For Regular Languages, Minimization of Finite Automata.		
MODULE 2:	**Context-Free Grammar/Languages**	**16 Hours**

Context-Free Grammars (CFG) and Context-Free Languages (CFL), Production, Parse Tree, and Derivation; Chomsky and Greibach Normal Forms, Non-deterministic Pushdown Automata (PDA) and Equivalence with CFG, Parse Trees, Ambiguity in CFG, Pumping Lemma for Context-Free Languages, Deterministic Pushdown Automata, Closure Properties of CFLs. Chomsky Hierarchy of Languages. Context-Sensitive Grammars: Context-Sensitive Grammars (CSG) and Context sensitive Languages (CSL), Linear Bounded Automata (LBA) and its Equivalence with CSG.		
MODULE 3:	**Turing Machines**	**9 Hours**
The Basic Model of Turing Machines (TM), Turing-Recognizable (Recursively Enumerable) and Turing-Decidable (Recursive) Languages and Their Closure Properties, Variants of Turing Machines, Non-deterministic TMs and its Equivalence with Deterministic TMs, Unrestricted Grammars and Equivalence with Turing Machines, TMs as Enumerators.		
MODULE 4:	**Undecidability**	**5 Hours**
Church-Turing Thesis, Universal Turing Machine, The Universal and Diagonalization Languages, Reduction between Languages and Rice's Theorem, Undecidable Problems about Languages.		
TOTAL LECTURES		**45 Hours**

Books:

1. John E. Hopcroft, Rajeev Motwani , Jeffrey D. Ullman, Introduction to Automata Theory, Languages, And Computation, Pearson
2. Michael Sipser, Introduction to the Theory of Computation, Cengage
3. Dexter C. Kozen, Automata and Computability, Undergraduate Texts in Computer Science, Springer.
4. John Martin, Introduction to Languages and The Theory of Computation, Tata Mcgraw Hill.
5. Harry R. Lewis and Christos H. Papadimitriou, Elements of The Theory of Computation, Pearson Education Asia.

Computer Organization & Architecture + Lab (TIU-UCBCS-C201)

Program: B. Tech. in CSBS	**Year, Semester:** 2rd Yr., 3rd Sem
Course Title: Computer Organization & Architecture + Lab	**Subject Code:** TIU-UCBCS-C201
Contact Hours/Week: 3–1–2 (L–T–P)	**Credit:** 5

COURSE OBJECTIVE:

Enable the student to:
1. understand the human learning aspects and primitives in learning process by computer
2. analyse the nature of problems solved with machine learning techniques
3. design and implement suitable machine learning technique for a givenapplication

The student will be able to:

Course Outcomes		
CO 1:	Understand the physical and logical features of digital computers and express the data representation	K1
CO 2:	Describe system architecture and identify instruction sets.	K2
CO 3:	Illustrate the logic design of Arithmetic and control units.	K3
CO 4:	Identify the mechanism of control units and distinguish hazards in pipelining to enhance system performance.	K3
CO 5:	Describe and identify the standard I/O interface and peripheral devices.	K3
CO 6:	Choose the appropriate memory mapping procedure and design.	K4

COURSE CONTENT:

MODULE 1:	**FUNCTIONAL BLOCKS OF COMPUTER**	**3 Hours**
CPU, memory, input-output subsystems, control unit, memory hierarchy		
MODULE 2:	**INSTRUCTION SET ARCHITECTURE OF A CPU, INTRODUCTION TO X86 ARCHITECTURE**	**8Hours**
Registers, instruction execution cycle, RTL interpretation of instructions, addressing modes, instruction set. Outlining instruction sets of some common CPUs.		

MODULE 3:	**DATA REPRESENTATION & COMPUTER ARITHMATIC**	**6 Hours**
Integer addition and subtraction, ripple carry adder, carry look-ahead adder, etc. multiplication – shift-and add, Booth multiplier, carry save multiplier, etc. Division restoring and non-restoring techniques, floating point arithmetic, IEEE 754 format		
MODULE 4:	**CPU CONTROL UNIT DESIGN**	**6 Hours**

Hardwired and micro-programmed design approaches, design of a simple hypothetical CPU		
MODULE 5:	**MEMORY SYSTEM DESIGN & MEMORY ORGANISATION**	**8 Hours**
Semiconductor memory technologies, memory organization, Memory interleaving, concept of hierarchical memory organization, cache memory, cache size vs. block size, mapping functions, replacement algorithms, write policies.		
MODULE 6:	**PERIPHERAL DEVICES AND THEIR CHARACTERISTICS**	**6 Hours**
Input-output subsystems, I/O device interface, I/O transfers – program controlled, interrupt driven and DMA, privileged and non-privileged instructions, software interrupts and exceptions. Programs and processes – role of interrupts in process state transitions, I/O device interfaces – SCII, USB		
MODULE 7:	**PIPELINEING**	**8 Hours**
Basic concepts of pipelining, throughput and speedup, pipeline hazards. Parallel Processors: Introduction to parallel processors, Concurrent access to memory and cache coherency		
TOTAL LECTURES		**45 Hours**

Laboratory

MODULE 1:	**BASIC LOGIC FUNDAMENTALS**	**5 Hours**
Boolean algebra, Logic gates, Truth tables, K-map simplification, Implementation of logic functions using gates		
MODULE 2:	**COMBINATIONAL CIRCUIT DESIGN**	**5 Hours**
Design and implementation of Adders, Subtractors, Multiplexers, Decoders, and Encoders using logic gates		
MODULE 3:	**SEQUENTIAL CIRCUITS AND STATE MACHINES**	**5 Hours**
Flip-Flops (SR, D, JK, T), Registers, Counters (Synchronous and Asynchronous), Finite State Machines		
MODULE 4:	**MEMORY ORGANIZATION AND ADDRESSING**	**5 Hours**
RAM and ROM architectures, Cache memory design, Memory hierarchy, Address decoding		
MODULE 5:	**ARITHMETIC LOGIC UNIT (ALU) AND PROCESSOR DESIGN**	**5 Hours**
Design of an ALU, Arithmetic operations (addition, subtraction, multiplication), Logical operations, Bitwise manipulations		
MODULE 6:	**CPU DESIGN AND PERFORMANCE OPTIMIZATION**	**5 Hours**
Instruction set architecture, Execution cycle, Control unit design, Pipelining, Performance evaluation metrics		
TOTAL LAB HOURS		**30 Hours**

Text Books:

T1. Computer System Architecture M. M. Mano:, 3rd ed., Prentice Hall of India, New Delhi, 1993.
T2. Computer Organization and Design: The Hardware/Software Interface, David A. Patterson and John L. Hennessy.
T3. Computer Organization and Embedded Systems, Carl Hamacher.

Reference Books:

R1.Computer Architecture and Organization, John P. Hayes.
R2. Computer Organization and Architecture: Designing for Performance, William Stallings. R3. Computer System Design and Architecture, Vincent P. Heuring and Harry F. Jordan

Object Oriented Programming + LAB(TIU-UCBCS-C203)

Program:B.Tech in CSBS	**Year, Semester:** 2nd Yr., 3rd Sem.
Course Title: Object Oriented Programming + LAB	**Subject Code:** TIU-UCBCS-C203
Contact Hours/Week: 3–0–2 (L–T–P)	**Credit:** 4

Prerequisites: A course on "Programming for Problem Solving using C".

COURSE OBJECTIVE:

Enable the student to:

1. understand the real-world problem and design solutions by object-oriented programming
2. analyze the nature of problems solved with object-oriented techniques
3. design and implement suitable programming approach for a given application

COURSE OUTCOME:

The students will be able to:

CO-1:	Define an object-oriented approach to programming and identify potential benefits of object-oriented programming over other approaches.	K1, K2
CO-2	Understand the difference between the top-down and bottom-up program design approach	K2
CO-3:	Demonstrate the use of various OOPs concepts using C++	K3
CO-4:	Solve a computational problem by implementing the solution as a real-world entity	K3,K4
CO-5:	Understand and apply some advanced constructs of C++ like virtual functions, operator overloading, exception handling, standard template library	K2 ,K3

COURSE CONTENT:

MODULE 1:	**INTRODUCTION**	**10 Hours**

Introduction to Object Oriented Paradigm, Need of object-oriented design, Drawbacks of Procedure Oriented Programming, Features of object-oriented languages, POP Vs OOP, Benefits & Applications of OOP, Difference between C and C++.		
MODULE 2:	**BASIC CONCEPTS OF OBJECT ORIENTATION**	**12 Hours**
Class, Object, Data abstraction, Encapsulation, Inheritance, Polymorphism, Message Passing, Dynamic binding.		
MODULE 3:	**FUNDAMENTALS OF OOPs**	**12 Hours**
Fundamentals of OOPs: Class & Objects, Constructors & Destructor. Different perspectives on inheritance, Types of inheritance, Polymorphism: Compile Time & Run time Polymorphism, Virtual functions, Virtual table construction, Overloading, Overriding, Abstract Class, Virtual Class.		
MODULE 4:	**ADVANCE OOP CONCEPTS**	**11 Hours**
Class and Function Templates, Standard Template Libraries in C++: lists, vectors, sets, maps. Exceptions Handling.		
TOTAL LECTURES		**45 Hours**

Laboratory

MODULE 1:	**INTRODUCTION TO JAVA PROGRAMMING BASICS**	**5 Hours**
Overview of Java programming language, IDE setup, and compiling Java programs. Understanding the basic structure of a Java program, including classes, methods, and variables. Overview of primitive data types (int, float, char, etc.). Operators: Arithmetic, relational, logical, and assignment operators. Introduction to decision-making statements in Java (if, nested if, switch).		
MODULE 2:	**LOOP CONTROL STRUCTURES AND ARRAYS**	**5 Hours**

Implementing for, while, and do-while loops for repeating code execution. Nested loops for multi-level iteration. string operations such as substring(), length(), charAt(), etc. creation and manipulation of single-dimensional and multi-dimensional arrays.		
MODULE 3:	**CLASSES, OBJECTS AND STATIC MEMBERS**	**5 Hours**
Understanding the basic concepts of classes and objects in Java. Using constructors, instance methods, and instance variables. concept of static members. significance of static variables, methods, and static blocks in Java.		
MODULE 4:	**OBJECT-ORIENTED CONCEPTS: INHERITANCE, POLYMORPHISM, AND ABSTRACTION**	**5 Hours**
Concept of inheritance in Java: extending classes, constructor chaining, method overriding. Types of inheritance: single, multilevel, and hierarchical inheritance. Understanding the use of abstract classes and abstract methods. Use cases for abstract classes in Java.		
MODULE 5:	**PACKAGES, EXCEPTION HANDLING, AND MULTITHREADING**	**5 Hours**
Introduction to Java packages and their role in organizing code. Demonstrating the use of built-in packages (e.g., java.util). Basics of exception handling: try, catch, throw, throws, and finally. Creating custom exceptions and handling multiple exceptions.		
MODULE 6:	**APPLET PROGRAMMING AND GUI DEVELOPMENT WITH AWT**	**5 Hours**

Introduction to applet programming: lifecycle methods (init(), start(), stop(), destroy()). Differences between applets and applications. Overview of GUI programming in Java using AWT. Working with basic GUI components: Button, Label, TextField, etc. Event handling in AWT components.

TOTAL LAB HOURS	**30 Hours**

Text Books:

T1. Robert Lafore, Object-Oriented Programming in C++, Fourth Edition, Pearson.
T2. Herbert Schildt, C++: The Complete Reference, Fourth Edition, Mc-Graw Hill Education, India, 2003.

Reference Books:

R1. Bjarne Stroustrup, The C++ Programming Language, Third Edition, Pearson, 2000.
R2. E. Balagurusamy, Object-Oriented Programming with C++, 8th Edition, Mc-Graw Hill Education India, 2021.
R3. Scott Meyers, Effective Modern C++, O'Reilly Media, Inc., 2014.
R4. Scott Meyers, Effective STL: 50 Specific Ways to Improve Your Use of the Standard Template Library, Addison-Wesley Professional Computing Series,2001.

Computational Statistics + LAB(TIU-UCBCS-C205)

Program: B. Tech. in CSBS	**Year, Semester:** 2nd Yr., 3rd Sem.
Course Title: Computational Statistics + LAB	**Subject Code:** TIU-UCBCS-C205
Contact Hours/Week: 3–0–2 (L–T–P)	**Credit: 4**

COURSE OBJECTIVE:

Enable the student to:

1. Understand Multivariate Normal Distribution.
2. Apply Multiple Linear Regression Models and Explore Multivariate Regression Analysis.
3. Perform Discriminant Analysis and Implement Principal Component Analysis (PCA).
4. Conduct Factor Analysis and Apply Cluster Analysis Techniques, Develop Practical Skills in Python for Multivariate Data Analysis.:

COURSE OUTCOME:

The student will be able to:

CO-1:	explore the underlying Multivariate normal distribution, analysis and build multiple linear regression models.
CO-2:	Apply multivariate regression techniques and perform discriminant analysis for classification.
CO-3:	Implement principal component analysis (PCA) Conduct Factor Analysis and conduct factor analysis.
CO-4:	Apply various clustering techniques and Python for multivariate data analysis.
CO-5:	Apply Knowledge to Real-World problems.
CO-6:	Evaluate and interpret the results of multivariate analyses to derive meaningful insights and support data-driven decision-making.

COURSE CONTENT:

Theory		
MODULE 1	**MULTIVARIATE NORMAL DISTRIBUTION**	**7 Hours**
Multivariate Normal Distribution Functions, Conditional Distribution and its relation to regression model, Estimation of parameters. Multiple Linear Regression Model: Standard multiple regression models with emphasis on detection of collinearity, outliers, non-normality and autocorrelation, Validation of model assumptions.		
MODULE 2	**MULTIVARIATE REGRESSION**	**7 Hours**
Assumptions of Multivariate Regression Models, Parameter estimation, Multivariate Analysis of variance and covariance.		
MODULE 3	**DISCRIMINANT ANALYSIS**	**7 Hours**
Statistical background, linear discriminant function analysis, Estimating linear discriminant functions and their properties.		
MODULE 4	**PRINCIPAL COMPONENT ANALYSIS**	**8 Hours**
Principal components, Algorithm for conducting principal component analysis, deciding on how many principal components to retain, H-plot.		
MODULE 5	**FACTOR ANALYSIS**	**8 Hours**
Factor analysis model, Extracting common factors, determining number of factors, Transformation of factor analysis solutions, Factor scores.		
MODULE 6	**CLUSTER ANALYSIS**	**8 Hours**
Introduction, Types of clustering, Correlations and distances, clustering by partitioning methods, hierarchical clustering, overlapping clustering, K-Means Clustering, Profiling and Interpreting Clusters.		
	TOTAL LECTURE	**45 Hours**

Laboratory		
MODULE-1:	**PYTHON BASICS & DATA HANDLING**	**7 Hours**
Overview of Python for statistics, interpreter & execution, expressions, flow control, functions, class definitions, data structures (lists, tuples, dictionaries, sets), text & binary file operations (reading & writing).		
MODULE-2:	**DATA VISUALIZATION & DESCRIPTIVE STATISTICS**	**8 Hours**

Matplotlib basics, plotting graphs, controlling graph aesthetics, adding text, different graph types (line, bar, scatter, histogram), descriptive statistics (mean, median, mode, variance, standard deviation), probability distributions (normal, binomial, Poisson).		
MODULE-3:	**MULTIVARIATE ANALYSIS & CLUSTERING**	**8 Hours**
Multiple & polynomial regression, multivariate regression, evaluation metrics (R^2, MSE, RMSE), cluster analysis (K-Means, hierarchical clustering, DBSCAN), practical implementation using datasets.		
MODULE-4:	**DIMENSIONALITY REDUCTION & PROJECT WORK**	**7 Hours**
Factor analysis, Principal Component Analysis (PCA), Linear Discriminant Analysis (LDA), mini-projects & case studies using real-world datasets.		
	TOTAL PRACTICAL	**15 Hours**

Books:

1. An Introduction to Multivariate Statistical Analysis, T.W. Anderson.

2. Applied Multivariate Data Analysis, Vol I & II, J.D. Jobson.

3. Statistical Tests for Multivariate Analysis, H. Kris.

4. Programming Python, Mark Lutz.

5. Python 3 for Absolute Beginners, Tim Hall and J-P Stacey. 6. Beginning Python: From Novice to Professional, Magnus Lie Hetland. Edition, 2005.

Database Management System +Lab (TIU-UCBCS-C209)

Program: B. Tech. in CSBS	**Year, Semester:** 2nd Year, 3rd Sem.
Course Title: Database Management System +Lab	**Subject Code:**TIU-UCBCS-C209
Contact Hours/Week: 3–0–2 (L–T–P)	**Credit:** 4

COURSE OBJECTIVE :

1. Understand the basic concepts and the applications of database systems and the relational database design principles.
2. Master the basics of SQL and construct queries using SQL.
3. Familiar with the basic issues of transaction processing and concurrency control and database storage structures and access techniques.

COURSE OUTCOME :

The student will be able to:

CO1:	Understand the core concepts and features of Database Management System	K2
CO2:	Design and development of DBMS solutions based on relevant project work	K3
CO3:	Analyze and troubleshoot database related problems and finding the solution using the DBMS knowledge as acquired	K4

CO4:	Study the latest trends in DBMS and get the connectivity with the cutting-edge technologies	K3
CO5:	Implement database security, backup, and recovery techniques to ensure data integrity.	K3
CO6:	optimize SQL queries and database operations for improved performance.	K4

COURSE CONTENT :

MODULE 1:	**INTRODUCTION**	**2 Hours**
General introduction to database systems, Concept of file System and Disadvantages, Database-DBMS distinction, Role of DBA, Approaches to building a database, Data models, Database management system, Three-schema architecture of a database, Data Independency, Integrity constraints.		
MODULE 2:	**RELATIONAL DATA MODEL**	**2 Hours**
Concept of relations, Schema-instance distinction, Keys, Referential integrity and foreign keys. Relational Algebra Operators: Selection, Projection, Union, Intersection, Set difference, Cross product, Rename, Assignment, Various types of joins, Division, Example queries. Tuple Relational Calculus, Domain Relational Calculus.		
MODULE 3:	**SQL (Structured Query Language)**	**7 Hours**
Introduction, Data definition in SQL, Table, key and foreign key definitions, Update behaviors, querying in SQL, Basic select- from- where block and its semantics, Nested queries-correlated and uncorrelated, Notion of aggregation, Aggregation functions group by and having clauses, Embedded SQL		
MODULE 4:	**Database Design Concepts (part-1)-Dependencies and Normal forms**	**9 Hours**
Importance of a good schema design, Problems encountered with bad schema designs, Motivation for normal forms, dependency theory – functional dependencies, Armstrong's axioms for FD's, Closure of a set of FDs, Minimal covers, Definitions of 1NF, 2NF, 3NF and BCNF, Decompositions and desirable properties of them, Algorithms for 3NF and BCNF normalization, multi-valued dependencies and 4NF, Join dependencies and definition of 5NF, DKNF.		
MODULE 5:	**Database Design Concepts (part-2) -ER Model**	**6 Hours**
Conceptual data modeling-motivation, Entities, Entity types, Various types of attributes, Relationships, Relationship types, E/R diagram notation, High-level conceptual modeling, ER Modeling concepts, ER Diagrams, Cardinality constraints Enhanced ER Model: Higher-order relationships, Enhanced ER Model (EER), Weak-entity types, Subclasses and inheritance, Specialization and Generalization, Modeling of UNION types using categories.		
MODULE 6:	**Data Storage and Indexes**	**7 Hours**
File organizations, Primary, Secondary index structures, Various index structures - hash-based, Dynamic hashing techniques, Multi-level indexes, B+ trees.		
MODULE 7:	**Transaction Processing and Concurrency Control**	**9 Hours**
Transaction Fundamentals: OLTP environments, Concurrency issues, need for transactions, Necessary properties of transactions (ACID properties), Transaction states, serializability, Serial schedules, Conflict serializability, View serializability, Recoverable and non-recoverable schedules, Cascading rollbacks, Cascadeless schedules. Concurrency control: Serialized and non-serialized schedules, Testing for serializability, Locking, Lock compatibility matrix, Locking and serializability, Deadlocks and starvation, Two-phase locking (2PL) protocol, Conservative, strict and rigorous 2PL, 2PL with lock conversions, Timestamp-ordering based protocol, Multi versioning protocol, Multi-granularity locking, Deadlock prevention protocols, Wait-die and wound-wait schemes, Time-out based schemes, Deadlock recovery, Nested		

transactions.		
MODULE 8:	**Database Recovery Techniques**	**3 Hours**
Recovery concepts, Deferred updates technique, Immediate update technique, Shadow paging.		
TOTAL LECTURES		45 **Hours**

Laboratory

MODULE 1:	**DDL AND DML OPERATIONS**	**5 Hours**
Introduction to SQL; DDL Statements: CREATE, ALTER, DROP; DML Statements: INSERT, UPDATE, DELETE; Constraints and data integrity		
MODULE 2:	**JOIN OPERATIONS**	**5 Hours**
Inner Join, Outer Join (Left, Right, Full); Cross Join, Self Join; Performance considerations in join operations		
MODULE 3:	**BUILT-IN FUNCTIONS AND INTEGRITY CONSTRAINTS**	**5 Hours**
Aggregate Functions (SUM, COUNT, AVG, MAX, MIN); String Functions; Integrity Constraints (NOT NULL, UNIQUE, PRIMARY KEY, FOREIGN KEY)		
MODULE 4:	**REFERENTIAL INTEGRITY**	**5 Hours**
Concept of Referential Integrity, Enforcing foreign key relationships, Handling cascading updates and deletes		
MODULE 5:	**INDEXING AND VIEWS**	**5 Hours**
Creating and using indexes, Advantages and limitations of indexes, Creating and managing views		
MODULE 6:	**STORED PROCEDURES, TRANSACTIONS, AND TRIGGERS**	**5 Hours**
Creating and executing stored procedures, Transaction Control (COMMIT, ROLLBACK, SAVEPOINT), Creating and managing triggers		
	TOTAL LAB HOURS	**30 Hours**

Books:

1. Avi Silberschatz, Henry F. Korth, S. Sudarshan, Database System Concepts,Tata McGraw - Hill Education.
2. Ramez Elmasri and Shamkant Navathe, Fundamentals of Database Systems, Publisher -Pearson Education, 5th Edition
3. Database systems, 6th edition, Ramez Elmasri, Shamkant B.Navathe, Pearson Education
4. Database Systems Design, Implementation, and Management, Peter Rob & Carlos Coronel, 7th Ed
5. Fundamentals of Database Systems, ElmasriNavrate, Pearson Education
6. Microsoft SQL Server 2019 documentation: Databases - SQL Server | Microsoft Docs
7. Microsoft Azure SQL documentation: Azure SQL documentation - Azure SQL | Microsoft Docs
8. Microsoft Azure CosmosDB documentation: Introduction to Azure Cosmos DB |Microsoft Docs
9. Articles on Microsoft Azure and SQL Server: Sucharita Das, Author at SQLServerCentral
10. Transaction Processing in SQL Server: https://youtu.be/vO4OgihpAGw

Indian Constitution(TIU-UCBLL-T201)

Program: CSBS	**Year, Semester:** 2nd Year, 3rd Sem
Course Title: Indian Constitution	**Subject Code:** TIU-UCBLL-T201
Contact Hours/Week: 2–0–0 (L–T–P)	**Credit:** 0

COURSE OBJECTIVE :

Enable the student to:

1. To **understanding** of basic concepts of Indian Constitution and various organs created by the constitution including their functions and relationships.
2. Student will learn areas of constitutional law that are essential for an understanding of the fundamental concepts and the unique features of the Indian constitutional system.
3. Student will explore the meaning and concept of fundamental rights, fundamental duties and Directive principles of state policies.

COURSE OUTCOME :

On completion of the course, the student will be able to:

CO-1:	**Define** the key concepts of constitutional law, including the Preamble, the definition of the State, the meaning of law, and fundamental rights enshrined in the Indian Constitution.
CO-2:	**Explain and Recognise** the significance of the Preamble, the scope of State action, and the essential features of fundamental rights, with a focus on their role in ensuring justice, liberty, equality, and fraternity.
CO-3:	**Examine and Interpret** the judicial approach towards fundamental rights, including the Right to Equality, Right to Freedom, Right against Exploitation, Right to Freedom of Religion, Cultural and Educational Rights, and the Right to Constitutional Remedies.

CO-4:	**Compare or Criticise** the evolution and application of fundamental rights in India, analyzing their enforcement, limitations, and interplay with Directive Principles of State Policy and constitutional amendments.
CO-5:	**Summarise** landmark judicial decisions and constitutional provisions that have shaped the interpretation and implementation of fundamental rights in India.
CO-6:	**Recommend** legal and policy measures for strengthening constitutional rights, ensuring effective protection against State encroachments, and promoting constitutionalism in India.

COURSE CONTENT :

MODULE 1:	**INTRODUCTION**	**8 Hours**
Nature and Special Features of the Constitution of India, Preamble		
MODULE 2:	**FUNDAMENTAL RIGHTS**	**12 Hours**
Definition of State for enforcement of fundamental rights-Justiciability of fundamental rights Doctrine of eclipse, severability, waiver, distinction between pre-constitutional law and post constitutional Law Right to Equality: Doctrine of Reasonable classification and the principle of absence of arbitrariness Fundamental Freedom: Freedom of speech and expression, Freedom of Association, Freedom of Movement, Freedom of Reside and Settle, Freedom of Trade, Business and Profession-expansion by judicial interpretation-reasonable restrictions.		
MODULE 3:	**FUNDAMENTAL RIGHTS**	**8 Hours**
Right to life and personal liberty-scope and content (expensive interpretation) Preventive detention under the Constitution-Policy and safeguards-Judicial review Right against		
MODULE 4:	**RIGHT TO CONSTITUTIONAL REMEDIES**	**7 Hours**
Right to Constitutional Remedies-Judicial Review Writs: Hebeas Corpus, Mandamus, Certiorari, Prohibition and Quo-warranto-Art.32 and 226		
MODULE 5:	**PART IV & IVA**	**6 HOURS**
Directive Principle, Fundamental Duties, Social Justice and Right to Information Directive Principle of State Policy-Nature and justiciability of the Directive Principles- Interrelationship between Fundamental Rights and Directive Principles-Fundamental Duties, Social justice under the Indian Constitution-Compensatory discrimination for backward Classes Mandal Commission's case and other cases-Protective discrimination doctrine		
TOTAL LECTURES		**41 Hours****

Books:

1. Constitution Law of India: Dr.J.N.Pandey
2. Constitution of India: Durda Das Basu
3. Indian Constitutional Law : M.P. Jain
4. Constitution of India : V.N. Shukala

SEMESTER 4

Operating Systems Lab (Unix) (TIU-UCBCS-C202)

Program: B. Tech. in CSBS	**Year, Semester:**2nd Yr., 4th Sem.
Course Title: Operating Systems+Lab (Unix)	**Subject Code:** TIU-UCBCS-C202
Contact Hours/Week: 3–0–2 (L–T–P)	**Credit:** 4

COURSE OBJECTIVE :

Enable the student to:

1. Understand the structure, functions, and operations of operating systems, including computing environments and open-source OS.
2. Explore process management, scheduling, multithreading, and inter-process communication with synchronization techniques.
3. Learn memory management strategies, including virtual memory, paging, segmentation, and page replacement techniques.
4. Analyze deadlocks, including detection, prevention, and recovery, along with file system implementation and storage management.
5. Examine system protection, access control mechanisms, security policies, and cryptographic techniques for system security.

COURSE OUTCOME:

The student will be able to:

CO1:	Understand fundamental operating system abstractions such as processes, threads, files, semaphores, IPC abstractions, shared memory regions, etc.
CO2:	Analyze important algorithms e.g. Process scheduling and memory management algorithms, Disk scheduling algorithms.
CO3:	Categorize the operating system's resource management techniques, dead lock management techniques, memory management techniques.
CO4:	Demonstrate the ability to perform OS tasks in Red Hat Linux Enterprise.
CO5:	Evaluate OS performance through scheduling, memory, and file system optimizations.
CO6:	Develop shell scripts and system programs for process management and automation.

COURSE CONTENT:

MODULE 1:	**INTRODUCTION TO OS**	**8 Hours**
Operating Systems Overview: Operating system functions, Operating system structure, Operating systems operations, Computing environments, Open-Source Operating Systems. System Structures: Operating System Services, User and Operating-System Interface, systems call, Types of System Calls, system programs, operating system structure, operating system debugging, System Boot.		
MODULE 2:	**PROCESS MANAGEMENT**	**10 Hours**
Process Concept: Process scheduling, Operations on processes, Inter-process communication, Communication in client server systems. Multithreaded Programming: Multithreading models, Thread libraries, Threading issues. Process Scheduling: Basic concepts, Scheduling criteria, Scheduling algorithms, Multiple processor scheduling, Thread scheduling.		

Inter-process Communication: Race conditions, Critical Regions, Mutual exclusion with busy waiting, Sleep and wakeup, Semaphores, Mutexes, Monitors, Message passing, Barriers, Classical IPC Problems – Dining philosophers problem, Readers and writers problem.		
MODULE 3:	**MEMORY MANAGEMENT**	**10 Hours**
Memory-Management Strategies: Introduction, Swapping, Contiguous memory allocation, Paging, Segmentation. Virtual Memory Management: Introduction, Demand paging, Copy on-write, Page replacement, Frame allocation, Thrashing, Memory-mapped files, Kernel memory allocation.		
MODULE 4:	**DEADLOCKS & FILE SYSTEM**	**9 Hours**
Deadlocks: Resources, Conditions for resource deadlocks, Ostrich algorithm, Deadlock detection and recovery, Deadlock avoidance, Deadlock prevention. File Systems: Files, Directories, File system implementation, management and optimization. Secondary-Storage Structure: Overview of disk structure, and attachment, Disk scheduling, RAID structure, Stable storage implementation.		
MODULE 5:	**SECURITY, SYSTEM PERFORMANCE**	**8 Hours**
System Protection: Goals of protection, Principles and domain of protection, Access matrix, Access control, Revocation of access rights. System Security: Introduction, Program threats, System and network threats, Cryptography for security, User authentication, implementing security defenses, Firewalling to protect systems and networks, Computer security classification. Case Studies: Linux, Microsoft Windows.		
TOTAL LECTURES		**45 Hours**

Laboratory

MODULE 1:	**PROCESS MANAGEMENT AND SCHEDULING**	**5 Hours**
Concept of processes and threads, CPU scheduling algorithms (FCFS, SJF, RR, Priority), Process creation and management in Linux.		
MODULE 2:	**INTER-PROCESS COMMUNICATION AND SYNCHRONIZATION**	**5 Hours**
IPC mechanisms (pipes, message queues, shared memory), Process synchronization, Semaphores, and mutex locks.		
MODULE 3:	**MEMORY MANAGEMENT TECHNIQUES**	**5 Hours**
Paging and segmentation, Virtual memory, Page replacement algorithms (FIFO, LRU, Optimal).		
MODULE 4:	**FILE SYSTEM AND DISK MANAGEMENT**	**5 Hours**
File operations, File allocation methods, Disk scheduling algorithms (FCFS, SSTF, SCAN, C-SCAN).		
MODULE 5:	**DEADLOCK HANDLING AND RESOURCE ALLOCATION**	**5 Hours**
Deadlock prevention and avoidance, Banker's algorithm, Resource allocation graphs.		
MODULE 6:	**SYSTEM PERFORMANCE AND SECURITY**	**5 Hours**
Monitoring system performance, Troubleshooting OS issues, and Security management in Linux.		

TOTAL LAB HOURS	30 Hours

Books:

1. Operating System Concepts – Abraham Silberschatz, Peter B. Galvin, Greg Gagne
2. Modern Operating Systems – Andrew S. Tanenbaum, Herbert Bos
3. Operating Systems: Internals and Design Principles – William Stallings
4. Operating Systems: A Concept-Based Approach – Dhananjay M. Dhamdhere

Design and Analysis of Algorithms + Lab (TIU-UCBCS-C212)

Program: B. Tech. in CSBS	**Year, Semester:** 2nd Yr., 4th Sem.
Course Title: Design and Analysis of Algorithms + Lab	**Subject Code:** TIU-UCBCS-C212
Contact Hours/Week: 3–1–2 (L–T–P)	**Credit:** 5

COURSE OBJECTIVE:

Enable the student to:

1. Understand the Fundamental Principles of Algorithm Design
2. Master Asymptotic Analysis and Notations
3. Analyze Algorithm Efficiency in Different Scenarios
4. Apply Algorithm Design to Real-world Problems.

The student will be able to:

CO1	Explain the basic concepts involved in designing, analyzing, and implementing algorithms.
CO 2	Analyze problem characteristics to devise efficient algorithms tailored to specific tasks.
CO 3	Identify and distinguish between tractable and intractable problems in algorithm design.
CO4	Utilize algorithm design principles to solve real-world problems, implementing solutions and conducting complexity analyses
CO5	Assess and compare the efficiency of various algorithms based on time and space complexity.
CO6	Apply advanced algorithmic techniques, such as approximation and parallel algorithms, to solve complex problems efficiently

COURSE CONTENT:

MODULE 1:	**Foundation of Algorithm & Analysis**	**10 Hours**
Introduction to algorithm design and importance of its analysis, Asymptotic notations and their significance, Complexity analysis of algorithms – best case, worst case and average case with example of Insertion sort, Quick sort and Heap sort, Time & space trade-offs, Analysis of recursive algorithms – Substitution method, Recursion tree method and Masters' theorem, Lower bound for comparison-based sort.		

MODULE 2:	**Algorithmic Paradigms**	**10 Hours**
Classification of algorithm design techniques for problem solving: Brute-force, Divide-and-Conquer, Greedy, Dynamic Programming, Backtracking and Branch-and-Bound, Methodology and application domains, Illustration of the techniques with suitable examples: Activity selection, Huffman code, Knapsack problem, Matrix Chain Multiplication, 8-Queen problem, 15-puzzle problem. [extra problem in tutorial]		
MODULE 3:	**Graph Algorithms**	**12 Hours**
Traversal algorithms: DFS, BFS - concept, complexity analysis and applications, Minimum Spanning Tree finding algorithm: Prim's, Kruskal - concept, complexity analysis, Disjoint set operations, shortest path finding algorithm: single source and all pairs –Bellman-Ford, Dijkstra and Floyd-Warshall, Topological sort, Network flow algorithm: Ford-Fulkerson, Max-flow Min-cut theorem.		
MODULE 4:	**Problem Reducibility and NP-completeness**	**8 Hours**
Problem classification on Computability: P, NP, NP-complete and NP-hard, Reducibility of NP-complete problems with example – Satisfiability, Vertex cover, Traveling Salesman problem, Cook's theorem.		
MODULE 5:	**Advanced Topics**	**5 Hours**
Approximation algorithm, Randomized algorithm technique Amortized analysis.		
TOTAL LECTURES		**45 Hours**

LABORATORY

MODULE 1:	**INTRODUCTION TO ALGORITHMS AND COMPLEXITY ANALYSIS**	**5 Hours**
Definition and Importance of Algorithms, Performance Analysis: Time and Space Complexity, Asymptotic Notation: Big-O, Big-Theta, and Big-Omega, Empirical and Theoretical Analysis: Experimental evaluation with iterative and recursive algorithms		
MODULE 2:	**SORTING AND SEARCHING ALGORITHMS**	**5 Hours**
Sorting Techniques: Bubble Sort, Insertion Sort, Selection Sort (basic sorting). Merge Sort: Divide and Conquer Strategy. Quick Sort: Partitioning and Randomized Pivot Selection. Heap Sort: Using Max-Heap and Min-Heap. Searching Techniques: Linear Search and Binary Search. Complexity Analysis: Best-case, Worst-case, and Average-case performance comparison.		
MODULE 3:	**GREEDY ALGORITHMS**	**5 Hours**
Greedy Methodology: Characteristics and Applicability. Applications: Fractional Knapsack Problem, Minimum Spanning Tree (MST) using Prim's and Kruskal's Algorithms. Complexity Analysis: Time and Space Complexity of Greedy Algorithms.		
MODULE 4:	**DYNAMIC PROGRAMMING (DP)**	**5 Hours**
Dynamic Programming Paradigm: Optimal Substructure and Overlapping Subproblems. Applications: 0/1 Knapsack Problem, Longest Common Subsequence (LCS), All-pairs shortest path using Floyd-Warshall Algorithm. Complexity Analysis: Time and Space Complexity of DP algorithms.		
MODULE 5:	**GRAPH ALGORITHM**	**5 Hours**
Graph Representation: Adjacency Matrix and Adjacency List. Graph Traversal: Breadth-First Search (BFS), Depth-First Search (DFS). Single-Source Shortest Path: Dijkstra's Algorithm.		
MODULE 6:	**BACKTRACKING AND BRANCH & BOUND**	**5 Hours**

Backtracking Concepts: Solving problems using backtracking. Applications: N-Queens Problem. Branch and Bound: Concept and Applications. Solving Traveling Salesman Problem (TSP). Complexity Analysis: Time complexity of backtracking and branch and bound.	
TOTAL LAB HOURS	**30 Hours**

Books:

1. Introduction to Algorithms- Thomas H. Cormen Charles E. Leiserson Ronald L. Rivest Clifford Stein, The MIT Press
2. Fundamentals of computer algorithms by Satroj Sahani and Ellis Horowitz.

Software Engineering + Lab(TIU-UCBCS-C214)

Program: B. Tech. in CSBS	**Year, Semester**: 2nd Yr., 4th Sem.
Course Title: Software Engineering + Lab	**Subject Code**: TIU-UCBCS-C214
Contact Hours/Week: 3–0–2 (L–T–P)	**Credit**: 4

COURSE OBJECTIVE

1. To develop basic Knowledge in Software Engineering and its applications.
2. To understand software Engineering layered architecture and the process framework.
3. To analyze software process models such as the waterfall, spiral, evolutionary models and agile method for software development.
4. To design software requirements and specifications of documents.

COURSE OUTCOME

CO1:	Identify and describe fundamental software engineering concepts, principles and models.	K2
CO2:	Analyze and document software requirements using appropriate elicitation techniques and requirement engineering processes.	K4
CO3:	Design software solutions using modeling techniques such as UML, architectural styles, and design patterns.	K3
CO4:	Implement software applications by applying programming principles, coding standards, and development methodologies.	K3
CO5:	Evaluate software quality through testing strategies, verification, validation, and project management techniques.	K4
CO6:	Demonstrate teamwork, ethical considerations, and professional responsibility in software development projects.	K4

COURSE CONTENT

MODULE 1:	**INTRODUCTION TO SOFTWARE ENGINEERING**	**12 Hours**
Introduction to software engineering: Software and software engineering, phases in software development, software development process models, role of management in software development, role of metrics and measurement.		
MODULE 2:	**REQUIREMENT ANALYSIS AND SPECIFICATION, PROJECT MANAGEMENT**	**12 Hours**
Software requirement specifications: Role of SRS, problem analysis, requirement specification, validation, metrics, monitoring and control. Planning a software project: Cost estimation, project scheduling, staffing, personal planning, team structures, SCM, quality assurance plans, project-monitoring plans, risk management, Knowledge driven approach and development.		
MODULE 3:	**SOFTWARE DESIGN**	**7 Hours**
System design: Design objectives, design principles, module level concepts, design methodology, structured design, design specifications, verification metrics, monitoring and control. Detailed design: Module specification, detailed design and process design language, verification.		
MODULE 4:	**CODING AND TESTING**	**7 Hours**
Coding: Programming practice, verification, and metrics. Testing: Testing fundamentals, functional testing, structural testing, testing process, comparison of different V & V techniques.		
MODULE 5:	**SOFTWARE QUALITY**	**7 Hours**
Software quality; Garvin's quality dimensions, McCall's quality factor, ISO 9126 quality factor; Software Quality Dilemma; Introduction to Capability Maturity Models (CMM and CMMI); Introduction to software reliability, reliability models and estimation.		
TOTAL LECTURES		**45 Hours**

Laboratory

MODULE 1:	**INTRODUCTION TO SOFTWARE ENGINEERING**	**6 Hours**
Initial Project Proposal and Problem Definition: Team formation & brainstorming session, Problem identification and documentation, Components of a strong project proposal, Project scope, assumptions, and constraints Project Scope and Process Models : Software Process Models overview: Waterfall, Incremental, Spiral, Agile, Project scope elaboration, Subtask breakdown and milestone planning, Justifying the selected process model. Process Model and Scope Refinement: In-depth review of selected models, Group presentations and peer feedback, Refining the solution space and model suitability		
MODULE 2:	**Software Requirements and Project Management**	**6 Hours**

Requirement Gathering and Draft SRS: Team role assignment, Methods: Interviews, Observation, Questionnaire, Writing a structured draft SRS Project Planning Tools: Introduction to Project Planning, PERT Chart and Gantt Chart creation, Setting project milestones and timelines Estimation, Design, and Final SRS: Resource estimation techniques, Overview of software design principles, Preparing the Final SRS document		
MODULE 3:	**SOFTWARE DESIGN**	**8 Hours**
Object-Oriented Design and UML Data Flow Diagrams (DFD) – up to Level 2, Entity-Relationship (ER) models, Creating a Data Dictionary Advanced Diagram and Model Refinement Analyzing and improving DFD levels, ER model optimization, Refining data dictionaries for accuracy. Case Study and Group Collaboration: OOD principles and diagram discussions, Group activity: Peer review and collaborative design. Detailed UML Diagrams: Use Case Diagrams for various scenarios, Class and Deployment diagrams, Interpreting system interactions and architecture.		
MODULE 4:	**CODING AND TESTING**	**4 Hours**
User Interface Design: UI/UX principles, Screen design (Login, Data Entry, Reports), User feedback and improvement cycle Testing and Requirement Tracking: Writing test cases for project modules, Requirement Traceability Matrix (RTM) creation, Introduction to basic testing tools		
MODULE 5:	**SOFTWARE QUALITY**	**6 Hours**
Revision and Finalization Comprehensive review of, SRS, Diagrams, Charts, UI Screens, Process models and Testing artifacts. Peer feedback and refinement, Final document submission & viva preparation.		
TOTAL LAB HOURS		**30 Hours**

Books:

1. Roger S Pressman, Software Engineering-A Practitioners Approach, McGraw Hill Publications.
2. Pankaj Jalote, An Integrated Approach to Software Engineering, BPB Publications
3. Rajib Mall, Fundamentals of Software Engineering, PHI Learning Private Limited
4. Software Engineering, Ian Sommerville

Marketing Research and Marketing Management (TIU-UCBMG-T202)

Program: B. Tech. in CSBS	**Year, Semester:** 2nd Yr., 4th Sem.

Course Title: Marketing Research and Marketing Management	**Subject Code:** TIU-UCBMG-T202
Contact Hours/Week: 2–0–0 (L–T–P)	**Credit:** 2

COURSE OBJECTIVE :

Enable the student to:

1. **To develop a comprehensive understanding of core marketing principles**

   Students will explore the scope, functions, and evolution of marketing, emphasizing the marketing mix (4Ps), customer-centric strategies, and the role of digital transformation in modern marketing environments.

2. **To equip students with foundational knowledge and tools of marketing research and consumer behavior analysis**

   Learners will gain insight into research methodologies, data collection techniques, and analysis tools, along with an understanding of psychological, social, and technological factors that influence consumer decision-making and market segmentation.

3. **To enable strategic thinking and application of digital marketing technologies**

   Students will learn to design marketing strategies using traditional and digital channels, apply data-driven decision-making techniques, and integrate emerging technologies such as AI, CRM, and IoT to enhance marketing effectiveness and customer engagement.

COURSE OUTCOME :

The student will be able to:

CO-1:	Explain the core concepts, scope, and functions of marketing, including the marketing mix and customer-centric approaches in the context of technology-driven markets.
CO-2:	Analyze various types of marketing research and distinguish between qualitative and quantitative research methodologies.
CO-3:	Apply appropriate data collection methods and sampling techniques to conduct basic marketing research projects.
CO-4:	Interpret consumer behavior by examining psychological, social, and technological influences on buying decisions and segmentation.
CO-5:	Demonstrate the ability to formulate strategic marketing plans using tools such as SWOT, PESTEL, and positioning strategies for both traditional and digital channels.
CO-6:	Utilize digital marketing tools and technologies—including CRM systems, social media platforms, and AI-based analytics—to develop integrated marketing solutions.

COURSE CONTENT :

MODULE 1:	FOUNDATIONS OF MARKETING & MARKETING RESEARCH	6 Hours

Introduction to Marketing

Scope and functions of marketing in modern business, The Marketing Mix (4Ps) with emphasis on tech-driven products, Customer orientation and digital transformation.

Basics of Marketing Research

Purpose and scope of marketing research, Types of research: Exploratory, Descriptive, Causal, Qualitative vs. Quantitative research approaches.

Research Tools & Techniques

Primary vs. Secondary data; data sources, Survey methods, interviews, focus groups, observation, Sampling techniques: Probability and non-probability.

MODULE 2:	CONSUMER BEHAVIOR AND MARKET SEGMENTATION	6 Hours

Understanding Consumer Behavior

Psychological and social influences on buyer decisions, The consumer decision-making process, Impact of technology and digital platforms on buying behavior.

Customer Segmentation

Segmentation bases: Demographic, Psychographic, Behavioral, Targeting and positioning concepts.

MODULE 3:	DATA ANALYSIS IN MARKETING RESEARCH	6 Hours

Quantitative Data Analysis

Descriptive statistics, correlation, regression (basic introduction), Data visualization using Excel, Tableau.

Qualitative Analysis

Content and thematic analysis,

Tech in Data Analytics

CRM, Big Data, social media, and AI in marketing research, Overview of Google Analytics, SurveyMonkey.

MODULE 4:	MARKETING STRATEGY AND PLANNING	6 Hours

Strategic Marketing Concepts

SWOT, PESTEL, and competitor analysis, Positioning strategies and crafting value propositions

Strategic Planning Across Channels Traditional vs. digital strategy development, Integrating offline and online marketing efforts		
MODULE 5:	**DIGITAL MARKETING MANAGEMENT & TECHNOLOGY INTEGRATION**	**6 Hours**
Digital Marketing Channels SEO, PPC, email marketing, social media, influencer marketing, Content marketing and customer engagement. **Marketing Technology Tools** Automation tools: CRM, email platforms, marketing software, Integration with e-commerce, ERP, smart tech, and IoT systems **AI & ML in Marketing** Personalized marketing, Predictive analytics and customer insights		
TOTAL LECTURES		**30 Hours**

Text Books:

1. "Marketing Management" by Philip Kotler, Kevin Lane Keller, Pearson
2. "Marketing Research: An Applied Orientation" by Naresh K. Malhotra, Pearson
3. "Consumer Behavior" by Leon G. Schiffman & Joseph Wisenblit, Pearson
4. "Digital Marketing" by Seema Gupta, McGraw Hill

Introduction to Innovation, IP Management & Entrepreneurship (TIU-UCBCS-T202)

Program: B. Tech. in CSBS	**Year, Semester:** 2nd Yr,4th Sem
Course Title: Introduction to Innovation, IP Management & Entrepreneurship	**Subject Code:** TIU-UCBCS-T202
Contact Hours/Week: 3–0–0 (L–T–P)	**Credit:** 3

COURSE OBJECTIVE :

Enable the student to:

1. Learn system through which Engineering/management students can enhance their innovation & creative thinking skills.
2. Acquaint themselves with the special challenges of starting new ventures.
3. Use of IPR as an effective tool to protect their innovations & intangible assets from exploitation.

COURSE OUTCOME :

The student will be able to:

CO-1:	Learnto be familiar with creative & innovative thinking styles.
CO-2:	Learn opportunity reorganization & entrepreneurship skills.
CO-3:	Learn to investigate, understand & internalize the process of founding a startup
CO-4:	Understand financial aspects of Entrepreneurship.
CO-5:	Learn to manage various types of IPR to protect competitive advantage.
CO-6:	Understand the types of IP

COURSE CONTENT :

MODULE 1:	**INNOVATION: WHAT & WHY?**	**6 Hours**
Innovation as a core business process, sources of Innovation, Knowledge push vs need pull innovations. Class Discussion: Is innovation manageable or just a random gambling activity?		
MODULE 2:	**BUILDING AN INNOVATIVE ORGANIZATION:**	**6 Hours**
Creating new products& services. Exploiting open innovation & collaboration. Use of innovation for starting a new venture. Class Discussion: Innovation: Co-operating across networks vs 'go-it-alone' approach.		
MODULE 3:	**ENTREPRENEURSHIP:**	**6 Hours**
Opportunity recognition & entry strategies, Entrepreneurship as a style of Management, Maintaining competitive advantage-Use of IPR to protect Innovation.		
MODULE 4:	**ENTREPRENEURSHIP-FINANCIAL PLANNING**:	**6 Hours**
Financial projections & Valuation, Stages of Financing, Debt, Venture Capital & Other forms of Financing.		
MODULE 5:	**INTELLECTUAL PROPERTY RIGHTS (IPR)**	**6 Hours**
Introduction & the economics behind development of IPR: Business Perspective, IPR in India-Genesis & Development. International Context. Concept of IP Management, Use in Marketing.		
MODULE 6:	**TYPES OF INTELLECTUAL PROPERTY:**	**6 Hours**
Ensemble Learning, - Bagging and Boosting - Random Forest - Meta learning - Deep Learning - Reinforcement Learning – Applications.		
TOTAL LECTURES		**36 Hours**

Text Books:

T1. Joe Tidd, John Bessant. Managing Innovation: Integrating Technological, Market & Organizational Change.

1. T2. Case Study Materials.

Design Thinking (TIU-UCBCS-S208)

Program: B. Tech. in CSBS	**Year, Semester:** 2nd Yr., 4th Sem
Course Title: Design Thinking	**Subject Code:**TIU-UCBCS-S208
Contact Hours/Week: 0–1–2 (L–T–P)	**Credit:** 2

COURSE OBJECTIVE:

Enable the student to:

- Recognize the importance of Design Thinking (DT) and explain the phases in the DT process
- List the steps required to complete each phase in DT process
- Apply each phase in the DT process
- Use doodling and storytelling in presenting ideas and prototypes
- Create value proposition statements as part of their presentations
- Recognize how Agile and DT complement each other to deliver customer satisfaction

COURSE OUTCOME:

The student will be able to:

CO-1:	Understand the five-step Design Thinking (DT) process and its importance in problem-solving.
CO-2:	Apply Design Thinking principles to analyze and define real-world problems effectively.
CO-3:	Utilize UX design principles to enhance the prototyping phase of the DT process.
CO-4:	Implement Agile project management techniques to structure and refine the Define phase in DT.
CO-5:	Develop teamwork and leadership skills through collaborative problem-solving in DT.
CO-6:	Evaluate and test prototypes created using the DT process to refine solutions based on user feedback.

COURSE CONTENT:

MODULE 1:	**Introduction to Design Thinking**	**7 Hours**
Importance of Design Thinking in business through real-world stories and examples. Personal relevance of Design Thinking through experiential reflection activities. Understanding the 5-step Stanford Model of Design Thinking. Introduction to empathy through interactive activity and discussion. Empathy development through observation and the Moccasin Walk activity. Immersion activity using flowcharts, handouts, and examples. Field immersion in groups across different campus locations for observation and insights.		
MODULE 2:	**Problem Identification**	**3 Hours**

Creation of user personas using videos and immersion data. Developing meaningful problem statements with case examples. Group activity to define, review, and validate problem statements		
MODULE 3:	**Matrix, array and basic mathematical functions**	**7 Hours**
Introduction to ideation using video-based insights and discussion. Engagement in ideation games such as Six Thinking Hats and Million-dollar Idea. Idea generation exercises based on identified problem statements. Doodling as a creative tool for ideation and early prototyping. Research and storytelling activity on successful applications of Design Thinking.		
MODULE 4:	**Prototyping and Testing**	**12 Hours**
Importance of prototyping with activity-based and video-supported learning. Hands-on group prototyping exercises based on prior ideation. Creation of value proposition statements using videos and discussions. Testing in Design Thinking explained through videos and real-life cases Prototype testing activity with feedback collection and iteration. Exploration of how Design Thinking enhances problem-solving in coding. Discussion on the synergy between Agile methodologies and Design Thinking. Course-wide reflection activity on key learnings and personal growth		
MODULE 5:	**Implementation**	**1 Hour**
Capstone group activity to develop a final prototype applying Design Thinking to a functional or real-world scenario		
TOTAL LECTURES		**30 Hours**

Text book:

1. **Brown, Tim** – *Change by Design: How Design Thinking Creates New Alternatives for Business and Society*, Harvard Business Press.
2. **Kelley, Tom & David Kelley** – *Creative Confidence: Unleashing the Creative Potential Within Us All*, Crown Publishing.
3. **Liedtka, Jeanne & Ogilvie, Tim** – *Designing for Growth: A Design Thinking Toolkit for Managers*, Columbia University Press.
4. **Plattner, Hasso, Meinel, Christoph & Leifer, Larry (eds.)** – *Design Thinking Research: Building Innovation Eco-Systems*, Springer.
5. **Gray, Dave; Brown, Sunni; Macanufo, James** – *Gamestorming: A Playbook for Innovators, Rulebreakers, and Changemakers*, O'Reilly Media.
6. **Dam, Rikke & Siang, Teo Yu** – *The Interaction Design Foundation's Design Thinking Handbook* (Free online resource at interaction-design.org).

Operations Research + Lab (TIU-UCBCS-C210)

Program: B. Tech. in CSBS	**Year, Semester:** 2nd Yr., 4th Sem.
Course Title: Operations Research + Lab	**Subject Code:** TIU-UCBCS-C210
Contact Hours/Week: 2–0–0 (L–T–P)	**Credit:** 3

COURSE OBJECTIVE :

Enable the student to:

1. understand the the importance and value of Operations Research in real life
2. formulate linear programming problem from verbal description, and finding solutions
3. understand the need of inventory management and choosing the appropriate queuing model for a given practical application

COURSE OUTCOME :

On completion of the course, the student will be able to:

CO-1:	To examine any real-life system with limited constraints and formulate them in linear programming form.	K4
CO-2:	To find the solution of linear programming problems using various methods.	K4
CO-3:	To solve both balanced , unbalanced transportation problems using various methods and determine solutions of a variety of problems mathematically such as assignment, travelling salesman etc.	K4
CO-4:	To analyze simple inventory models reflecting different inventory situations and examine them analytically.	K4
CO-5:	To formulate different queuing situations and generate the optimal solutions using models for different situations.	K4
CO-6:	To prepare idea of network models for service and manufacturing systems, and interpret these network problems using operations research techniques and algorithms.	K4

COURSE CONTENT :

MODULE 1:	**INTRODUCTION TO OR**	**4 Hours**
Definition - Origin of OR and its definition. Concept of optimizing performance measure, Types of OR problems, Deterministic vs. Stochastic optimization, Phases of OR problem approach – problem formulation, building mathematical model, deriving solutions, validating model, controlling and		

implementing solution.		
MODULE 2:	**LINEAR PROGRAMMING**	**7 Hours**
Examples from industrial cases, formulation & definitions, Matrix form. Implicit assumptions of LPP. Some basic concepts and results of linear algebra – Vectors, Matrices, Linear Independence/Dependence of vectors, Rank, Basis, System of linear eqns., Hyperplane, Convex set, Convex polyhedron, Extreme points, Basic feasible solutions. Geometric method: 2-variable case, Special cases – infeasibility, unboundedness, redundancy & degeneracy, Sensitivity analysis. Simplex Algorithm – slack, surplus & artificial variables, computational details, big-M method, identification and resolution of special cases through simplex iterations. Duality – formulation, results, fundamental theorem of duality, dual-simplex and primal-dual algorithms.		
MODULE 3:	**TRANSPORTATION AND ASSIGNMENT PROBLEM**	**6 Hours**
Examples, Definitions – decision variables, supply & demand constraints, formulation, Balanced & unbalanced situations, Solution methods – NWCR, minimum cost and VAM, test for optimality (MODI method), degeneracy and its resolution. AP - Examples, Definitions – decision variables, constraints, formulation, Balanced & unbalanced situations, Solution method – Hungarian, test for optimality (MODI method), degeneracy & its resolution.		
MODULE 4:	**PERT-CPM**	**4 Hours**
Project definition, Project scheduling techniques – Gantt chart, PERT & CPM, Determination of critical paths, Estimation of Project time and its variance in PERT using statistical principles, Concept Of project crashing/time-cost trade-off.		
MODULE 5:	**INVENTORY CONTROL**	**4 Hours**
Functions of inventory and its disadvantages, ABC analysis, Concept of inventory costs, Basics of inventory policy (order, lead time, types), Fixed order-quantity models – EOQ, POQ & Quantity discount models. EOQ models for discrete units, sensitivity analysis and Robustness, Special cases of EOQ models for safety stock with known/unknown stock out situations, models under prescribed policy, Probabilistic situations.		
MODULE 6:	**QUEUING THEORY AND SIMULATION METHODOLOGY**	**5 Hours**
Definitions – queue (waiting line), waiting costs, characteristics (arrival, queue, service discipline) of queuing system, queue types (channel vs. phase). Kendall's notation, Little's law, steady state behaviour, Poisson's Process & queue, Models with examples - M/M/1 and its performance measures; M/M/m and its performance measures; brief description about some special models. Queuing systems and Inventory systems.		
TOTAL LECTURES		**30 Hours**

Laboratory

MODULE 1:	**Introduction to Operations Research (OR)**	**5 Hours**
Formulation of OR Problems: Real-life scenario: e.g., resource allocation in a small manufacturing firm. Mathematical model construction. Application of each phase in the OR approach. **Deterministic vs. Stochastic Optimization:** Design of two simple models, Deterministic: e.g., transportation cost minimization with fixed demand. Stochastic: same problem with probabilistic demand. Comparative analysis.		
MODULE 2:	**Linear Programming**	**5 Hours**
Graphical Method for LP: Formulate and solve a 2-variable LP problem. Identify feasible region, optimal point. Discuss special cases (unbounded, infeasible, alternate optima). **Simplex Method:** Manual implementation of the Simplex algorithm. Verification using Python, MATLAB, or Excel Solver. **Sensitivity Analysis in LP:** Analyze the impact of changes in: Objective function coefficients. Right-hand side (RHS) values.		

Duality in Linear Programming: Solve the dual of a given LP problem. Interpret the economic significance of dual variables. **Artificial Variable Techniques:** Use Big-M method or Two-Phase method. Handle ≥ or = constraints.		
MODULE 3:	**Transportation and Assignment Problems**	**5 Hours**
Transportation Problem Solving: Initial solutions using: Northwest Corner Rule (NWCR). Vogel's Approximation Method (VAM). Optimization using MODI method. Discussion on degeneracy and unbalanced cases. **Assignment Problem Solving:** Program or Excel model implementation using the Hungarian method. Solutions for both balanced and unbalanced cases. **Optimality and Degeneracy in Transportation:** Test optimality using MODI method. Resolve degeneracy in transportation tables.		
MODULE 4:	**Project Management Using PERT & CPM**	**6 Hours**
Critical Path Method (CPM): Draw network diagram with given activities and dependencies. Identify the critical path. **Program Evaluation and Review Technique (PERT):** Compute: Expected time. Variance. Probability of completion within deadline. Time-cost trade-off analysis and crashing.		
MODULE 5:	**Inventory Control**	**5 Hours**
EOQ and Inventory Models: Develop Economic Order Quantity (EOQ) model. Perform sensitivity analysis on: Ordering cost. Holding cost. Compare: EOQ. Production Order Quantity (POQ). Quantity discount models. **Inventory Simulation with Uncertainty:** Simulate inventory systems (e.g., newspaper vendor problem). Analyze safety stock for different service levels. Consider probabilistic demand and lead times.		
MODULE 6:	**Queuing Theory and Simulation Methodology**	**4 Hours**
Simulation of M/M/1 Queuing System: Implement simulation using spreadsheet or programming. Calculate: Average queue length, Average waiting time, System utilization.		
TOTAL PRACTICAL		**30 Hours**

Books:

2. Linear Programming and Game Theory by Ghosh and Chakraborty
3. Operations Research: An Introduction by Hamdy A. Taha
4. Operations Research: Theory and Applications by J K Sharma
5. Operations Research by S D Sharma
6. Operations Research by Kanti Swarup

Essence of Indian Traditional Knowledge (TIU-UCBCS-T206)

Program: B. Tech. in CSBS	**Year, Semester:** 2nd Yr., 4th Sem.

Course Title: Essence of Indian Traditional Knowledge	**Subject Code:** TIU-UCBCS-T206
Contact Hours/Week: 2–0–0 (L–T–P)	**Credit: 0**

COURSE OBJECTIVE :

Enable the student to:

- To provide students with a broad understanding of the philosophical foundations, scientific approaches, and cultural continuity of Indian knowledge systems.
- To develop an appreciation for traditional knowledge in fields like Ayurveda, mathematics, architecture, ecology, arts, and governance.
- To inspire learners to relate classical wisdom to contemporary societal, ecological, and ethical challenges

COURSE OUTCOME :

The student will be able to:

CO-1:	Recognize the core principles of Indian knowledge systems and their historical evolution.
CO-2:	Identify contributions of ancient Indian scientists, scholars, and technologists.
CO-3:	Describe traditional systems like Ayurveda, Yoga, Sanskrit grammar, Vastu, and classical arts.
CO-4:	Analyze the relevance of Indian ethical frameworks in contemporary socio-politicalsettings.
CO-5:	Evaluate India's traditional environmental and ecological wisdom.
CO-6:	Appreciate the interdisciplinary and holistic worldview of Bharatiya knowledge traditions.

COURSE CONTENT :

MODULE 1:	**INTRODUCTION TO INDIAN KNOWLEDGE SYSTEMS (IKS)**	8 **Hours**
Definition and scope of IKS; Civilizational continuity, Six systems of Indian Philosophy (Darshanas), Contributions of Vedas, Upanishads, and other classical texts, Concept of holistic knowledge and integration of disciplines, Introduction to traditional education systems: Gurukula, Tols, Pathshalas		
MODULE 2:	**SCIENCE, TECHNOLOGY, AND FINE ARTS IN IKS**	8 **Hours**
Indian contributions to mathematics (Baudhayana, Aryabhata, Bhaskara, etc.), Ayurveda: principles, diagnosis, and wellness approach, Ancient astronomy, metallurgy, water harvesting techniques, Traditional Indian architecture (Vastu Shastra), sculpture, and performing arts (Natya Shastra, classical dance, and music), Sanskrit grammar and language sciences		
MODULE 3:	**SOCIETY, POLITY AND ETHICS IN IKS**	**7 Hours**
Indian concepts of Dharma, Karma, and social order Chanakya's Arthashastra: governance and administration Ethical texts: Manusmriti, Tirukkural, Bhagavad Gita (selected ideas) Status and role of women in ancient India Caste system: origin and evolution; perspectives from IKS		
MODULE 4:	**ECOLOGY, SUSTAINABILITY, AND RELEVANCE TODAY**	**7 Hours**
TOTAL LECTURES		**30 Hours**

Text Books:

T1: Indian Knowledge System – An Introduction Author: Kapil Kapoor & Michel Danino Publisher: PHISPC, Centre for Studies in Civilizations Description: A comprehensive introduction to the Indian Knowledge Systems, covering philosophy, science, arts, language, and social thought.

T2: Foundations of Indian Culture Author: Sri Aurobindo Publisher: Sri Aurobindo Ashram Description: Explores India's cultural foundations through its philosophy, spirituality, and education systems.

T3. The Beautiful Tree: Indigenous Indian Education in the Eighteenth Century Author: Dharampal Publisher: Other India Press Description: A historical account based on British surveys highlighting India's pre-colonial education system.

T4. Bharatiya Vidya: Indigenous Knowledge Systems and the Indian Perspective Author: Rekha Pande & V. S. Jaya Kumar Publisher: Centre for Indian Knowledge Systems (CIKS) Description: Discusses Indian systems of health, ecology, architecture, and their relevance to modern sustainability.

T5. Introduction to Indian Knowledge System: Concepts and Applications Authors: B. Mahadevan, M. D. Srinivas, H. R. Nagendra Publisher: PHI Learning Pvt. Ltd. Description: This AICTE-recommended text bridges traditional Indian knowledge with applications in modern education and engineering.

SEMESTER 5

Software Design with UML + LAB(TIU-UCSBS-C307)

Program: B. Tech. in CSBS	**Year, Semester:** 3rd Year, 5th Semester
Course Title: Software Design with UML + LAB	**Subject Code:** TIU-UCSBS-C307
Contact Hours/Week: 2–0–2 (L–T–P)	**Credit:** 3

COURSE OBJECTIVE

1. To develop basic Knowledge in Software Engineering and its applications.
2. To understand software Engineering layered architecture and the process frame work.
3. To analyze software process models such as the waterfall, spiral, evolutionary models and agile method for software development.
4. To design software requirements and specifications of documents.
5. To understand project planning, scheduling, cost estimation, risk management.
6. To describe data models, object models, context models and behavioral models.
7. To learn coding style and testing issues.
8. To know about the quality checking mechanism for software process and product.

COURSE OUTCOME

CO1	Describe the purpose, history, and benefits of using UML in software design.
CO2	Develop the ability to create and interpret key UML diagrams.
CO3	Apply object-oriented principles, such as encapsulation, inheritance, and polymorphism, to software design using UML.
CO4	Construct system architecture diagrams to outline how software components interact and are deployed in a real-world environment.
CO5	Apply UML effectively in agile and iterative development contexts.
CO6	Use UML as a communication tool within a development team to convey design choices and project changes effectively.

COURSE CONTENT

Module No.	Module	Lecture Hours
1	Introduction to on Object Oriented Technologies and the UML Method. Software development process: The Waterfall Model vs. The Spiral Model. The Software Crisis, description of the real world using the Objects Model. Classes, inheritance and multiple configurations. Quality software characteristics. Description of the Object Oriented Analysis process vs. the Structure Analysis Model. Standards. Elements of the language. General description of various models. The process of Object Oriented software development. Description of Design Patterns. Technological Description of Distributed Systems.	12
2	Requirements Analysis Using Case Modeling Analysis of system requirements. Actor definitions. Writing a case goal. Use Case Diagrams. Use Case Relationships. The Logical View Design Stage: The Static Structure Diagrams. The Class Diagram Model. Attributes descriptions. Operations descriptions. Connections descriptions in the Static Model. Association, Generalization, Aggregation, Dependency, Interfacing, Multiplicity.	9
3	Transfer from Analysis to Design in the Characterization Stage: Interaction Diagrams. Description of goal. Defining UML Method, Operation, Object Interface, Class. Sequence Diagram. Finding objects from Flow of Events. Describing the process of finding objects using a Sequence Diagram. Describing the process of finding objects using a Collaboration Diagram.	10
4	Package Diagram Model. Description of the model. White box, black box. Connections between packagers. Interfaces. Create Package Diagram. Drill Down. Dynamic Model: State Diagram / Activity Diagram. Description of the State Diagram. Events Handling. Description of the Activity Diagram. Exercise in State Machines.	10
5	Component Diagram Model. Physical Aspect. Logical Aspect. Connections and Dependencies. User face. Initial DB design in a UML environment. Deployment Model. Processors. Connections. Components. Tasks. Threads. Signals and Events.	4
Total		**45**

Laboratory

MODULE 1:	Use Case Diagrams	3 Hours
Draw a Use Case Diagram for an **Online Food Ordering System**, identifying actors, use cases, and relationships. Develop a Use Case Diagram for a **Social Media Platform (e.g., Facebook)**, showing interactions between users, posts, and messages. Model a Use Case Diagram and Sequence Diagram for a **Flight Booking System**.		
MODULE 2:	**Class and Sequence Diagrams**	**4 Hours**
Create a Class Diagram and Sequence Diagram for an **IoT-based Smart Home Automation System**. Create a Class Diagram for an **Online Examination System**, including students, questions, and evaluation criteria. Create a Class Diagram for a **University Management System**, including student, faculty, and course relationships. (Repeated) Create a Class Diagram and Sequence Diagram for an **IoT-based Smart Home Automation System**. Construct a Class Diagram and Object Diagram for a **Library Management System**, showing relationships between books, students, and librarians.		
MODULE 3:	**Sequence Diagrams**	**3 Hours**
Design a Sequence Diagram for an **E-Wallet Transaction**, showing interactions between user, payment gateway, and bank. Design a Sequence Diagram for a **Banking System Login**, showing interactions between the user, login system, and database.		
MODULE 4:	**Activity Diagrams**	**2 Hours**
Develop an Activity Diagram for a **Railway Reservation System**, depicting the process from ticket booking to confirmation.		
MODULE 5:	**State Transition Diagrams**	**3 Hours**
Model a State Transition Diagram for an Order Processing System, showing states like order placed, processed, shipped, and delivered. \Construct a State Transition Diagram for an ATM Machine, representing states like idle, card validation, transaction, and cash withdrawal.		
MODULE 6:	**Component Diagrams**	**3 Hours**
Illustrate the organization and dependencies among software components. Design a Component Diagram for an E-Commerce Application, showing modules like user authentication, payment, and inventory.		
MODULE 7:	**Interaction Overview Diagrams**	**3 Hours**
Combine activity and sequence diagram elements to show control flow with message interactions. Create an Interaction Overview Diagram for an Online Shopping Cart system.		
MODULE 8:	**Deployment Diagrams**	**3 Hours**
Depict hardware architecture and deployment of software components. Create a Deployment Diagram for a Hospital Management System, illustrating software and hardware architecture.		
MODULE 9:	**Collaboration Diagrams**	**3 Hours**
Develop a Collaboration Diagram for a Hotel Booking System, showing message exchanges between objects. 19. Construct a Collaboration Diagram and Activity Diagram for an Online Banking System handling fund transfers.		

MODULE 10:	Composite Structure and Package Diagrams	3 Hours
Develop a Composite Structure Diagram for a Real-Time Chat Application, illustrating internal object collaboration. 21. Make a Composite Structure Diagram and Package Diagram for a Large-Scale ERP System.		
TOTAL PRACTICAL		**30 Hours**

Text Books

1. Roger S Pressman, Software Engineering-A Practitioners Approach, McGraw Hill Publications.
2. Pankaj Jalote, An Integrated Approach to Software Engineering, BPB Publications

Reference Books

1. Rajib Mall, Fundamentals of Software Engineering, PHI Learning Private Limited
2. Software Engineering, Ian Sommerville

Compiler Design+ Lab (LEX & YACC) (TIU-UCBCS-C303)

Program: B. Tech. in CSBS	**Year, Semester:** 3rd Yr., 5th Sem
Course Title: Compiler Design+ Lab (LEX & YACC) **Contact Hours/Week**: 3–1–2 (L–T–P)	**Subject Code:**TIU-UCBCS-C303 **Credit:** 5

COURSE OBJECTIVE:

1. To make the student aware about the basic concepts, i.e. different phases such as lexical analysis, syntax analysis, semantic analysis and code generation of compiler.
2. The students should know the different functionalities of compiler.
3. To make the students aware about the possible errors that can occur at different phases and how they can be addressed.
4. Make the students aware about the tools LEX and YACC.

COURSE OUTCOME:

The students will be able to:

CO-1:	Understand fundamentals of language parser and identify the relationships among different phases of compiler
CO-2:	Illustrate the use of different types of parsers and their constructions, production rules and language semantics
CO-3:	Inherited and synthesized attributes with their evaluations, run time storage Allocation

CO-4:	Describe techniques for intermediate code generation and code optimization
CO-5:	Analyze error detection and recovery techniques in different compiler phases.
CO-6:	Implement and evaluate code generation techniques for efficiency.

COURSE CONTENT:

MODULE 1:	**Compiler Structure**	**3 Hours**
Analysis-synthesis model of compilation, various phases of a compiler, tool-based approach to compiler construction.		
MODULE 2:	**Lexical Analysis**	**6 Hours**
Interface with input, parser and symbol table, token, lexeme and patterns, difficulties in lexical analysis, error reporting, and implementation. Regular definition, Transition diagrams, LEX		
MODULE 3:	**Syntax analysis**	**21 Hours**
Context free grammar, ambiguity, associativity, precedence, top-down parsing, recursive descent parsing, transformation on the grammars, predictive parsing, Bottom-up parsing, operator precedence grammars, LR parsers (SLR, LALR, LR), YACC.		
MODULE 4:	**Syntax directed definitions**	**3 Hours**
Inherited and synthesized attributes, dependency graph, evaluation order, bottom up and top-down evaluation of attributes, L- and S-attributed definitions.		
Module-5:	**Type checking**	**2 Hours**
Type system, type expressions, structural and name equivalence of types, type conversion, overloaded functions and operators, polymorphic functions.		
Module-6:	**Run time system**	**2 Hours**
Storage organization, activation tree, activation record, parameter passing, Symbol table, dynamic storage allocation. Intermediate code generation: Intermediate representations, translation of declarations, assignments Intermediate Code generation for control flow, Boolean expressions and procedure calls, implementation issues.		
Module-7:	**Code generation and instruction selection**	**6 Hours**
Issues, basic blocks and flow graphs, register allocation, code generation DAG representation of programs, code generation from DAGs, peep-hole optimization, code generator generators, specifications of machine		
Module-8:	**Code optimization**	**5 Hours**
Source of optimizations, and optimization of basic blocks, loops, global dataflow analysis, and solution to iterative data flow equations. Code improving transformations, dealing with aliases, data flow analysis of structured flow graphs.		
		Total Lecture: 48 Hours

Laboratory

MODULE-1:	Module 1: (Environment Setup and Basics of Lexical Analysis)	6 Hours
Installation and configuration of LEX and YACC in Linux Operating System. LEX Program to check whether the given input is: Integer, Float, Alphabet, Other than alphabet LEX Program to find the number of vowels and consonants in a string. LEX Program to implement a basic lexical analyzer with output.		
MODULE-2:	**Module 2: (Token Identification and String Analysis)**	**6 Hours**
LEX Program to print all factors of a user-given number. LEX Program to check if a number is perfect. LEX Program to check if the input is a valid keyword. LEX Program to check if the phone number is valid. LEX Program to calculate the length of the longest string from a sentence. LEX Program to count total number of keywords in a string. LEX Program to identify the type of operator from user input. LEX Program to detect any character apart from alphabets in a string. LEX Program to check whether input is a digit or not. LEX Program to check for the substring "bb" in a string. LEX Program to count the number of tokens.		
MODULE-3:	**Module 3: (String/File Handling and Data Transformation)**	**6 Hours**
LEX Program to convert decimal number to binary. LEX Program to implement calculator functionality. LEX Program to check whether a given string or number is palindrome. LEX Program to check whether a number is an Armstrong number. LEX Program to calculate the sum of digits of a number. LEX Program to calculate factorial of a number. LEX Program to print the multiplication table of a number. LEX Program to identify/count positive and negative numbers. LEX Program to check whether a number is prime. LEX Program to check if a string starts with a vowel. LEX Program to check if input matches any predefined numeric words. LEX Program to count number of words, spaces, and lines in a file. LEX Program to convert lowercase to uppercase and reverse. LEX Program to accept string starting with a vowel or not. LEX Program to replace word "A" with "Best" in a file and store it in another file.		
MODULE-4:	**Module 4: (Introduction to Syntax Analysis using YACC)**	**6 Hours**
LEX Program to implement a lexical analyzer. YACC Program to implement a calculator. YACC Program to evaluate an arithmetic expression. YACC Program to check the syntax of a FOR loop.		
MODULE-5:	**Module 5: (Parser Design and Grammar Implementation)**	**6 Hours**
YACC Program to implement an LL(1) parser. YACC Program to implement an SLR parser. YACC Program for binary to decimal conversion (with LEX). YACC Program to recognize strings of the form $\{ a^n b^n \mid n \geq 0 \}$. Design of a user-defined language: Generate lexical and syntactic rules. Implement corresponding lexical analyzer and parser.		

TOTAL PRACTICAL	**30 Hours**

Recommended Books:

Main Reading

1. Aho, Ullman,Sethi and Lam, Principles of Compiler Design, Pearson Education
2. Holub, Compiler Design in C, PHI

Supplementary Reading

1. Andrew L. Appel,Modern Compiler Implementation in C, Foundation Books, Delhi
2. Dick Gruneet. Al., Modern Compiler Design, Wiley Dreamtech
3. S. Chattopadhyay, Compiler Design, PHI
4. S. Pal: Systems Programming, Oxford University Press

Fundamentals of Management (TIU-UCBMG-T301)

Program: B. Tech. in CSBS	**Year, Semester:** 3rd Yr., 5th Sem.
Course Title: Fundamentals of Management	**Subject Code:** TIU-UCBMG-T301
Contact Hours/Week: 2–0–0 (L–T–P)	**Credit:** 2

COURSE OBJECTIVE :

Enable the student to:

- To provide students with an understanding of the basic concepts, principles, and functions of management.
- To enable students to analyze the roles and responsibilities of managers in different organizational settings.
- To develop the ability to apply management theories to real-world business situations.
- To foster critical thinking and decision-making skills required for effective management in a dynamic environment.

COURSE OUTCOME :

The student will be able to:

CO-1:	Describe the key functions of management such as planning, organizing, leading, and controlling.
CO-2:	Explain the evolution and significance of management theories and practices.
CO-3:	Analyze various organizational structures and evaluate their effectiveness in different contexts.
CO-4:	Apply strategic and operational planning techniques in solving managerial problems.
CO-5:	Demonstrate leadership and communication skills necessary for team management and conflict resolution.
CO-6:	Assess the impact of external and internal environmental factors on managerial decision-making.

COURSE CONTENT :

MODULE 1:	**INTRODUCTION TO MANAGEMENT**	**6 Hours**
Definition, nature, and scope of management. Levels and roles of managers. Managerial skills: technical, human, and conceptual. Functions of management: Planning, Organizing, Leading, Controlling. Contemporary perspectives on management: Systems theory, Contingency theory. Management in the digital age: agility, innovation, and responsiveness.		
MODULE 2:	**EVOLUTION OF MANAGEMENT THOUGHT**	**4 Hours**
Classical approaches: Scientific management, Administrative theory, Bureaucratic management Behavioral approaches: Human relations movement, Behavioral science approach Quantitative approaches: Management science and operations research Modern approaches: Total Quality Management (TQM), Six Sigma, and Lean Thinking Emergence of agile and design thinking frameworks in managerial practices		
MODULE 3:	**PLANNING AND DECISION-MAKING**	**6 Hours**
Meaning, types, and importance of planning Strategic, tactical, and operational planning Tools for effective planning: SWOT analysis, SMART goals Decision-making process and types of decisions Contemporary frameworks: VUCA framework for decision-making in uncertain environments Introduction to OKRs (Objectives and Key Results)		
MODULE 4:	**ORGANIZING AND LEADING**	**8 Hours**
Principles of organizing and organizational structure Types of organizational structures: Functional, Divisional, Matrix, Network Delegation of authority and decentralization Leadership vs. management Leadership theories: Trait theory, Behavioral theories, Situational approaches Modern leadership frameworks: Transformational leadership, Servant leadership, and Emotional Intelligence (EI) Team dynamics and high-performance teams		
MODULE 5:	**Controlling and Modern Management Challenges**	**6 Hours**
Meaning and process of control in management Types of control: feedforward, concurrent, and feedback Tools of control: budgets, performance standards, KPIs Managing change and innovation Corporate governance and ethical management practices Contemporary topics: Sustainability, Diversity & Inclusion, and ESG (Environmental, Social, Governance) Frameworks Role of technology and data analytics in managerial control		
TOTAL LECTURES		**30 Hours**

Text Books:

1. Stephen P. Robbins and Mary Coulter, Management, 14th Edition, Pearson Education.

2. Koontz, Harold and Heinz Weihrich, Essentials of Management, 10th Edition, McGraw-Hill Education.

3. Richard L. Daft, Management, 13th Edition, Cengage Learning.

4. James A. F. Stoner, R. Edward Freeman, and Daniel R. Gilbert Jr., Management, 6th Edition, Pearson Education.

5. Ricky W. Griffin, Management Principles and Practices, 12th Edition, Cengage Learning.

Business Strategy (TIU-UCBMG-T303)

Program: B. Tech. in CSBS	**Year, Semester: 3**rd Yr., 5th Sem.
Course Title: Business Strategy	**Subject Code:** TIU-UCBMG-T303
Contact Hours/Week: 2–0–0 (L–T–P)	**Credit:** 2

COURSE OBJECTIVE :

Enable the student to:

- To develop an understanding of strategic management principles, models, and frameworks.
- To enable students to analyze internal and external business environments for strategic decision-making.
- To equip students with the skills to formulate and implement effective business strategies across various industries.
- To foster critical thinking and ethical considerations in addressing complex strategic challenges in a dynamic global environment.

COURSE OUTCOME :

The student will be able to:

CO-1:	Explain the fundamentals of strategic management and its role in business success.
CO-2:	Analyze the external environment using tools such as PESTEL and Porter's Five Forces.
CO-3:	Conduct internal analysis using frameworks like VRIO, Value Chain, and SWOT.
CO-4:	Formulate business-level, corporate-level, and global strategies for organizations.
CO-5:	Evaluate strategy implementation processes, including structure, culture, and leadership alignment.
CO-6:	Apply strategic thinking to contemporary issues such as innovation, sustainability, and digital transformation.

COURSE CONTENT :

MODULE 1:	**INTRODUCTION TO STRATEGIC MANAGEMENT**	**6 Hours**
Concept and importance of strategy in business. Levels of strategy: corporate, business, and functional. Strategic management process and decision-making hierarchy. Vision, mission, goals, and objectives Strategic fit and competitive advantage. Overview of strategic intent and stakeholder analysis		
MODULE 2:	**EXTERNAL ENVIRONMENT ANALYSIS.**	**6 Hours**
General environment analysis using PESTEL framework. Industry environment analysis using Porter's Five Forces. Competitor analysis and strategic group mapping. Identifying key success factors in an industry. Opportunities and threats in a dynamic global context. Application of scenario planning and environmental scanning.		
MODULE 3:	**INTERNAL ENVIRONMENT AND RESOURCE-BASED VIEW**	**6 Hours**
Internal analysis of firm capabilities and resources VRIO framework and core competencies Value Chain Analysis for identifying value-creating activities SWOT analysis: integrating internal and external perspectives Organizational culture, structure, and leadership influence Dynamic capabilities and strategic flexibility		

MODULE 4:	STRATEGY FORMULATION	6 Hours
Business-level strategies: cost leadership, differentiation, focus. Corporate-level strategies: growth, stability, retrenchment, diversification. Global and international strategies: multi-domestic, transnational, global standardization. Blue Ocean Strategy and innovation-based strategic thinking. Mergers, acquisitions, strategic alliances, and joint ventures. Ethical considerations and sustainability in strategic choices.		
MODULE 5:	**Strategy Implementation and Evaluation**	**6 Hours**
Strategic implementation: structure, systems, and culture alignment. Role of leadership, communication, and change management. Balanced Scorecard and KPIs for strategy monitoring. Strategic control and evaluation techniques. Challenges in strategy execution and turnaround strategies. Digital transformation and strategic agility in modern organizations.		
TOTAL LECTURES		**30 Hours**

Text Books:

1. Hitt, Ireland, and Hoskisson, Strategic Management: Competitiveness and Globalization, Cengage Learning.
2. Michael A. Hitt, R. Duane Ireland, Robert E. Hoskisson, Strategic Management: Concepts and Cases, Cengage Learning.
3. Fred R. David and Forest R. David, Strategic Management: A Competitive Advantage Approach, Concepts and Cases, Pearson Education.
4. Wheelen, Thomas L. and Hunger, J. David, Strategic Management and Business Policy: Globalization, Innovation and Sustainability, Pearson Education.
5. Johnson, Scholes, and Whittington, Exploring Strategy: Text and Cases, Pearson Education.

Business Communication and Value Science-III (TIU-UCBEN-T301)

Program: Btech in CSBS	**Year, Semester:** 3rd Yr., 5th Sem.
Course Title: Business Communication and Value Science-III	**Subject Code:** TIU-UCBEN-T301
Contact Hours/Week: 2–0–0 (L–T–P)	**Credit:** 2

COURSE OBJECTIVE :

Enable the student to:

1. Develop advanced business communication skills, including technical writing and public speaking.
2. Understand value science and its application in business and technology.
3. Explore ethical decision-making and responsible leadership in a corporate setting.

COURSE OUTCOME :

On completion of the course, the student will be able to:

CO-1:	Apply advanced business communication techniques, including verbal, non-verbal, and written communication

CO-2:	Demonstrate technical writing and professional correspondence in various business contexts
CO-3:	Evaluate ethical decision-making models and corporate social responsibility in business practices
CO-4:	Develop teamwork and leadership skills through personality analysis
CO-5:	Assess cross-cultural communication and leadership effectiveness in global business environments
CO-6:	Create and present business communication projects that integrate ethical and value-based strategies..

COURSE CONTENT :

MODULE 1:	**Fundamentals of Business Communication**	**5 Hours**
Role of communication in organizational success and stakeholder engagement. Types of communication: Verbal, non-verbal, written, and digital. Barriers to effective communication and overcoming them.		
MODULE 2:	**Technical Writing and Professional Correspondence**	**5 Hours**
Writing professional emails, reports, and proposals. Research and documentation for business and technology. Structuring business correspondence for clarity and impact.		
MODULE 3:	**Presentation and Public Speaking Skills**	**5 Hours**
Structuring presentations: introduction, body, conclusion, and Q&A. Storytelling techniques and use of visuals in presentations. Techniques for public speaking, voice modulation, and audience engagement.		
MODULE 4:	**Value Science in Business and Technology**	**5 Hours**
Introduction to value science and decision-making. Ethical business practices and corporate social responsibility. Impact of technology on business ethics and stakeholder engagement.		
MODULE 5:	**Cross-Cultural Communication and Leadership**	**5 Hours**
Understanding cultural pluralism and communication strategies. The role of culture in leadership and decision-making. Avoiding common mistakes in cross-cultural business environments.		
MODULE 6:	**Value-Based Leadership and Organizational Effectiveness**	**5 Hours**
Leadership models and values-driven decision-making. Creating an ethical and accountable corporate culture. Measuring business success through value-based performance metrics.		
TOTAL LECTURES		**30 Hours**

Books:

1. Edward de Bono, *Six Thinking Hats*, Back Bay Books, ISBN: 978-0316178310.
2. Richard E. Mayer, *Multimedia Learning*, Cambridge University Press, ISBN: 978-1107574996.
3. Simon Sinek, *Leaders Eat Last: Why Some Teams Pull Together and Others Don't*, Portfolio, ISBN: 978-1591848011.
4. Geert Hofstede, *Cultures and Organizations: Software of the Mind*, McGraw-Hill, ISBN: 978-0071664189.
5. Robert L. Heath, *Handbook of Public Relations*, SAGE Publications, ISBN: 978-1412977807.

Conversational Systems (Elective -I) + Lab (TIU-UCBCS-C355)

Program: B. Tech. in CSBS	**Year, Semester:** 3rd Yr., 5th Sem.
Course Title: Conversational Systems (Elective -I) + Lab	**Subject Code:** TIU-UCBCS-C355
Contact Hours/Week: 3–0–2 (L–T–P)	**Credit:** 4

COURSE OBJECTIVE:

Enable the student to:

Understand the evolution, types, and applications of conversational systems across industries.

Learn and apply natural language processing techniques essential for building conversational agents.

Design and evaluate chatbots and voice assistants using modern platforms and architectures tailored for real-world business systems.

COURSE OUTCOME:

The student will be able to:

CO-1:	**Explain** the core concepts, types, and use cases of conversational systems.
CO-2:	**Apply** NLP techniques like tokenization, POS tagging, and intent recognition to understand user inputs.
CO-3:	**Analyze** and compare different dialogue architectures including rule-based, statistical, and neural models.
CO-4:	**Design and implement** conversational agents using tools like Dialog Flow, Rasa, or IBM Watson Assistant.
CO-5:	**Integrate** conversational agents with business platforms (e.g., CRM, ERP) while considering privacy and ethical aspects.
CO-6:	**Evaluate** conversational systems using appropriate metrics and explore emerging trends like emotion-aware and multimodal agents.

COURSE CONTENT :

MODULE 1:	INTRODUCTION TO CONVERSATIONAL SYSTEMS	5 Hours

History and evolution of conversational agents
Rule-based vs statistical vs neural dialogue systems
Types of conversational systems:
Chatbots
Voice assistants (e.g., Alexa, Siri)
Virtual agents
Applications in Business, Healthcare, E-commerce, and Education

Activities:

Case study: ChatGPT, Alexa, and customer service bots
Demo session of real conversational agents

MODULE 2:	NATURAL LANGUAGE PROCESSING (NLP) FUNDAMENTALS	8 Hours

Ext preprocessing: Tokenization, Lemmatization, Stopword removal

POS tagging, Named Entity Recognition (NER)
Word embeddings: Word2Vec, GloVe, BERT
Introduction to Language Models
Intent Recognition and Entity Extraction

MODULE 3:	DIALOGUE MANAGEMENT & ARCHITECTURES	8 Hours

Dialogue system architecture:

NLU (Natural Language Understanding)
Dialogue Manager (State tracking, policy learning)
NLG (Natural Language Generation)

Rule-based dialogue management

Statistical approaches (dialogue state tracking)

Reinforcement learning in dialogue systems

MODULE 4:	BUILDING CHATBOTS AND VOICE ASSISTANTS	8 Hours

Platforms: Google Dialogflow, Rasa, IBM Watson Assistant

Designing conversation flows

Integrating NLP and APIs

Handling intents, contexts, and fallback

Voice-based systems and ASR (Automatic Speech Recognition)

MODULE 5:	CONVERSATIONAL AI IN BUSINESS SYSTEMS	8 Hours

Business use cases: Customer support, lead generation, HR bots, etc. KPIs for conversational systems Integration with CRM, ERP, and other enterprise systems Ethics, privacy, and bias in conversational AI		
MODULE 6:	**EVALUATION, TRENDS, AND FUTURE OF CONVERSATIONAL AI**	**8 Hours**
Evaluation metrics: Precision, Recall, F1, BLEU, Dialog Success Rate Human-in-the-loop systems Trends: Multimodal agents, Emotion detection, Large Language Models Open challenges and research directions		
TOTAL LECTURES		**45 Hours**

Text Books:

1. **"Speech and Language Processing"**, Daniel Jurafsky and James H. Martin, 3rd Edition , Pearson
2. **"Designing Bots: Creating Conversational Experiences"**, Amir Shevat, O'Reilly Medi
3. **"Natural Language Processing with Python: Analyzing Text with the Natural Language Toolkit"**, Steven Bird, Ewan Klein, and Edward Loper, O'Reilly Media
4. **"Build Better Chatbots: A Complete Guide to Getting Started with Chatbots"**, Rashid Khan and Anik Das, Apress

Cloud Microservies and Applications (Elective -I) + Lab (TIU-UCBCS-C353)

Program: B. Tech. in CSBS	**Year, Semester:** 3rd Yr., 5th Sem.
Course Title: Cloud Microservies and Applications (Elective -I) + Lab	**Subject Code:** TIU-UCBCS-C353
Contact Hours/Week: 3–0–2 (L–T–P)	**Credit:** 4

COURSE OBJECTIVE :

Enable the student to:

1. Understand fundamental concepts of Cloud Computing and Microservices architectures.
2. Design scalable, reliable, and deployable microservice applications on cloud platforms.
3. Explore DevOps practices and containerization using Docker and Kubernetes.
4. Implement and evaluate cloud-native applications integrating databases, APIs, and security.

COURSE OUTCOME :

The student will be able to:

CO-1:	Explain the core concepts of cloud computing models and services (IaaS, PaaS, SaaS).
CO-2:	Describe and differentiate between monolithic and microservice architectures.
CO-3:	Design microservices using best practices with RESTful APIs and service discovery.
CO-4:	Deploy microservices using Docker containers and orchestrate them via Kubernetes.
CO-5:	Integrate cloud-based services (e.g., Firebase, AWS Lambda) into applications.
CO-6:	Evaluate cloud applications in terms of scalability, fault tolerance, and cost-efficiency.

COURSE CONTENT

Theory		
MODULE 1:	**INTRODUCTION TO CLOUD COMPUTING**	**5 Hours**
Definition, Characteristics of Cloud Computing, Cloud Models: IaaS, PaaS, SaaS, Public, Private, Hybrid Cloud Benefits and Challenges of Cloud Virtualization: VMs, Containers, Hypervisors		
MODULE 2:	**MICROSERVICES ARCHITECTURE FUNDAMENTALS**	**9 Hours**
Monolithic vs Microservice architecture Principles of microservices: Loose coupling, bounded context RESTful API design, Service discovery, Interservice communication (HTTP/gRPC, Message queues) Database per service pattern		
MODULE 3:	**DESIGNING AND DEVELOPING MICROSERVICES**	8 **Hours**
Microservice decomposition strategies Designing APIs with Swagger/OpenAPI Security in Microservices: OAuth2, JWT API Gateway patterns, Circuit Breaker, Retry, Timeout		
MODULE 4:	**DEPLOYMENT USING DOCKER AND KUBERNETES**	**6 Hours**
Introduction to Docker: Images, Containers, Volumes, Networks Writing Dockerfiles, Multi-container apps (docker-compose) Kubernetes: Pods, Services, Deployments, ReplicaSets Orchestration and Scaling		
MODULE 5:	**CLOUD APPLICATIONS AND SERVICES INTEGRATION**	**9 Hours**
Cloud Services: Firebase, AWS Lambda, Google Cloud Functions Cloud Databases (Firestore, DynamoDB, MongoDB Atlas) Serverless computing and event-driven architecture CI/CD pipelines for microservices (GitHub Actions, Jenkins)		
MODULE 6:	**OBSERVABILITY, PERFORMANCE AND COST MANAGEMENT**	**8 Hours**
Logging, Monitoring (Prometheus, Grafana), Tracing Autoscaling, Load Balancing, Fault Tolerance Billing models and cost optimization techniques Trends: Service Mesh (Istio), Cloud Native Buildpacks, Edge Computing		
TOTAL LECTURES		**45 Hours**

Laboratory		
MODULE 1:	**INTRODUCTION TO CLOUD & VIRTUALIZATION**	6 **Hours**
Exp 1: Explore virtualization and create VMs and containers using VirtualBox and Docker Desktop		
MODULE 2:	**MICROSERVICE DESIGN AND APIs**	6 **Hours**
Exp 2: Develop and test RESTful APIs using Flask/FastAPI Exp 3: Service registration and discovery simulation using Consul/Eureka		
MODULE 3:	**SECURITY AND API GATEWAYS**	**6Hours**
Exp 4: Implement OAuth2 and JWT authentication Exp 5: Configure API Gateway and rate limiting		
MODULE 4:	**DOCKER & KUBERNETES PRACTICALS**	**6 Hours**
Exp 6: Containerize a microservice application using Docker Exp 7: Deploy containerized app on Kubernetes cluster (minikube or cloud provider)		
MODULE 5:	**CLOUD SERVICES & INTEGRATION**	**3 Hours**
Exp 8: Build a serverless function using AWS Lambda/Firebase Cloud Function Exp 9: Integrate with a cloud database (Firestore/MongoDB Atlas)		
MODULE 6:	**MONITORING, COST & PERFORMANCE**	**3 Hours**
Exp 10: Monitor app using Prometheus and visualize in Grafana Exp 11: Implement autoscaling policy and simulate load testing using tools like Locust		
TOTAL LECTURES		**30 Hours**

Text Books:

1. "Cloud Computing: Concepts, Technology & Architecture" by Thomas Erl
2. "Building Microservices" by Sam Newman, O'Reilly Media
3. "Kubernetes Up & Running" by Brendan Burns, Joe Beda, Kelsey Hightower

Machine Learning (Elective -I) + Lab (TIU-UCBCS-C351)

Program: B. Tech. in CSBS	**Year, Semester:** 3rd Year, 5th Sem
Course Title: Machine Learning (Elective -I) + Lab	**Subject Code:** TIU-UCBCS-C351
Contact Hours/Week: 3–0–2 (L–T–P)	**Credit:** 4

COURSE OBJECTIVE :

Enable the student to:

1. understand the human learning aspects and primitives in learning process by computer
2. analyze the nature of problems solved with machine learning techniques
3. design and implement suitable machine learning technique for a given application

COURSE OUTCOME :

The student will be able to:

CO1:	Explore the underlying principles, mathematical foundations, practical uses, and constraints of current machine learning methods.
CO2:	Recognize the criteria for assessing the effectiveness of the developed model.
CO3:	Investigate and devise contemporary machine learning applications, emphasizing recent advancements and innovative perspectives.
CO4:	Construct the learning model tailored to a specific task.
CO5:	Utilize cutting-edge development frameworks and software libraries to implement
CO6:	Optimize machine learning models by fine-tuning hyperparameters and improving generalization.

COURSE CONTENT :

MODULE 1:	**INTRODUCTION**	**7 Hours**
Definition - Types of Machine Learning - Examples of Machine Learning Problems - Training versus Testing - Characteristics of Machine learning tasks - Predictive and descriptive tasks - Machine learning Models: Geometric Models, Logical Models, Probabilistic Models. Features: Feature types - Feature Construction and Transformation - Feature Selection.		
MODULE 2:	**CLASSIFICATION AND CONCEPT LEARNING**	**7 Hours**
Classification: Binary Classification- Assessing Classification performance - Class probability Estimation - Multiclass Classification - Regression: Assessing performance of Regression - Error measures - Overfitting- Theory of Generalization: Effective number of hypothesis - Bounding the Growth function.		
MODULE 3:	**LINEAR AND PROBABILISTIC MODELS**	**7 Hours**
Least Squares method - Multivariate Linear Regression - Perceptron, Multiple Layer Perceptron - Support Vector Machines - Obtaining probabilities from Linear classifiers - Kernel methods for non-Linearity - Probabilistic models for categorical data –Transfer Learning in Neural Networks, Naïve Bayes Classifier		
MODULE 4:	**DISTANCE BASED MODELS**	**8 Hours**
Distance Based Models: Neighbors and Examples - Nearest Neighbors Classification - Clustering for Edge AI Applications - Distance based clustering – K-Means Algorithm - K-Medoids Algorithm - Hierarchical clustering - Vector Quantization, Self-Organizing Feature Map - Principal Component Analysis		
MODULE 5:	**RULE BASED AND TREE BASED MODELS**	**8 Hours**
Rule Based Models: Rule learning for subgroup discovery - Association rule mining - Tree Based Models: Decision Trees - Ranking and Probability estimation Trees - Regression trees - Classification and Regression Trees (CART), AutoML- Automated Machine Learning		
MODULE 6:	**TRENDS IN MACHINE LEARNING**	**8 Hours**

Ensemble Learning, - Bagging and Boosting - Random Forest - Meta learning - Deep Learning - Reinforcement Learning – Applications.	
TOTAL LECTURES	**45 Hours**

Laboratory

MODULE 1:	**INTRODUCTION TO PYTHON FOR MACHINE LEARNING**	**5 Hours**
Understanding Python libraries (NumPy, Pandas, Matplotlib, Seaborn, Scikit-learn), Data loading, manipulation, and visualization techniques, Data preprocessing: Handling missing values, feature scaling, and encoding		
MODULE 2:	**SUPERVISED LEARNING - REGRESSION & CLASSIFICATION**	**5 Hours**
Implementing Linear Regression and Logistic Regression, Training and evaluating Decision Trees, Random Forests, and Support Vector Machines (SVM), Hyperparameter tuning using GridSearchCV&RandomizedSearchCV		
MODULE 3:	**UNSUPERVISED LEARNING & DIMENSIONALITY REDUCTION**	**5 Hours**
Implementing K-Means Clustering and choosing the optimal K, Feature extraction and Principal Component Analysis (PCA)		
MODULE 4:	**NEURAL NETWORKS**	**5 Hours**
Implementing a Feedforward Neural Network using TensorFlow/Keras, Tuning number of layers, neurons, batch size, and learning rate, Training and testing on MNIST dataset		
MODULE 5:	**NATURAL LANGUAGE PROCESSING**	**5 Hours**
Text tokenization and TF-IDF vectorization, Implementing Naïve Bayes for Sentiment Analysis, Hyperparameter tuning for Naïve Bayes (Laplace smoothing)		
MODULE 6:	**MACHINE LEARNING MODEL DEPLOYMENT**	**5 Hours**
Saving trained ML models using joblib, Creating a Flask API for serving predictions, Testing the deployed model with real-time inputs		
TOTAL LAB HOURS		**30 Hours**

Books:

1. P. Flach, "Machine Learning: The art and science of algorithms that make sense of data", Cambridge University Press, 2012, ISBN-10: 1107422221, ISBN-13: 978-1107422223.
2. Trevor Hastie, Robert Tibshirani, Jerome Friedman, "The Elements of Statistical Learning: Data Mining, Inference, and Prediction", Second Edition (Springer Series in Statistics), 2016, ISBN-10: 0387848576, ISBN-13: 978-0387848570.
3. Christopher Bishop, "Pattern Recognition and Machine Learning (Information Science and Statistics)", Springer, 2007.
4. Kevin Murphy, "Machine Learning: A Probabilistic Perspective", MIT Press, 2012, ISBN-10: 0262018020, ISBN-13: 978-0262018029
5. Y. S. Abu-Mostafa, M. Magdon-Ismail, and H.-T. Lin, "Learning from Data", AMLBook Publishers, 2012 ISBN 13: 978-1600490064.
6. Tom Mitchell, "Machine Learning", McGraw-Hill, 1997, ISBN-10: 0071154671, ISBN-13: 978-0071154673.
7. Jiawei Han, Micheline Kamber, "Data Mining Concepts and Techniques", Chris Ullman, Morgan Kaufmann Publishers,Third Edition, 2011, ISBN 0123814790, ISBN-13 9780123814791.

Behavioural Economics (Elective -II) (TIU-UCBEM-E301A)

Program: B. Tech. in CSBS	**Year, Semester:** 3rd Yr., 5th Sem.
Course Title: Behavioural Economics (Elective -II)	**Subject Code:** TIU-UCBEM-E301A
Contact Hours/Week: 3–0–0 (L–T–P)	**Credit:** 3

COURSE OBJECTIVE :

Enable the student to:

- Understand how psychological, emotional, cognitive, and social factors affecteconomic decisions.
- Analyze deviations from standard economic theories through empirical and experimental insights.
- Apply behavioral insights to real-world problems in business, policy-making, and daily life.

COURSE OUTCOME :

The student will be able to:

CO 1:	Explain the foundational concepts of behavioral economics and contrast them with traditional economic theories.
CO 2:	Analyze heuristics, biases, and bounded rationality in individual decision-making.
CO 3:	Apply prospect theory and understand framing effects in choices under risk and uncertainty.
CO 4:	Evaluate the role of social preferences and fairness in economic interactions.
CO 5:	Assess the implications of behavioral economics in market design, public policy, and organizational behavior.
CO 6:	Design behavioral interventions and nudges for improved decision-making.

COURSE CONTENT:

MODULE 1:	INTRODUCTION TO BEHAVIORAL ECONOMICS	9 Hours

Foundations of Behavioral Economics

Definition and scope of Behavioral Economics, Differences between traditional economics and behavioral approaches, Real-world failures of rationality assumptions in classical economics, Contributions of pioneers: Herbert Simon, Daniel Kahneman, Amos Tversky

Bounded Rationality and Decision-Making

Concept of bounded rationality and satisficing behavior, Limited attention and processing capacity in human decision-making, Impact of information overload on economic choices, Applications in consumer and financial decisions

Experimental and Evidence-Based Economics

Role of laboratory and field experiments in behavioral research, Understanding causality through controlled settings, Introduction to Randomized Controlled Trials (RCTs), Case examples: Savings behavior, voting behavior, and charitable giving

MODULE 2:	DECISION MAKING UNDER UNCERTAINTY	9 Hours

Heuristics and Cognitive Biases

Introduction to heuristics: mental shortcuts used in judgment, Availability heuristic, Representativeness heuristic, Anchoring bias, Biases in probability estimation and risk assessment, Implications in consumer finance, marketing, and health choices

Prospect Theory and Loss Aversion

Overview of Prospect Theory (Kahneman and Tversky), Value function: Losses loom larger than gains, Endowment effect, status quo bias, and reference dependence, Practical implications in pricing, policy, and insurance

Framing and Mental Accounting

Framing effects: how presentation influences decisions, Positive vs. negative frames, gain vs. loss framing, Mental accounting: categorizing money into mental budgets, Implications in budgeting, saving, and spending behavior

MODULE 3:	INTERTEMPORAL CHOICES AND SELF-CONTROL	9 Hours

Time Discounting and Hyperbolic Preferences

Understanding time preferences and discount functions, Exponential vs. hyperbolic discounting models, Dynamic inconsistency and present bias, Applications in retirement planning and addiction

Self-Control and Commitment Devices

Self-control failures and the conflict between short- and long-term selves, Commitment devices: auto-debit, public pledges, temptation bundling, Applications in fitness, savings, productivity, and education

Behavioral Applications in Policy and Practice

Real-life interventions for improving long-term behavior, Case studies: Save More Tomorrow program, gym memberships, default options, Behavioral interventions in time management and health behaviors

MODULE 4:	SOCIAL PREFERENCES AND FAIRNESS	9 Hours

Altruism, Reciprocity, and Fairness

Definitions and distinction from self-interest models, Strong reciprocity and fairness norms Distributional preferences: inequality aversion, equity vs. efficiency, Experimental evidence from dictator, trust, and ultimatum games

Social Norms and Identity in Decision-Making

Role of identity, group affiliation, and norms in economic behavior, Conformity, peer effects, and cultural influences, Applications in energy conservation, tax compliance, and education

Behavioral Game Theory and Cooperation

Overview of Behavioral Game Theory, Trust games, public goods games, coordination failures Implications for collective action and policy design, Institutional design to promote cooperation and fairness

MODULE 5:	APPLICATIONS AND POLICY IMPLICATIONS	9 Hours

Nudging and Choice Architecture

The concept of a "nudge" (Thaler & Sunstein), Defaults, simplification, feedback, and reminders Designing environments for better choices without coercion, Case studies from organ donation, cafeteria design, and pension plans.

Behavioral Public Policy Applications

Applications in health: vaccinations, diet, hygiene behavior, Finance: default savings plans, payday loans, disclosure simplification, Environment: energy usage, plastic reduction, sustainable behavior Education: attendance, learning nudges, parental involvement.

Ethics, Limitations, and Future Directions

Ethical concerns in behavioral manipulation and autonomy, The line between nudging and paternalism, Transparency, accountability, and informed consent, Future research directions: machine learning, AI, behavioral tech.

TOTAL LECTURES	45 Hours

Text Books:

1. 'Misbehaving: The Making of Behavioral Economics' by Richard H. Thaler
2. 'Thinking, Fast and Slow' by Daniel Kahneman
3. 'Behavioral Economics' by Edward Cartwright
4. 'Nudge: Improving Decisions About Health, Wealth, and Happiness' by Thaler & Sunstein

Psychology (Elective -II) (TIU-UCBEM-E301C)

Program: B. Tech. in CSBS	**Year, Semester:** 3rd Yr., 5th Sem.
Course Title: Psychology (Elective -II)	**Subject Code:** TIU-UCBEM-E301C
Contact Hours/Week: 3–0–0 (L–T–P)	**Credit:** 3

COURSE OBJECTIVE:

Enable the student to:

1. Enable students to learn about the concept of Engineering Psychology and ways of performing research and applying it to solve real life problems.
2. Provides an idea and concept about Stress and ways of managing it.
3. Enable students to learn to correlate Psychology with real life applications.

COURSE OUTCOME:

The student will be able to:

CO-1:	To provide students a detailed knowledge about Engineering Psychology and its application in solving problems.
CO-2:	To let the students understand about the contribution of Psychomotor skills in performing tasks and the factors which influence work motivation.
CO-3:	To provide a detailed knowledge about Stress and how it is caused, ways of managing it.
CO-4:	To explore the concept of intelligence, its types and theories, emotional intelligence and its components, along with the relationship between emotion, thought, and behavior, emphasizing the importance of EI and EQ competencies
CO-5:	To familiarize students with the principles of human perception and cognition, including attention, memory, and decision-making, and their impact on human performance in engineering tasks.
CO-6:	To equip students with the ability to analyze and design human-machine systems by applying human factors principles, ensuring efficiency, safety, and user satisfaction in various engineering applications.

COURSE CONTENT:

MODULE 1:	**Basics of Engineering Psychology**	**7 Hours**
Introduction to psychology and engineering psychology, research methodology, application.		
MODULE 2:	**Cognitive Functions**	**8 Hours**
Time and motion study, motor skill control, multitasking, decision-making, work motivation.		
MODULE 3:	**Stress and Coping**	**7 Hours**
Concept of stress, types, models (GAS and Lazarus), stress management, problem focused and emotion focused coping strategies.		
MODULE 4:	**Intelligence and Emotional Intelligence**	**10 Hours**
Concept of intelligence, types, theories (Gardener's Multifactor Theory, Sternberg's Triarchic Theory),intelligence tests, concept of emotional intelligence, components ,models (any two), EQ competencies, importance of EI, emotional awareness, relationship between emotion, thought and behaviour.		

TOTAL HOURS: 32 HOURS

Books:

T1 Ciccarelli, S. K., & Meyer, G. E. (2006). Psychology. Pearson Education India.
T2 Baron, R. A., Kalsher, M. J., & Henry, R. A. (2005). Psychology: From science to practice. Pearson/Allyn and Bacon.
T3 Wickens, C.D., Helton, W.S., Hollands, J.G., & Banbury, S. (2021). Engineering Psychology and Human Performance (5th ed.). Routledge. https://doi.org/10.4324/9781003177616
T4 Luthans, F., Luthans, B. C., & Luthans, K. W. (2015). Organizational behavior: An evidence-based approach. Iap

Project I (TIU-UCS-P301)

Program: B. Tech CSBS	**Year, Semester:** 3rd Year, 5th Sem.
Course title: Project I	**Subject Code:** TIU-UCS-P301
Contact Hours/ Weeks: 0-0-2 (L-T-P)	**Credit:** 1

COURSE OBJECTIVE:

1. To introduce students to systematic project development, documentation, and presentation skills.
2. To provide exposure to problem identification, requirement analysis, and prototype development.
3. To develop collaboration, planning, and project execution capabilities in a small group setting.
4. To bridge theoretical knowledge and real-world application through hands-on exploration.

COURSE OUTCOME:

	Bloom's Taxonomy Level
CO1: Understand the mini project lifecycle, objective setting, and domain selection	**Understand**
CO2: Analyze user requirements, system needs, and perform task planning.	**Analyze**
CO3: Apply foundational concepts to design a basic working prototype.	**Apply**
CO4: Demonstrate implementation and integration using appropriate tools/technologies	**Apply**
CO5: Present and document the project with effective communication and technical writing skills.	**Evaluate**

COURSE CONTENT:

Module 1:	**INTRODUCTION & TOPIC SELECTION**	5 Hours

Orientation to mini project scope and structure, Topic brainstorming, team formation (up to 3 students), Setting objectives and expected outcomes, Deliverable: Project Proposal & Team Registration Module		
Module 2:	**PROBLEM DEFINITION & RESEARCH**	5 Hours
Defining the problem and project scope, Research methodology and resource gathering		
Module 3:	**FEASIBILITY STUDY & REQUIREMENT GATHERING**	5 Hours
Feasibility study (technical, economic, legal), System requirements gathering from stakeholders		
Module 4:	**Implementation & Testing**	5 Hours
Build basic working module or simulation, Test features with sample data/use-case		
Module 5:	**Final Demo & Evaluation**	5 Hours
Peer and faculty demo presentation, Final documentation and report submission		
Module 6:	**Technology & Tool Selection**	5 Hours
Discussion of various tools and technologies (e.g., databases, frameworks, cloud)		
Total		30 Hours

Books:

1. "The Art of Project Management" by Scott Berkun
2. "Project-Based Learning Handbook" by Thom Markham
3. "Code Complete: A Practical Handbook of Software Construction" by Steve McConnell
4. "How to Write a Thesis" by Umberto Eco
5. "Design Thinking: Understand – Improve – Apply" by Peter G. Rowe

SEMESTER 6

Computer Networks + Lab (TIU-UCBCS-C302)

Program: B. Tech. in CSBS	**Year, Semester:** 3rd Yr., 5th Sem.
Course Title: Computer Networks + Lab	**Subject Code:** TIU-UCBCS-C302
Contact Hours/Week: 3–1–2 (L–T–P)	**Credit:** 5

COURSE OBJECTIVE :

Enable the student to:

1. understand network fundamentals including network types and topologies.
2. Analyze Network Protocols including TCP/IP, UDP, HTTP, FTP, and DNS, and understand their roles in data communication.
3. Explore OSI and TCP/IP Models and how data flows through different network layers.
4. Implement Routing and Switching Techniques including static and dynamic routing protocols

COURSE OUTCOME :

The students will be able to:

CO1:	Describe the general principles of data communication, the concept of the layered approach
CO2:	Describe how computer networks are organized with the concept of layered Approach
CO3:	Design logical sub-address blocks with a given address block and network Topology
CO4:	Understanding of simple LAN with hubs, bridges, and switches
CO5:	Describe how routing protocols work
CO6:	Understand network security threats and basic security mechanisms to protect data and communication.

COURSE CONTENT :

MODULE 1:	**INTRODUCTION TO NETWORK**	**10 Hours**
Network hardware, Network software, OSI, TCP/IP Reference models, Example Networks: ARPANET, Internet. Physical Layer: Guided Transmission media: twisted pairs, coaxial cable, fiber optics, Wireless transmission.		
MODULE 2:	**DATA LINK LAYER**	**12 Hours**
Data link layer: Design issues, framing, Error detection and correction. Elementary data link protocols: simplex protocol, A simplex stop and wait protocol for an error-free channel, A simplex stop and wait protocol for noisy channels. Sliding Window protocols: A one-bit sliding window protocol, A protocol using Go-Back-N, A protocol using Selective Repeat, Example data link protocols. Medium Access sublayer: The channel allocation problem, Multiple access protocols: ALOHA, Carrier sense multiple access protocols, collision free protocols. Wireless LANs, Data link layer switching.		
MODULE 3:	**NETWORK LAYER**	**10 Hours**
Network Layer: Design issues, Routing algorithms: shortest path routing, Flooding, Hierarchical routing, Broadcast, Multicast, distance vector routing, Congestion Control Algorithms, Quality of Service, Internetworking, The Network layer in the internet.		
MODULE 4:	**TRANSPORT LAYER**	**8 Hours**
Transport Layer: Transport Services, Elements of Transport protocols, Connection management,		

TCP and UDP protocols.		
MODULE 5:	**APPLICATION LAYER**	**5 Hours**
Application Layer –Domain name system, SNMP, Electronic Mail; the World WEB, HTTP, Streaming audio and video.		
TOTAL LECTURES		**45 Hours**

Laboratory

MODULE 1:	**INTRODUCTION TO NETWORK**	**6 Hours**
Network hardware, Network software, OSI, TCP/IP Reference models, Example Networks: ARPANET, Internet. Physical Layer: Guided Transmission media: twisted pairs, coaxial cable, fiber optics, Wireless transmission.		
MODULE 2:	**DATA LINK LAYER**	**7 Hours**
Data link layer: Design issues, framing, Error detection and correction. Elementary data link protocols: simplex protocol, A simplex stop and wait protocol for an error-free channel, A simplex stop and wait protocol for noisy channels. Sliding Window protocols: A one-bit sliding window protocol, A protocol using Go-Back-N, A protocol using Selective Repeat, Example data link protocols. Medium Access sublayer: The channel allocation problem, Multiple access protocols: ALOHA, Carrier sense multiple access protocols, collision free protocols. Wireless LANs, Data link layer switching.		
MODULE 3:	**NETWORK LAYER**	**5 Hours**
Design issues, Routing algorithms: shortest path routing, Flooding, Hierarchical routing, Broadcast, Multicast, distance vector routing, Congestion Control Algorithms, Quality of Service, Internetworking, The Network layer in the internet**.**		
MODULE 4:	**TRANSPORT LAYER**	**6 Hours**
Transport Services, Elements of Transport protocols, Connection management, TCP and UDP protocols.		
MODULE 5:	**APPLICATION LAYER**	**6 Hours**
Domain name system, SNMP, Electronic Mail; the World WEB, HTTP, Streaming audio and video.		
TOTAL LAB HOURS		**30 Hours**

Books:

1. A. S. Tanenbaum and D. J. Wetherall, “Computer Networks”, Pearson, 5th Edition, 2010, ISBN-10: 0132126958, ISBN-13: 978-0132126953.

2. B. A. Forouzan, "Data Communications and Networking", McGraw-Hill Education, 5th Edition, 2012, ISBN-10: 0073376221, ISBN-13: 978-0073376226.
3. J. F. Kurose and K. W. Ross, "Computer Networking: A Top-Down Approach", Pearson, 8th Edition, 2021, ISBN-10: 0136681553, ISBN-13: 978-0136681557.
4. W. Stallings, "Data and Computer Communications", Pearson, 10th Edition, 2013, ISBN-10: 0133506487, ISBN-13: 978-0133506488.
5. D. E. Comer, "Computer Networks and Internets", Pearson, 6th Edition, 2014, ISBN-10: 0133587932, ISBN-13: 978-0133587937.
6. M. A. Gallo and W. M. Hancock, "Computer Communications and Networking Technologies", Cengage Learning, 1st Edition, 2001, ISBN-10: 053437130X, ISBN-13: 978-0534371305.

Information Security + Lab(TIU-UCBCS-C304)

Program: B. Tech in CSBS	**Year, Semester**: 3rd Year, 6th Semester
Course Title: Information Security + Lab	**Subject Code**: TIU-UCBCS-C304
Contact Hours / Week: 3-0-2 (L-T-P)	**Credit**: 4

COURSE OBJECTIVES:

1. Understand Core Security Concepts and Principles.
2. Explore and Evaluate Access Control Models.
3. Design Secure Systems and Policies.
4. Apply Security in Operating Systems and Databases

COURSE OUTCOMES:

CO-1:	Explain fundamental principles of information security and the importance of securing information systems.
CO-2:	Recognize and analyze various threats and vulnerabilities in information systems.
CO-3:	Apply appropriate security measures and controls to protect information assets.
CO-4:	Analyze and manage risks associated with information security.
CO-5:	Understand and apply cryptographic techniques for securing data.
CO-6:	Analyze the legal and regulatory frameworks related to information security.

COURSE CONTENT:

MODULE 1	**OVERVIEW OF SECURITY PARAMETERS**	**7 Hours**
Confidentiality, integrity and availability; Security violation and threats; Security policy and procedure; Assumptions and Trust; Security Assurance, Implementation and Operational Issues; Security Life Cycle		
MODULE 2	**ACCESS CONTROL MODELS**	**7 Hours**
Discretionary, mandatory, roll-based and task-based models, unified models, access control algebra, temporal and spatio-temporal models.		

MODULE 3	**SECURITY POLICIES**	**7 Hours**
Confidentiality policies, integrity policies, hybrid policies, non-interference and policy composition, international standards.		
MODULE 4	**SYSTEMS DESIGN**	**8 Hours**
Design principles, representing identity, control of access and information flow, confinement problem. Assurance: Building systems with assurance, formal methods, evaluating systems.		
MODULE 5	**LOGIC-BASED SYSTEM**	**8 Hours**
Malicious logic, vulnerability analysis, auditing, intrusion detection. Applications: Network security, operating system security, user security, program security. Special Topics: Data privacy, introduction to digital forensics, enterprise security specification.		
MODULE 6	**OPERATING SYSTEMS SECURITY & DATABASE SECURITY**	**8 Hours**
Security Architecture, Analysis of Security in Linux/Windows, Security Architecture, Enterprise security, Database auditing.		
TOTAL LECTURES		**45 Hours**

Laboratory

MODULE-1:	**Overview of Security Parameters**	**5 Hours**
Implementing the CIA Triad (Python) Demonstrate Confidentiality, Integrity, and Availability. Security Violations Detection (C) Detect unauthorized access and ensure data integrity.		
MODULE-2:	**Access Control Models**	**5 Hours**
Implementing the Security Lifecycle (Python) Integrate security measures in various software lifecycle phases. CIA Triad - Real-World Scenarios (Python/C) Simulate real-world threats and apply CIA-based solutions.		
MODULE-3:	**Security Policies**	**5 Hours**
Threat Detection (C) . Simulate and prevent unauthorized access, deception, and disruption. Common Threat Types (C/Python) Implement snooping, spoofing, and data integrity mechanisms. Implementing Monoalphabetic and Polyalphabetic Ciphers (Python/C) Encrypt/decrypt using classical substitution techniques.		
MODULE-4:	**Systems Design**	**5 Hours**
Cryptography with Group Theory (Python) Use mathematical structures for cryptographic operations. Symmetric Key Cryptography (Python) Implement Caesar, Rail Fence, and Vigenère ciphers. Asymmetric Cryptography (C) . Implement RSA and Diffie-Hellman Key Exchange.		
MODULE-5:	**Logic-based Systems**	**5 Hours**
Access Control Models (Python) Apply Bell-LaPadula and Biba models. Digital Signatures using RSA (Python) Create and verify digital signatures.		

MODULE-6:	Operating System and Database Security	5 Hours
SQL Injection Prevention (C) . Secure database queries from injection attacks. Operating System Security (C). Implement process isolation and access controls. Active and Passive Attack Detection (Python/C) Detect and mitigate common network/system attacks.		
TOTAL LAB HOURS		**30 Hours**

Books:

1. *Security Engineering*, Ross Anderson.
2. *Computer Security: Art and Science*, M. Bishop, Pearson Education.
3. *Information Security: Principles and Practice*, M. Stamp.

Reference Books:

1. *Security in Computing*, C.P. Pfleeger, S.L. Pfleeger, J. Margulies.
2. *Secure Programming HOWTO*, David Wheeler.
3. *Browser Security Handbook*, Michael Zalewski.
4. *Handbook of Database Security*, M. Gertz, S. Jajodia.

Artificial Intelligence + LAB(TIU-UCBCS-C306)

Program: B. Tech. in CSBS	**Year, Semester:** 3rd Year, 6th Semester
Course Title: Artificial Intelligence + LAB	**Subject Code:** TIU-UCBCS-C306
Contact Hours/Week: 3–0–2 (L–T–P)	**Credit:** 4

COURSE OBJECTIVE:

1. Understanding the meaning of Artificial Intelligence
2. Understanding how knowledge and intelligence are used in solving real life problems.
3. Learning the basic tools and techniques in the field of Artificial Intelligence
4. Develop ability to apply one or more appropriate technique(s) to solve a given problem efficiently.

COURSE OUTCOME

CO1	Understand the informed and uninformed problem types and apply search strategies to solve them.
CO2	Apply difficult real-life problems in a state space representation so as to solve them using AI techniques like searching and game playing.
CO3	Design and evaluate intelligent expert models for perception and prediction from intelligent environment.

CO4	Formulate valid solutions for problems involving uncertain inputs or outcomes by using decision making techniques.
CO5	Demonstrate and enrich knowledge to select and apply AI tools to synthesize information and develop models within constraints of application area.
CO6	Examine the issues involved in knowledge bases, reasoning systems and planning.

COURSE CONTENT

Module No.	Module	Lecture Hours
MODULE 1	**Introduction, Overview of Artificial intelligence**	**6**
Problems of AI, AI technique, Tic - Tac – Toe problem. Intelligent Agents, Agents & environment, nature of environment, structure of agents, goal-based agents, utility-based agents, learning agents.		
MODULE 2	**Problem Solving, Problems, Problem Space & Search**	**4**
Defining the problem as state space search, production system, problem characteristics, issues in the design of search programs.		
MODULE 3	**Search Techniques**	**8**
Problem solving agents, searching for solutions; uniform search strategies: breadth first search, depth first search, depth limited search, bidirectional search, comparing uniform search strategies. Heuristic search strategies Greedy best-first search, A* search, AO* search, memory bounded heuristic search: local search algorithms & optimization problems: Hill climbing search, simulated annealing search, local beam search		
MODULE 4	**Constraint satisfaction problems**	**8**
Local search for constraint satisfaction problems. Adversarial search, Games, optimal decisions & strategies in games, the minimax search procedure, alpha-beta pruning, additional refinements, iterative deepening.		
MODULE 5	**Knowledge & Reasoning**	**6**
Knowledge representation issues, representation & mapping, approaches to knowledge representation. Using predicate logic, representing simple fact in logic, representing instant & ISA relationship, computable functions & predicates, resolution, natural deduction. Representing knowledge using rules, Procedural verses declarative knowledge, logic programming, forward verses backward reasoning, matching, control knowledge.		
MODULE 6	**Probabilistic reasoning**	**8**
Representing knowledge in an uncertain domain, the semantics of Bayesian networks,		

Dempster-Shafer theory, Planning Overview, components of a planning system, Goal stack planning, Hierarchical planning, other planning techniques.		
MODULE 7	**Expert Systems**	**5**
Representing and using domain knowledge, expert system shells, and knowledge acquisition.		
TOTAL		**45**

Laboratory

MODULE-1:	**Introduction, Overview of Artificial Intelligence**	**5 Hours**

Understand the basics of AI and foundational concepts like classification and regression.

Write a Python program to implement linear regression between two variables and:

– Estimate value of y given x

– Estimate value of x given y

Write a Python program to implement gradient descent algorithm to find the minimum of a function

Write a Python program to implement a perceptron algorithm and classify linearly separable data

MODULE-2:	**Problem Solving, Problems, Problem Space & Search**	**5 Hours**

Learn how to model and solve problems using AI search algorithms.

Write a Python program to create a tree and do a Depth First Traversal (DFS)

Write a Python program to create a tree and do a Breadth First Traversal (BFS)

Write a Python program to solve the N-Queens problem

Write a Python program to solve the Map Coloring problem

Write a Python program to solve the Sudoku problem

Write a PROLOG program to solve the N-Queens problem

Write a PROLOG program to solve the 8-Puzzle problem

MODULE-3:	**Search Techniques**	**5 Hours**

Apply informed search strategies like A*, Min-Max, and Alpha-Beta Pruning.

Write a Python program to create a weighted graph and perform A* Search

Write a Python program to perform Min-Max search on a game tree and find the optimal path

Extend the above: Apply Alpha-Beta pruning on the same tree		
MODULE-4:	**Constraint satisfaction problems**	**5 Hours**
Implement fuzzy logic systems and constraint solvers. Implement a Trapezoidal Fuzzy Set and write a function to compute membership values Write Python functions to compute Union, Intersection, and Complement of fuzzy sets		
MODULE-5:	**Knowledge & Reasoning**	**5 Hours**
Understand rule-based and tree-based models for decision making. Write a Python program to implement a Decision Tree and classify the IRIS dataset Write a Python program to implement a Random Forest algorithm for IRIS classification Write a Python program to implement the k-Nearest Neighbors (kNN) algorithm on the IRIS dataset Implement Logistic Regression on a synthetically generated dichotomous dataset		
MODULE-6:	**Probabilistic reasoning**	**5 Hours**
Use probabilistic models and neural networks to reason under uncertainty. Implement an Artificial Neural Network (ANN) and use it to classify IRIS data Implement a Convolutional Neural Network (CNN) for handwritten character recognition Implement a Genetic Algorithm to find the optimal solution to a second-order equation		
TOTAL LAB HOURS		**30 Hours**

Text Books:

1. Artificial Intelligent e: Elaine Rich, Kevin Knight, Mc-Graw Hill.
2. Introduction to AI & Expert System: Dan W. Patterson, PHI.
3. Artificial Intelligent by Luger (Pearson Education)
4. Russel & Norvig, Artificial Intelligent e: A Modern Approach, Pearson Education

Financial & Cost Accounting(TIU-UCBMG-T302)

Program: B. Tech. in CSBS	**Year, Semester:** 3rd Yr., 5th Sem.
Course Title: Financial & Cost Accounting	**Subject Code:** TIU-UCBMG-T302
Contact Hours/Week: 2–0–0 (L–T–P)	**Credit:** 2

COURSE OBJECTIVE :

Enable the student to:

1. To develop a fundamental understanding of the principles and practices of financial and cost accounting.
2. To enable students to prepare, analyze, and interpret financial statements.
3. To introduce cost accounting concepts for effective planning, control, and decision-making.
4. To apply accounting tools and techniques for business problem-solving and financial performance evaluation.

COURSE OUTCOME :

The student will be able to:

CO-1	Understand the fundamental concepts, principles, and systems of financial and cost accounting.
CO-2	Record journal entries and prepare primary financial statements such as the Income Statement, Balance Sheet, and Cash Flow Statement.
CO-3	Apply cost accounting methods including job costing, process costing, and activity-based costing.
CO-4	Use marginal costing and break-even analysis for short-term decision-making.
CO-5	Analyze and interpret financial statements using various financial ratios and tools.
CO-6	Prepare cost budgets and evaluate performance through standard costing and variance analysis.

COURSE CONTENT:

MODULE 1:	**INTRODUCTION TO ACCOUNTING PRINCIPLES**	**6 Hours**

Nature and Scope of Accounting

Definition, objectives, and importance of accounting, Types of accounting: Financial, Cost, and Management Accounting, Users of accounting information

Accounting Concepts and Conventions

Basic accounting principles: Entity, Going Concern, Matching, Consistency, Conventions: Materiality, Prudence, Full Disclosure, Accounting standards and IFRS overview

Double Entry System and Accounting Process

Rules of debit and credit, Journal, Ledger, Trial Balance, Cash book and subsidiary books

MODULE 2:	**FINAL ACCOUNTS AND ADJUSTMENTS**	**6 Hours**

Final Accounts of Sole Proprietorship

Trading and Profit & Loss Account, Balance Sheet preparation

Adjustments in Final Accounts

Outstanding and prepaid expenses, Accrued and unearned income, Depreciation, bad debts, provisions

Rectification of Errors

Types of errors: error of omission, commission, principle, Rectification before and after trial balance, Suspense account.

MODULE 3:	INTRODUCTION TO COST ACCOUNTING	6 Hours

Basics of Cost Accounting

Meaning, scope, and objectives of cost accounting, Cost centers and cost units, Differences between financial and cost accounting

Classification of Costs

Direct and indirect costs, Fixed, variable, and semi-variable costs, Product and period costs

Cost Sheet Preparation

Components: Prime cost, factory cost, cost of production, Format of cost sheet, Practical problems in cost computation.

MODULE 4:	COSTING TECHNIQUES AND MARGINAL COSTING	6 Hours

Job and Process Costing

Job costing: features and format, Process costing: concepts and process accounts, Treatment of normal and abnormal losses

Marginal Costing and Break-even Analysis

Marginal cost and contribution, Break-even point and margin of safety, CVP (Cost-Volume-Profit) analysis,

Applications in Decision Making

Make or buy decisions, Product mix decisions, Shutdown decisions

MODULE 5:	BUDGETING, STANDARD COSTING & VARIANCE ANALYSIS	6 Hours

Budgeting and Budgetary Control

Concept and types of budgets, Flexible and fixed budgets, Advantages and limitations of budgeting

Standard Costing

Definition and benefits, Establishment of standards: material, labor, overheads, Comparison with actual costs. **Variance Analysis** Material cost variance, Labor cost variance, Overhead variance – basic overview	
TOTAL LECTURES	**30 Hours**

Text Books:

1. **T.S. Grewal** – *Double Entry Book Keeping (Latest Edition)*, Sultan Chand & Sons
2. **M.C. Shukla, T.S. Grewal & S.C. Gupta** – *Advanced Accounts Vol. I*, S. Chand
3. **Maheshwari, S.N. & Maheshwari, S.K.** – *An Introduction to Accountancy*, Vikas Publishing
4. **Jain, Narang & Agarwal** – *Cost Accounting: Principles and Practice*, Kalyani Publishers
5. **Arora, M.N.** – *Cost Accounting – Principles and Practice*, Vikas Publishing House

Business Communication and Value Science-IV (TIU-UCBEN-T302)

Program: BTech in CSBS	**Year, Semester:** 3rd Yr., 6th Sem.
Course Title: Business Communication and Value Science-IV	**Subject Code:** TIU-UCBEN-T302
Contact Hours/Week: 2–1–0 (L–T–P)	**Credit:** 3

COURSE OBJECTIVE :

Enable the student to:

1. Understand the significance of diversity in the workplace and corporate environments.
2. Develop and apply effective communicative writing skills in real-life business scenarios.
3. Enhance public speaking and presentation abilities for professional growth.

COURSE OUTCOME :

On completion of the course, the student will be able to:

CO-1:	Demonstrate an understanding of diversity, inclusion, and workplace communication.
CO-2:	Apply communicative writing techniques, including charts and graphs, in business contexts.
CO-3:	Develop and deliver impactful public speaking presentations.
CO-4:	Utilize emotional intelligence and interpersonal skills for effective workplace interactions.
CO-5:	Analyze corporate social responsibility (CSR) principles and business ethics.
CO-6:	Implement best practices for stress and time management in professional settings

COURSE CONTENT :

MODULE 1:	**Workplace Diversity and Communication**	**5 Hours**
Understanding workplace diversity and inclusion. Effective communication strategies in diverse environments. Business idioms and corporate terminology.		
MODULE 2:	**Communicative Writing in Business**	**5 Hours**
Key aspects of communicative writing. Applying communicative writing in real-life scenarios. Using charts and graphs for business communication.		
MODULE 3:	**Public Speaking and Professional Presentation**	**5 Hours**

Importance of public speaking in the workplace. Best practices for public speaking and presentation. Engaging audience through storytelling and structured delivery.		
MODULE 4:	**Emotional Intelligence and Conflict Management**	**5 Hours**
Understanding emotional intelligence and its impact. Applying emotional intelligence in workplace interactions. Recognizing conflicts and managing them effectively.		
MODULE 5:	**Corporate Social Responsibility and Business Ethics**	**5 Hours**
Understanding corporate social responsibility (CSR). Ethical decision-making and corporate governance. Role of organizations in sustainable business practices		
MODULE 6:	**Stress and Time Management for Professionals**	**5 Hours**
Recognizing stress and its impact on personal and professional life. Best practices for stress management. Effective time management strategies for improved productivity.		
TOTAL LECTURES		**30 Hours**

Books:

1. Deborah C. Andrews & Margaret D. Andrews, *Management Communication: A Guide*, Waveland Press, ISBN: 978-1577664023.
2. Daniel Goleman, *Emotional Intelligence: Why It Can Matter More Than IQ*, Bantam, ISBN: 978-0553383713.
3. Stephen R. Covey, *The 7 Habits of Highly Effective People*, Simon & Schuster, ISBN: 978-1982137274.
4. Dale Carnegie, *The Art of Public Speaking*, Simon & Schuster, ISBN: 978-0671724009.
5. Robert L. Heath, *Handbook of Public Relations*, SAGE Publications, ISBN: 978-1412977807.
6. Richard E. Mayer, *Multimedia Learning*, Cambridge University Press, ISBN: 978-1107574996.

Modern Web Applications (Elective-III)+ Lab (TIU-UCBCS-C354A)

Program: B. Tech. in CSBS	**Year, Semester:** 3rd Year., 6th Sem.
Course Title: Modern Web Applications (Elective-III)+ Lab	**Subject Code:** TIU-UCBCS-C354A
Contact Hours/Week: 2–0–2 (L–T–P)	**Credit:** 3

COURSE OBJECTIVES:

1. Enable students to develop modern web application by leveraging latest technologies.
2. Build strong foundation in students making them job ready as per industry requirements.
3. Enable them to learn new technologies by applying foundation paradigms

4. Building strong expertise to develop end to end application - web frontend and backend development.

COURSE OUTCOMES:

The student will be able to:

CO-1:	Understand the Fundamentals of Web Development, and computer Networking.
CO-2:	Master the Basics of HTML5 and Web Page Structure.
CO-3:	Learn the Power of CSS3 for Web Design with application of HTML.
CO-4:	Develop JavaScript Skills for Dynamic Web Interaction incorporating CSS and/or HTML.
CO-5:	Work with Modern Front-End Frameworks: jQuery, Bootstrap, and AngularJS.
CO-6:	Understand Back-End Technologies and RESTful Web Services along with HTML.

COURSE CONTENT:

Theory

MODULE 1:	**INTRODUCTION**	**7 Hours**
Concept of website, its need and purpose, Types of websites: Static and dynamic website, Introduction to HTML, XML, JSON, Web Browsers, – Web Servers, Uniform Resource Locator, Tools and Web Programming Languages. Web Standards, Tiered Architecture: Client Server Model, Three Tier Model, Service Oriented Architectures, REST services		
MODULE 2:	**HYPERTEXT MARK UP LANGUAGE**	**7 Hours**
Languages used for website development, HTML5: basic tags, formatting tags, Adding images, Lists, Embedding multimedia in Web pages, Inserting tables, Internal and External Linking, Frames, Forms		
MODULE 3:	**CASCADING STYLE SHEETS (CSS3)**	**7 Hours**
Basics of Cascading Style sheets, Advantages of CSS, External Style sheet, Internal style sheet, Inline style sheet, CSS Syntax, color, background, Font, images		
MODULE 4:	**JAVA SCRIPT**	**8 Hours**
Features of JavaScript, extension of JavaScript, Syntax of JavaScript: data types, operators, variables, tag, Document Object Model (DOM) with JavaScript, Selection Statement using if and Switch, Iterative statement: for, for/in, while, do while, break and continue		
MODULE 5:	**FRONT END FRAMEWORK**	**8 Hours**
Introduction to jQuery - Syntax, Selectors, Events, Traversing, AJAX ; Introduction to Bootstrap – Basics, Grids, Themes ; Angular JS – Expressions, Modules, Data Binding, Scopes, Directives & Events, Controllers, Filters, Services, Validation		
MODULE 6:	**BACK END TECHNOLOGIES**	**8 Hours**
Introduction to RESTful services, Resources, Messages (Request, Response), Addressing, Methods – (GET, POST, PUT, DELETE), HTML, JS		
TOTAL LECTURES		**45 Hours**

Laboratory

MODULE-1:	**INTRODUCTION**	**5 Hours**
Understand the basics of the internet, HTTP/HTTPS, client-server architecture, and developer tools. Introduction to Web Technologies and Developer Tools (Chrome DevTools, VS Code) Create a basic static web page and view source code, inspect elements, console logs Understand the HTTP request-response cycle using Postman or browser network tools		

MODULE-2:	**HYPERTEXT MARKUP LANGUAGE (HTML5)**	**5 Hours**
Learn the structure of web pages using HTML5. Create a personal portfolio page using HTML5 Design a registration form using form tags, validation attributes, and input types Build a simple webpage using semantic HTML tags (header, section, article, footer)		
MODULE-3:	**CASCADING STYLE SHEETS (CSS3)**	**5 Hours**
Apply styles and layout techniques to HTML content using CSS3. Style the portfolio webpage using internal and external CSS Create a responsive layout using Flexbox or CSS Grid Implement a styled navigation bar, buttons, and hover effects using CSS3 transitions.		
MODULE-4:	**JAVA SCRIPT**	**5 Hours**
Add interactivity and dynamic behavior to web pages using JavaScript. Write a JS script to validate form input (e.g., email, password length) Create a simple calculator using JavaScript Implement DOM manipulation: dynamically add/remove elements on a webpage		
MODULE-5:	**FRONT-END FRAMEWORK**	**5 Hours**
Develop rich user interfaces using modern front-end frameworks like React (or Vue/Angular). Create a simple React application (e.g., TODO list or counter app) Use React components, props, and state to build a dynamic UI Fetch data from an API (like JSONPlaceholder) and render it using React useEffect		
MODULE-6:	**BACK-END TECHNOLOGIES**	**5 Hours**
Implement server-side logic using Node.js and Express with a database. Set up a basic Node.js + Express server and define GET/POST routes Create a REST API to perform CRUD operations on a sample dataset		
TOTAL LAB HOURS		**30 Hours**

Text Books:

T1. Clint Eccher, "Professional Web Design: Techniques and Templates (CSS & XHTML)",
T2. Uttam K. Roy, "WEB TECHNOLOGIES".

Reference Books:

R1. Jennifer Kyrnin Laura Lemay, Rafe Colburn, "Mastering HTML, CSS & JavaScript Web Publishing – 2023".
R2. Kevin Murphy, "Machine Learning: A Probabilistic Perspective", MIT Press, 2012, ISBN-10: 0262018020, ISBN-13: 978-0262018029
R3. Godbole , "Web Technologies".

Robotics and Embedded Systems(Elective-III) + Lab (TIU-UCBCS-C354B)

Program: B. Tech. in CSBS	**Year, Semester:** 3rd Yr., 6th Sem.
Course Title: Robotics and Embedded Systems (Elective-III) + Lab	**Subject Code:** TIU-UCBCS-C354B
Contact Hours/Week: 2–0–2 (L–T–P)	**Credit:** 3

COURSE OBJECTIVE :

Enable the student to:

1. Understand the foundational principles of robotics and embedded systems design.
2. Analyze robotic architectures including kinematics, dynamics, sensing, and actuation.
3. Learn interfacing techniques using microcontrollers and real-time embedded programming.
4. Apply control theory and algorithms for autonomous robot behavior.
5. Design and implement real-time embedded applications and robotic prototypes.

COURSE OUTCOME :

The student will be able to:

CO-1:	Define and classify robotic systems and embedded computing platforms.
CO-2:	Model robot kinematics and dynamics using matrix transformations and differential equations.
CO-3:	Interface sensors, actuators, and communication modules with embedded systems.
CO-4:	Program microcontrollers (e.g., Arduino, STM32) for real-time control in robotics.
CO-5:	Design robotic subsystems using sensor fusion, control strategies, and feedback loops.
CO-6:	Analyze and evaluate embedded robotic systems through lab experiments and project demonstrations.

COURSE CONTENT:

MODULE 1:	**INTRODUCTION TO ROBOTICS AND EMBEDDED SYSTEMS**	**5 Hours**
Definitions and classifications of robots (mobile, manipulator, humanoid), Evolution and applications of robotics: industrial, service, defense, medical, Embedded system overview: microcontroller vs. microprocessor, Real-time systems and embedded design flow, Activities: Showcasing modern robotic systems (Boston Dynamics, OpenDog)		
MODULE 2:	**KINEMATICS AND DYNAMICS OF ROBOTS**	8 **Hours**
Architecture of microcontrollers: AVR/ARM (Arduino, STM32), GPIO, Timers, ADC/DAC, Interrupts, PWM, Interfacing with sensors (IR, ultrasonic, IMU) and actuators (servo, DC motor, stepper), Communication protocols: UART, I2C, SPI, Real-time operating systems (RTOS) basics		
MODULE 3:	**EMBEDDED PROGRAMMING AND MICROCONTROLLER INTERFACING**	8 **Hours**

Dialogue system architecture: NLU (Natural Language Understanding), Dialogue Manager (State tracking, policy learning), NLG (Natural Language Generation), Rule-based dialogue management, Statistical approaches (dialogue state tracking), Reinforcement learning in dialogue systems.		
MODULE 4:	**CONTROL SYSTEMS IN ROBOTICS**	**8 Hours**
Types of control: open-loop vs. closed-loop, PID control: tuning, Ziegler-Nichols method, Sensor feedback and error correction, Modeling feedback loop in embedded control systems.		
MODULE 5:	**EMBEDDED SYSTEM DESIGN FOR AUTONOMOUS ROBOTS**	**8 Hours**
Power management, embedded safety, and fail-safe mechanisms, Sensor fusion (Kalman filter, complementary filter), Localization and mapping: odometry, SLAM (conceptual), Integration of software stacks (ROS basics) **Mini Project Planning**: Autonomous robot prototype with embedded controller		
MODULE 6:	**CASE STUDIES, TRENDS AND FUTURE OF ROBOTICS**	**8 Hours**
Applications: surgical robotics, agricultural drones, warehouse robots, Edge AI for embedded robotics, Ethics, privacy, and safety in robotics, Recent trends: swarm robotics, soft robotics, bio-inspired systems, Future research directions in robotics and embedded intelligence		
TOTAL LECTURES		**45 Hours**

Laboratory		
MODULE-1:	Introduction to Embedded Systems and Robotics Kits	**3 Hours**
Exp 1: Demo and hands-on exploration of Arduino, sensors, actuators, and robot chassis		
MODULE-2:	Robotic Kinematics Simulation	**6 Hours**
Exp 2: Simulate forward and inverse kinematics of a robotic arm in Python Exp 3: Develop Denavit-Hartenberg parameters and transformation matrices in MATLAB		
MODULE-3:	GPIO and Sensor Interfacing	**6 Hours**
Exp 4: Control LEDs and DC motors using Arduino GPIO Exp 5: Interface IR sensor, ultrasonic sensor, and IMU for perception and input		
MODULE-4:	Control Systems in Robotics	**6 Hours**
Exp 6: Implement PID control in a line-following robot Exp 7: Encoder feedback-based motion control for precision		
MODULE-5:	Mini Project Development	**3 Hours**
Exp 8: Build an autonomous navigation robot using embedded principles		
MODULE-6:	Performance Evaluation and Interaction	**6 Hours**

Exp 9: Evaluate localization and navigation precision Exp 10: Optional - Emotion-aware interaction using robotic face and sensors Exp 11: Final demonstration and viva	
TOTAL PRACTICAL	**30 Hours**

Text Books:

1. Introduction to Robotics: Mechanics and Control, John J. Craig, Pearson
2. Robotics, Vision and Control, Peter Corke, Springer
3. Embedded Systems with ARM Cortex-M Microcontrollers in Assembly and C, Yifeng Zhu
4. Programming Embedded Systems, Michael Barr and Anthony Massa, O'Reilly

Online Resources:

1. Arduino Documentation: https://docs.arduino.cc
2. STM32CubeIDE Tutorials: https://www.st.com
3. Peter Corke's Robotics Toolbox for MATLAB/Python
4. ROS Tutorials: http://wiki.ros.org
5. Coursera – Control of Mobile Robots (Georgia Tech)

Data Mining and Analytics(Elective-III) + Lab (TIU-UCBCS-C354C)

Program: B. Tech. in CSBS	**Year, Semester:** 3rd Yr., 6th Sem.
Course Title: Data Mining and Analytics(Elective-III) + Lab	**Subject Code:** TIU-UCBCS-C354C
Contact Hours/Week: 2–0–2 (L–T–P)	**Credit:** 3

COURSE OBJECTIVE :

Enable the student to:

1. Introduce the foundations of data mining and analytics from a statistical and computational perspective.
2. Enable students to apply data preprocessing, transformation, and visualization techniques.
3. Understand, implement, and evaluate frequent pattern mining, classification, clustering, and regression.
4. Learn advanced topics like anomaly detection, big data analytics, and ensemble learning.
5. Apply theoretical knowledge through practical lab experiments using real-world datasets and tools like Python, R, Weka, and Spark.

COURSE OUTCOME :

The student will be able to:

CO-1:	Understand the architecture, steps, and key concepts of the data mining and analytics process
CO-2:	Apply data preprocessing techniques such as cleaning, transformation, normalization, and handling missing values.
CO-3:	Implement frequent pattern mining algorithms (Apriori, FP-Growth) and interpret results.
CO-4:	Apply classification techniques (Decision Tree, Naive Bayes, SVM) and evaluate models using statistical metrics.
CO-5:	Perform clustering using k-Means, Hierarchical Clustering, and DBSCAN and assess cluster validity.
CO-6:	Apply advanced analytical tools and frameworks on large datasets, interpret trends, and build predictive analytics models.

COURSE CONTENT

Theory		
MODULE 1:	**INTRODUCTION TO DATA MINING & ANALYTICS**	6 **Hours**
Data mining vs. data analytics vs. machine learning, Architecture of a data mining system, KDD (Knowledge Discovery in Databases) process, Applications and challenges in mining structured and unstructured data Ethical and privacy issues in data mining.		
MODULE 2:	**DATA PREPROCESSING AND VISUALIZATION**	8 **Hours**
Data quality assessment, missing data imputation, Data cleaning, integration, transformation, Feature selection and dimensionality reduction (PCA, LDA), Data discretization and normalization, Exploratory Data Analysis (EDA) and visual analytics using matplotlib, seaborn		
MODULE 3:	**FREQUENT PATTERN MINING & ASSOCIATION RULES**	8 **Hours**
Market basket analysis, itemset mining, Apriori algorithm and support-confidence-lift metrics, FP-Growth algorithm and prefix trees, Rule evaluation and interestingness measures, Applications in retail, recommendation engines, intrusion detection.		
MODULE 4:	**CLASSIFICATION AND PREDICTIVE MODELING**	8 **Hours**
Decision Trees (ID3, C4.5), Random Forests, Naive Bayes classification, Bayes theorem, k-NN, Support Vector Machines (SVM), Model evaluation metrics: Accuracy, Precision, Recall, F1-score, ROC-AUC, Cross-validation and bias-variance trade-off.		
MODULE 5:	**CLUSTERING & UNSUPERVISED LEARNING**	7 **Hours**
Partition-based methods: k-Means, Hierarchical clustering: Agglomerative, Divisive, Density-based clustering: DBSCAN, Cluster evaluation: silhouette score, Davies-Bouldin index, Applications:		

Customer segmentation, document clustering		
MODULE 6:	**ADVANCED ANALYTICS & BIG DATA MINING**	8 **Hours**
Anomaly detection (Statistical, Proximity-based, Isolation Forest), Ensemble models: Bagging, Boosting (AdaBoost, Gradient Boosting), Time series analytics: ARIMA, exponential smoothing, Stream data mining and real-time analytics, Big data platforms: Hadoop, Spark MLlib introduction		
TOTAL LECTURES		**45 Hours**

Laboratory		
MODULE 1:	**DATA PREPARATION AND PATTERN MINING**	6 **Hours**
Data exploration and preprocessing (Python/R) Implement Apriori and FP-Growth for pattern mining		
MODULE 2:	**CLASSIFICATION AND EVALUATION**	6 **Hours**
Classification using Decision Tree and Naive Bayes Model evaluation metrics: accuracy, precision, recall, F1-score, ROC		
MODULE 3:	**CLUSTERING TECHNIQUES**	**6 Hours**
k-Means and Hierarchical clustering on sample datasets Density-based clustering using DBSCAN		
MODULE 4:	**ANOMALY DETECTION AND FORECASTING**	**6 Hours**
Detect anomalies using Z-score and Isolation Forest Perform time series forecasting using ARIMA and Exponential Smoothing (ETS)		
MODULE 5:	**CAPSTONE MINI PROJECT**	**3 Hours**
Mini project: Predictive modeling on real-world dataset (e.g., stock prices, energy data, IoT logs) Final presentation, visualization, and evaluation		
MODULE 6:	**EVALUATION AND EMOTION MODELING**	**3 Hours**
Evaluation & Trends – Evaluate chatbot using F1, BLEU, etc., and implement emotion detection using pretrained models		
TOTAL LECTURES		**30 Hours**

Tools and Platforms:

1. Programming: Python (NumPy, pandas, scikit-learn, statsmodels, seaborn), R

2. Cloud Environments: Google Colab / AWS SageMaker / Azure Notebooks

Text Books:

1. **Data Mining: Concepts and Techniques**, Jiawei Han, Micheline Kamber, Jian Pei – Morgan Kaufmann
2. **Introduction to Data Mining**, Pang-Ning Tan, Michael Steinbach, Vipin Kumar – Pearson
3. **Data Science for Business**, Foster Provost and Tom Fawcett – O'Reilly
4. **The Elements of Statistical Learning**, Hastie, Tibshirani, Friedman – Springer

Online Resources:

1. UCI Machine Learning Repository: https://archive.ics.uci.edu/ml/
2. Kaggle Datasets and Competitions: https://www.kaggle.com/
3. Scikit-learn Documentation: https://scikit-learn.org/
4. DataCamp, Coursera (Stanford ML, Johns Hopkins Data Science)
5. Apache Spark MLlib Docs: https://spark.apache.org/mllib/

Image Processing and Pattern Recognition (Elective IV) + Lab (TIU-UCBCS-C356A)

Program: B. Tech. in CSBS	**Year, Semester:** 3rdYear, 6th Sem.
Course Title: Image Processing and Pattern Recognition (Elective IV) + Lab	**Subject Code:** TIU-UCBCS-C356A
Contact Hours/Week: 3–0–2 (L–T–P)	**Credit:** 4

COURSE OBJECTIVE:

1. Introduce students to the fundamental concepts of digital image processing, including sampling, quantization, image transforms, and enhancement techniques.
2. Develop an understanding of spatial and frequency domain methods for image enhancement and their applications.
3. Enable students to apply segmentation techniques such as edge detection, thresholding, and region-based methods for effective image analysis.
4. Provide insights into image representation and description methods, including boundary and regional descriptors.

COURSE OUTCOME:

The students will be able to:

CO1:	Understand the fundamental concepts of digital image processing, including sampling and quantization, image transforms, and image enhancement.

CO2:	Apply spatial and frequency domain methods to enhance images.
CO3:	Segment images using edge detection, thresholding, and region-based methods.
CO4:	Represent and describe images using different schemes.
CO5:	Understand the fundamental problems in pattern recognition, including classification, clustering, and feature selection.
CO6:	Implement and evaluate image processing and pattern recognition techniques in real-world applications.

COURSE CONTENT:

MODULE 1:	**Digital Image Fundamentals & Image Transforms**	**5 Hours**
Sampling and Quantization, Binary image Analysis, 2-D FFT, Properties, Walsh Transform, Hadamard Transform, Discrete cosine Transform, Discrete Wavelet Transform,		
MODULE 2:	**Image Enhancement**	**9 Hours**
Spatial domain methods: Introduction, Image Enhancement in Spatial Domain, Bilateral and Guided Filtering, Enhancement Through Point Operation, Types of Point Operation, Histogram Manipulation, gray level Transformation, local or neighbourhood operation, median filter, spatial domain high- pass filtering. Frequency domain methods: Filtering in Frequency Domain, Obtaining Frequency Domain Filters from Spatial Filters, Generating Filters Directly in the Frequency Domain, Low Pass(smoothing) and High Pass (sharpening) filters in Frequency Domain.		
MODULE 3:	**Image Segmentation and Morphological Image Processing**	**7 Hours**
Detection of discontinuities, Edge linking and boundary detection, Thresholding, Region oriented segmentation Dilation and Erosion, structuring element, Opening and closing, The Hit and Miss Transform.		
MODULE 4:	**Representation and description**	**3 Hours**
Representation schemes, Boundary descriptors, Regional descriptors (Texture, moments)		
MODULE-5:	**Fundamental problem in pattern recognition**	**5 Hours**
Basic problem of pattern recognition with example, Pattern, Pattern class, Classification, Classifier, Pattern Recognition Model, Feature selection, False alarms.		
MODULE-6:	**Clustering**	**5 Hours**
Fundamental of lustering, Metric and non-metric proximity, Density estimation (Parzen window approach, nearest neighbor approach), Seed point selection (Single seed, Multi seed techniques), Hierarchical clustering (Agglomerative, Divisive: K-means, ISODATA), Fuzzy C-means		
MODULE-7:	**Classification**	**5 Hours**
Pattern classification by likelihood function, Bayes classifier, Artificial Neural Net (Neuron, types of neurons, Neural network model, Hopfield net algorithm, Single layer perceptron algorithm and multi-layer perceptron algorithm)		
MODULE-8:	**Remote sensing and application**	**6 Hours**
Characteristics of remote sensing (resolution, bands, spectral range, spectral reflection, LANDSAT, SPOT, IRS -1C), Classification of remote sensing data (Minimum distance classifier, Bayes classifier,		

parallelepiped classifier, multi-seed technique, Support Vector Machine), Application of remote sensing data.	
TOTAL LECTURES	**45 Hours**

Laboratory:

MODULE 1:	**FUNDAMENTALS OF IMAGE PROCESSING**	**6 Hours**
Introduction to digital images and pixel representation, Reading and storing images using Python (OpenCV, PIL, NumPy), Basic image transformations: Translation, Rotation, Scaling,Calculation of Centroid, Area, and Perimeter of objects, Understanding image formats and data structures		
MODULE 2:	**IMAGE CONVERSION AND HISTOGRAM OPERATIONS**	**5 Hours**
Image Conversion Techniques: RGB to Grayscale and other color model transformations, Image padding techniques; Histogram Processing: Histogram Equalization and Stretching, Exponential and Logarithmic Operators for contrast enhancement, Applications in medical imaging and remote sensing		
MODULE 3:	**IMAGE FILTERING AND NOISE REDUCTION**	**5 Hours**
Filtering Techniques for Image Enhancement: Mean, Median, and Gaussian filters Noise Reduction Techniques: Salt-and-Pepper Noise Removal, Smoothing and sharpening filters		
MODULE 4:	**EDGE DETECTION AND THRESHOLDING TECHNIQUES**	**5 Hours**
Edge Detection Methods: Sobel, Prewitt, Laplacian operators, Thresholding and Segmentation: Global and adaptive thresholding techniques, Binary and multi-level segmentation		
MODULE 5:	**FEATURE EXTRACTION FOR IMAGE ANALYSIS**	**5 Hours**
Shape-Based Feature Extraction: Bounding Box and Optimal Bounding Box, Circular and Elliptical Fit for 2D shapes; Texture Feature Extraction: Entropy, Contrast, Energy, Correlation, Applications in industrial inspection and medical diagnostics		
MODULE 6:	**MACHINE LEARNING AND CLASSIFICATION IN IMAGE PROCESSING**	**5 Hours**
Clustering Techniques for Pattern Recognition: K-Means, Fuzzy C-Means, Agglomerative Clustering; Remote Sensing and Supervised Classification: Generating training sets for water, concrete, and vegetation, Applying Minimum Distance and Parallelepiped Classifiers. Evaluating classifier performance on real-world datasets		

TOTAL LAB HOURS	**30 Hours**

Books:

1. R. C. Gonzalez and R. E. Woods, “Digital Image Processing”, Pearson, 2017, ISBN-10: 0133356728, ISBN-13: 978-0133356724.
2. B. B. Chaudhuri and U. Pal, “Digital Document Processing: Major Directions and Recent Advances”, Springer, 2007, ISBN-10: 184628501X, ISBN-13: 978-1846285013.
3. E. R. Davies, “Computer and Machine Vision: Theory, Algorithms, Practicalities”, Academic Press, 2018, ISBN-10: 0128092847, ISBN-13: 978-0128092842.
4. S. Theodoridis and K. Koutroumbas, “Pattern Recognition”, Academic Press, 2008, ISBN-10: 1597492728, ISBN-13: 978-1597492720.

Enterprise Systems (Elective IV) + Lab (TIU-UCBCS-C356B)

Program: B. Tech. in CSBS	**Year, Semester:** 3rd Yr., 6th Sem.
Course Title: Enterprise Systems (Elective IV) + Lab	**Subject Code:** TIU-UCBCS-C356B
Contact Hours/Week: 3–0–2 (L–T–P)	**Credit:** 4

COURSE OBJECTIVE:

Enable the student to:

1. To **understand** and learn the concepts of Enterprise Systems, Architecture, and Cloud Computing, and apply this knowledge effectively.
2.
3. To **explain** the characteristics and applications of Enterprise Systems, Architecture, and Cloud Computing.
4.
5. To **design and evaluate** the deployment of various Enterprise System Models and Architectures.

COURSE OUTCOME:

The student will be able to:

CO1:	**Explain** and classify the various functional areas of management, the information systems within them, and the information technologies that are used.
CO2:	**Apply** and assess the current role of IT within an organization, specifically in achieving organizational goals, objectives, and supporting the implementation of strategies.
CO3:	**Analyze** and examine the significance of business processes in facilitating the implementation of enterprise systems.
CO4:	**Design and implement** and assess the process of implementing enterprise systems within an organization.
CO5:	**Integrate** and describe how enterprise systems utilize relational database management systems (RDBMS) to manage organizational data and facilitate decision-making processes.
CO6:	**Evaluate** and analyze real-world cases of enterprise systems and their impact on decision-making.

COURSE CONTENT:

Theory		
MODULE 1:	**INTRODUCTION TO MODERN ENTERPRISE SYSTEMS**	**5 Hours**

Introduction to Enterprise Systems:
Business Information Systems (BIS), Decision Support Systems (DSS), Knowledge Management Systems (KMS)
Overview of the types and functions of these systems in an enterprise environment.
Types of Enterprise Systems
B2C (Business to Consumer)
B2B (Business to Business)
Explanation of how these models operate and their impact on business operations.
Components of Enterprise Systems
Channels: Communication pathways and their role in enterprise systems.
Data Management: How data is collected, stored, and processed for efficient system performance.
Workflow: The flow of tasks and processes across different departments and systems.
Controlling and Auditing: Mechanisms for ensuring compliance, monitoring processes, and maintaining transparency.
Accounting: Financial management and reporting within enterprise systems.

MODULE 2:	TYPES OF ENTERPRISE SYSTEMS AND WORKING	8 Hours

Key Enterprise Systems

Enterprise Resource Planning (ERP): Integrated systems to manage core business processes.
Supply Chain Management (SCM): Systems to manage the flow of goods, services, and information across the supply chain.
Customer Relationship Management (CRM): Systems that manage interactions with customers and enhance customer satisfaction.
Product Lifecycle Management (PLM): Systems to manage the lifecycle of a product from inception through design, production, and end-of-life.
Human Resource Management Systems (HRM): Systems for managing employee data, payroll, benefits, and performance.
General Ledger (GL) Systems: Accounting systems used for financial reporting and managing the organization's financial transactions.

MODULE 3:	KEY CONCEPTS AND ARCHITECTURE OF ENTERPRISE SYSTEMS	8 Hours

Key Concepts in Enterprise Systems:

Distributivity
Refers to the ability of enterprise systems to distribute data and processes across multiple locations or platforms, ensuring that tasks can be executed simultaneously and efficiently.
Managed Redundancy
Involves the strategic duplication of critical system components or data to ensure system reliability, fault tolerance.
Exception Processing
A mechanism to identify and handle errors or exceptions in the system, ensuring that they are managed promptly and do not disrupt normal business operations.
Collaboration
The process of facilitating cooperation between different departments, teams, or systems within an organization.
Data Transformation
The process of converting data from one format or structure to another to ensure compatibility between different.

Enterprise System Architectures:
Batch Processing Architecture
Involves processing data in large batches rather than in real-time. Suitable for tasks that do not require immediate responses but can be processed in scheduled intervals.
Monolithic Architecture
A traditional, unified system where all components are tightly integrated into a single framework, making it less.
Client-Server Architecture
A distributed system where clients (users or devices) request services or data.
E-commerce Architecture
Architecture designed to support online transaction systems, focusing on ensuring smooth customer interactions, secure payment processes.
Service-Oriented Architecture (SOA)
An architectural style that involves breaking down applications into discrete services that communicate through standardized protocols, enabling greater flexibility and scalability.
Microservices Architecture
A variation of SOA that focuses on small, independent services designed to handle specific business functions, providing greater agility.
Cloud Architecture
A model for designing systems that leverage cloud computing resources.
Enterprise Application Architectures:
Layered Architecture
Involves organizing application components into distinct layers (e.g., presentation, business logic, and data access layers) that interact with each other.
Event-Driven Architecture (EDA)
An architectural approach that focuses on producing, detecting, and reacting to events (such as user actions or system triggers.
Service-Oriented Architecture (SOA)
A modular design approach where applications are broken down into a set of services that interact over standardized communication protocols, improving flexibility, reusability, and scalability.
Microservice Architecture
A modern approach to software architecture where complex applications are broken down into smaller, independent services.
Plug-in Architecture
A flexible architecture that allows external modules (plug-ins) to be added to an existing system

MODULE 4:	ENTERPRISE SYSTEM INTEGRATION AND STYLES	8 Hours

Overview of Enterprise Integration

The process of connecting different systems, applications, and data sources within an organization to ensure seamless communication, data sharing, and workflow automation across various platforms and technologies.

Different Integration Styles

Point-to-Point Integration: Direct connections between systems, typically used for simpler environments but can be difficult to scale.
Hub-and-Spoke Integration: A centralized approach where multiple systems connect through a central hub, improving scalability and management.
Middleware Integration: The use of middleware platforms (such as Enterprise Service Buses) to handle communication and data translation between different systems.
Service-Oriented Integration: Involves organizing services into discrete components that interact over standardized protocols for greater flexibility and scalability.

MODULE 5:	ROLE AND ADVANTAGES OF CLOUD BASED SYSTEMS	8 Hours

Types of Cloud:
Private Cloud
A cloud environment exclusively used by a single organization. It offers greater control, customization, and security but requires.
Public Cloud
A cloud environment where services are provided by third-party providers and shared among multiple organizations.
Hybrid Cloud
A combination of private and public clouds, allowing businesses to maintain critical applications and data on private infrastructure.
Advantages of Cloud Computing:

Scalability
Cloud computing offers elastic scalability, enabling organizations to scale up or down their IT resources based on demand.
Availability
Cloud services are typically available 24/7 with minimal downtime, providing users with access to their applications and data.
Cost Efficiency
With cloud computing, businesses only pay for the resources they use, eliminating the need for expensive infrastructure investments

MODULE 6:	APPLICATION DEPLOYMENT AND IMPORTANCE OF ENTERPRISE ARCHITECTURE	8 Hours

Cloud-Based Application Development
Cloud platforms provide powerful tools and environments for developing and deploying applications without the need for on-premises infrastructure.
Docker
Containerization Technology: Docker is a platform for developing, shipping, and running applications within containers.
Benefits of Docker:
Simplifies deployment by encapsulating applications in lightweight, portable containers.
Microservices
Decentralized Application Architecture: Microservices is an architectural style where an application is broken down into smaller, loosely coupled services.
Benefits of Microservices:
Provides flexibility and scalability by allowing independent development, deployment, and scaling of individual services.
Kubernetes
Container Orchestration: Kubernetes is an open-source platform for automating the deployment, scaling, and management of containerized applications
Benefits of Kubernetes:
Simplifies the management of large-scale applications by automating tasks such as scaling and monitoring.
Ensures high availability and resilience of applications.
Serverless Computing
Event-Driven Architecture: In a serverless environment, the cloud provider manages the infrastructure, and developers focus solely on writing code
Benefits of Serverless:
Reduces operational overhead as there is no need to manage servers or worry about scaling.

Importance of Enterprise Architecture:

Defining the Structure of an Organization's IT Landscape
Enterprise architecture (EA) provides a strategic framework for aligning business objectives with IT infrastructure.
Benefits of Enterprise Architecture:
Improved Alignment: EA ensures that IT systems and resources align with business strategies and goals, improving overall efficiency and reducing waste.
Risk Management: Helps organizations mitigate risks by providing a comprehensive view of the IT environment, enabling proactive identification of potential issues.
Cost Efficiency: By reducing redundancy and optimizing resources, EA leads to more cost-effective IT investments.

TOTAL LECTURES	**45 Hours**

aboratory

MODULE-1:	INTRODUCTION TO ENTERPRISE SYSTEMS	5 Hours

Introduce students to the concept of enterprise systems, their components, and their role in business operations.

Lab Activity:

Overview of enterprise systems (ERP, CRM, SCM).
Demonstration of an ERP system (e.g., SAP, Oracle).
Hands-on: Navigate a basic ERP interface (order processing, inventory management, finance modules).
Assignment: Discuss the various types of enterprise systems and how they integrate business functions.

MODULE-2:	IMPLEMENTING AND CONFIGURING AN ERP SYSTEM (SAP/ORACLE)	6 Hours

Understand how ERP systems are implemented and configured to meet organizational needs.

Lab Activity:

Overview of SAP/Oracle system setup and configuration.
Hands-on: Configure a basic ERP system (e.g., creating a company, defining organizational structure).
Practical: Set up a chart of accounts, configure financial modules, and simulate a purchase order process.
Assignment: Write a report on the steps taken to configure the ERP system and challenges faced during configuration.

MODULE-3:	BUSINESS PROCESS MODELING AND SIMULATION	6 Hours

Learn about business process modeling techniques and simulate business processes within an enterprise system.

Lab Activity:

Introduction to Business Process Model and Notation (BPMN).
Use BPMN tools (e.g., Bizagi Modeler, Lucidchart) to create a business process model.
Hands-on: Model a business process like order-to-cash or procure-to-pay.
Simulation: Simulate the process flow and identify bottlenecks.
Assignment: Analyze the modeled process and suggest process optimizations.

MODULE-4:	**CUSTOMER RELATIONSHIP MANAGEMENT (CRM) SYSTEM CONFIGURATION**	**5 Hours**
Gain hands-on experience in configuring a CRM system and understand its role in enhancing customer relationships. **Lab Activity:** Overview of CRM systems (e.g., Salesforce, Microsoft Dynamics). Hands-on: Configure customer records, lead management, and sales pipeline. Create and manage customer interactions (e.g., service requests, email campaigns). Practical: Customize CRM fields, dashboards, and reports. Assignment: Develop a case study of how CRM can improve customer engagement in a given industry.		
MODULE-5:	**SUPPLY CHAIN MANAGEMENT (SCM) INTEGRATION WITH ERP**	**4 Hours**
Understand the role of SCM in enterprise systems and its integration with ERP. **Lab Activity**: Introduction to SCM concepts (e.g., procurement, logistics, demand planning). Hands-on: Integrate an SCM module with an ERP system to manage procurement and inventory processes. Practical: Perform inventory checks, track supplier orders, and manage stock levels. Assignment: Analyze how SCM and ERP systems reduce inefficiencies in supply chains.		
MODULE -6:	**DATA ANALYTICS AND REPORTING IN ENTERPRISE SYSTEMS**	
Learn how to use data analytics tools to generate reports and insights from enterprise systems. **Lab Activity**: Introduction to data analytics within ERP systems. Hands-on: Use tools like SAP BI, Oracle Analytics, or Power BI to create reports and dashboards. Practical: Generate reports on key business metrics (e.g., sales, financial performance). Assignment: Analyze a set of reports, interpret business trends, and present findings.		
MODULE-7:	**SECURITY AND DATA PRIVACY IN ENTERPRISE SYSTEMS**	**4 Hours**

Understand the importance of data security and privacy in enterprise systems and explore security best practices. **Lab Activity:** Overview of security risks and measures in enterprise systems. Hands-on: Implement role-based access control (RBAC), audit logs, and data encryption in ERP and CRM systems. Practical: Simulate a security breach and practice troubleshooting. Assignment: Write a report on the importance of data privacy in enterprise systems and the measures organizations should take to mitigate risks.	
TOTAL PRACTICAL	**30 Hours**

TEXTBOOKS:

1. Ralph Stair, George Reynold, " Principle of Information Systems ", 10 ed.
2. Martin Fowler et al, "Pattern of Enterprise Application Architecture;, Addison- Wesley, 2012
3. Gregor Hohpe, Bobby Woolf, Enterprise Integration Patterns: Designing, Building, and Deploying Messaging Solutions.
4. Mark Richards, Software Architecture patterns, 2015;Reilly.
5. Sam Newman, "Building Microservices, 2015;Reilly.
6. David Farley, Jez Humble, "Continuous Delivery: Reliable Software Releases through Build, Test, and Deployment Automation, Jan 2016

REFERENCE BOOKS:

1. Brendan Burns, Designing Distributed Systems; Reilly, 2016
2. Enterprise Integration Patterns - Messaging Patterns Overview
3. Software architecture in Practice 3rd Edition- 2014

WEB REFERENCES:

1. https://www.floridatechonline.com/blog/information-technology/ types-of-enterprise-systems-and-their-applications/
2. https://standardbusiness.info/enterprise-system/
3. https://pimcore.com/en/how-to-build-modern-enterprise-dataarchitecture
4. https://www.ringcentral.com/us/en/blog/what-is-enterprise-architecture-ea/

LAB BOOKS:

1. Enterprise Resource Planning: Concepts, Methodologies, Tools, and Applications" by K. K. Goyal, Sudhir Rana, and P. K. Suri
2. Practical Guide to Business Process Modeling" Author: James C. C. W. Chang.

Advance Finance (Elective IV)+Lab (TIU-UCBCS-C356C)

Program: B. Tech. in CSBS	**Year, Semester:** 3RD YEAR, 6 SEM
Course Title: Advance Finance (Elective IV)+Lab	**Subject Code:** TIU-UCBCS-C356C
Contact Hours/Week: 3–0–2 (L–T–P)	**Credit: 5**

COURSE OBJECTIVE:

Enable the student to:

- Understand the core principles of corporate finance, financial markets, and instruments.
- Analyze financial statements, evaluate investment decisions, and assess risk and return.
- Apply techniques for capital budgeting, working capital management, and portfolio management.
- Develop practical skills in financial analysis, forecasting, and decision-making using Python and spreadsheets.

COURSE OUTCOME:

The student will be able to:

CO1:	Understand financial principles, corporate goals, and time value of money.
CO2:	Analyze and interpret financial statements to assess a company's performance.
CO3:	Evaluate investment projects using capital budgeting techniques.
CO4:	Apply portfolio theory and risk-return analysis in investment decision-making.
CO5:	Use financial models and tools for forecasting and working capital analysis.
CO6:	Implement financial analysis using Python and Excel with real-world data.

COURSE CONTENT:

Theory		
MODULE 1	**FINANCIAL MANAGEMENT BASICS**	**7 Hours**
Introduction to Finance, Role of Financial Manager, Financial Goals, Agency Conflicts, Time Value of Money – Present and Future Value, Annuities and Perpetuities		
MODULE 2	**FINANCIAL STATEMENT ANALYSIS**	**7 Hours**
Balance Sheet and Income Statement overview, Cash Flow Statement, Financial Ratios, Common-Size Analysis, Trend Analysis, DuPont Analysis.		

MODULE 3	**CAPITAL BUDGETING**	**7 Hours**
Investment decision process, Cash flow estimation, Evaluation techniques: NPV, IRR, Payback Period, Profitability Index,		
MODULE 4	**RISK AND RETURN ANALYSIS**	**8 Hours**
Concept of risk and return, Risk types, Portfolio theory, CAPM, Beta estimation, Security Market Line.		
MODULE 5	**WORKING CAPITAL MANAGEMENT**	**8 Hours**
Working Capital Concepts, Inventory and Receivables Management, Cash Management, Operating Cycle, Financing Current Assets.		
MODULE 6	**INTRODUCTION TO PORTFOLIO MANAGEMENT**	**8 Hours**
Diversification, Portfolio Risk and Return, Efficient Frontier, Portfolio Performance Measures, Introduction to Behavioral Finance.		
	TOTAL LECTURE	**45 Hours**

Laboratory		
MODULE-1:	**FINANCIAL CALCULATIONS IN PYTHON & EXCEL**	**7 Hours**
Basics of Python for finance, Excel formulas, NPV, IRR, Time Value of Money computations, Loan Amortization.		
MODULE-2:	**FINANCIAL STATEMENT ANALYSIS TOOLS**	**8 Hours**
Importing and analyzing financial data in Python and Excel, computing financial ratios, visualization, DuPont breakdown.		
MODULE-3:	**CAPITAL BUDGETING SIMULATIONS**	**8 Hours**
Cash flow estimation, capital budgeting decision models, scenario and sensitivity analysis, Python-based financial modeling.		
MODULE-4:	**PORTFOLIO CONSTRUCTION & RISK ANALYSIS**	**7 Hours**
Using Python libraries like NumPy, pandas, and matplotlib to model portfolios, calculate returns, risk, Beta, and Sharpe Ratio; visualization of Efficient Frontier.		
	TOTAL PRACTICAL	**30 Hours**

Books:

1. *Principles of Corporate Finance* – Richard A. Brealey, Stewart C. Myers
2. *Financial Management: Theory & Practice* – Prasanna Chandra
3. *Essentials of Financial Management* – Eugene F. Brigham
4. *Python for Finance* – Yves Hilpisch
5. *Financial Modeling in Excel* – Danielle Stein Fairhurst

SEMESTER 7

IT Workshop Skylab / Matlab Lab (TIU-UCBCS-L401)

Program: B. Tech. in CSBS	**Year, Semester:** 4th Yr., 7th Sem.
Course Title: IT Workshop Skylab / Matlab Lab	**Subject Code:** TIU-UCBCS-L401
Contact Hours/Week: 0–0–4 (L–T–P)	**Credit:** 2

COURSE OBJECTIVE :

Enable the student to:

1. understand the programming technique on MATLAB
2. apply the knowledge of MATLAB commands and design a program to execute mathematical operations
3. evaluate a MATLAB codebase and create optimized codeflow for any function in needed.

COURSE OUTCOME :

The student will be able to:

CO-1:	Explain the fundamental concepts and features of MATLAB or Skylab.	K2
CO-2:	Write and execute MATLAB/Skylab scripts for various applications.	K2
CO-3:	Manipulate variables and understand data types in MATLAB/Skylab.	K4
CO-4:	Apply built-in functions and toolboxes to enhance functionality.	K3
CO-5:	Create effective data visualizations using MATLAB/Skylab.	K3
CO-6:	Analyze data sets and perform calculations to derive insights.	K3

COURSE CONTENT :

MODULE 1:	**Introduction to MATLAB**	**3 Hours**
History, basic features, strengths and weaknesses, good programming practices and plan your code.		
MODULE 2:	**Variables, workspace, and miscellaneous commands**	**7 Hours**
Creating MATLAB variables, overwriting variables error messages, making corrections, controlling the hierarchy of operations or precedence, controlling the appearance of floating point number, managing the workspace, keeping track of work session entering multiple statements per line, miscellaneous commands.		
MODULE 3:	**Matrix, array and basic mathematical functions**	**7 Hours**
Matrix generation, entering a vector, entering a matrix matrix indexing, colon operator, linear spacing Creating a submatrix, matrix generators, Special matrices matrix operations and functions array and array operations solving linear equations, and other mathematical functions		

MODULE 4:	**Basic plotting**	**5 Hours**
Overview, creating simple plots, adding titles, axis labels, and annotations, multiple data sets in one plot, specifying line styles and colours.		
MODULE 5:	**Introduction to programming & Debugging**	**10 Hours**
Introduction, M-file scripts, script side effect, M-file functions, Input and output arguments input to a script file, output commands Debugging process, setting breakpoints, running with breakpoints Correcting and ending debugging, correcting an M-file.		
MODULE 6:	**Control flow and operators**	**7 Hours**
"If..end" structure, relational and logical operators "for….end" loop, "while….end" loop other flow structures, operator precedence, saving output to a file		
TOTAL LECTURES		**39 Hours**

Text book:

1. 'MATLAB-a Practical Introduction to Programming and Problem Solving', Stormy Attaway, Butterworth Heinmenn.

Usability Design of Software Applications Lab (TIU-UCBCS-C403)

Program: B. Tech. in CSBS	**Year, Semester:** 4th Year, 7th Sem
Course Title: Usability Design of Software Applications Lab	**Subject Code:** TIU-UCBCS-L403
Contact Hours/Week: 0–1–3 (L–T–P)	**Credit:** 2.5

COURSE OBJECTIVE:

Enable the student to:

1. Understand the core principles of Human-Computer Interaction (HCI) and usability.
2. Conduct user research and translate insights into design specifications.
3. Build interactive prototypes using modern UI/UX tools.
4. Evaluate the usability of software applications through user testing and heuristic methods.
5. Enhance accessibility and inclusivity in software application design.

COURSE OUTCOME:

The student will be able to:

CO1	Understand usability design concepts, HCI principles, and user-centered design methodology.

CO2	Conduct requirement gathering using user personas, scenarios, and storyboarding.
CO3	Design wireframes and interactive user interfaces for software applications.
CO4	Apply usability testing techniques including heuristic evaluation and user feedback.
CO5	Use tools like Figma or Adobe XD to create functional prototypes.
CO6	Improve real-world application usability through iterative refinement based on evaluation.

COURSE CONTENT:

Laboratory		
MODULE-1:	**TOOL INTRODUCTION & USER ANALYSIS**	**6 Hours**
Intro to design tools (Figma, Adobe XD, Balsamiq) Create personas, storyboards, and user scenarios Simple task analysis and affinity diagrams		
MODULE-2:	**WIREFRAMING & UI DESIGN**	**6 Hours**
Low-fidelity wireframe creation UI layout design using grids and guides Designing navigation flows and screen linking Aesthetics: Color palette, fonts, icon usage		
MODULE-3:	**USABILITY TESTING & ANALYSIS**	**7 Hours**
Conduct heuristic evaluation Perform user testing and observe behavior Gather and interpret user feedback Document usability issues and design revisions		
MODULE-4:	**MINI PROJECT – APP DESIGN**	**6 Hours**
Choose a domain: E.g., Health app, Booking app, E-learning Build UI wireframes and interactive prototype Conduct usability test and improve design Present usability report and final design		
	TOTAL PRACTICAL	**25 Hours**

Books:

1. **The Design of Everyday Things** – Don Norman
2. **Don't Make Me Think** – Steve Krug
3. **Designing Interfaces** – Jenifer Tidwell
4. **About Face: The Essentials of Interaction Design** – Alan Cooper

5. **A Project Guide to UX Design** – Russ Unger & Carolyn Chandler
6. **Lean UX** – Jeff Gothelf

Financial Management (TIU-UCBMG-T401)

Program: B. Tech. in CSBS	**Year, Semester:** 4thYr., 7th Sem
Course Title: Financial Management	**Subject Code:** TIU-UCBMG-T401
Contact Hours/Week: 2.5–0–0 (L–T–P)	**Credit:** 2.5

Course Outcome(s):

CO-1:	Understand the fundamental concepts of financial management
CO-2:	Appreciate basic concepts such as time value of money, cost of capital, risk and return, working capital management, capital budgeting etc.
CO-3:	Leverage the concept for deciding financial angle of IT projects

Course Objectives :

1. To introduce the fundamental concepts of financial management and the goals of a firm in a financial environment.
2. To develop an understanding of the time value of money and its applications in financial decision-making.
3. To provide knowledge on valuation of securities including bonds, stocks, and their associated risk-return tradeoffs.
4. To explore the concepts of operating and financial leverage, their effects on firm performance, and capital structure decisions.
5. To familiarize students with the concepts and computation of cost of capital and its impact on investment decisions.
6. To enable the application of capital budgeting techniques for evaluating and selecting investment projects.
7. To impart knowledge of working capital management and its components including cash, receivables, and inventory.
8. To understand the practices and policies involved in managing cash flows and credit in business environments.

Course Content:

Module 1	Introduction	3 Hours
Introduction : Introduction to Financial Management - Goals of the firm - Financial Environments. **Time Value of Money :** Simple and Compound Interest Rates, Amortization, Computing more that once ayear, Annuity Factor.		
Module 2	**Valuation of Securities**	**5 Hours**
Valuation of Securities : Bond Valuation, Preferred Stock Valuation , Common Stock Valuation,Concept of Yield and YTM. **Risk & Return:** Defining Risk and Return, Using Probability Distributions to Measure Risk, Attitudes Toward Risk,Risk and Return in a Portfolio Context, Diversification, The Capital Asset Pricing Model (CAPM)		
Module 3	**Operating & Financial Leverage**	**16 Hours**
Operating & Financial Leverage: Operating Leverage, Financial Leverage, Total Leverage, IndifferenceAnalysis in leverage study **Cost of Capital** :Concept , Computation of Specific Cost of Capital for Equity - Preference – Debt,Weighted Average Cost of Capital – Factors affecting Cost of Capital 4L **Capital Budgeting :** The Capital Budgeting Concept & Process - An Overview, Generating Investment ProjectProposals, Estimating Project, After Tax Incremental Operating Cash Flows, Capital Budgeting Techniques,Project Evaluation and Selection - Alternative Methods		
Module 4	**Working Capital Management**	**21 Hours**
Working Capital Management: Overview, Working Capital Issues, Financing Current Assets (Short Termand Long Term- Mix), Combining Liability Structures and Current Asset Decisions, Estimation of WorkingCapital. **Cash Management:** Motives for Holding cash, Speeding Up Cash Receipts, Slowing Down Cash Payouts,Electronic Commerce, Outsourcing, Cash Balances to maintain, Factoring. **Accounts Receivable Management:** Credit & Collection Policies, Analyzing the Credit Applicant, CreditReferences, Selecting optimum Credit period. 4L		
Total		**45 Hours**

Text Book

Chandra, Prasanna - Financial Management - Theory & Practice, Tata McGraw Hill.

References Books :

Srivastava, Misra: Financial Management, OUP

Van Horne and Wachowicz : Fundamentals of Financial Management, Prentice Hall/ Pearson Education.

Human Resource Magement (TIU-UCBMG-T403)

Program: B. Tech. in CSBS	**Year, Semester:** 4th Yr 7th Sem
Course Title: Human Resource Management	**Subject Code:** TIU-UCBMG-T403
Contact Hours/Week: 2–0–0 (L–T–P)	**Credit:** 2

COURSE OBJECTIVE :

Enable the student to:

1. Learn Concept & challenges of HRM,Philosophy
2. Acquaint system design,HRprofession,Functional areas of HRM
3. Learn HRM planning, Strategic management of HRM, HRM in Service Sector

COURSE OUTCOME :

The student will be able to:

CO-1:	Explain the fundamental concepts, theories, and functions of human resource management
CO-2:	Develop and implement effective recruitment and selection strategies
CO-3:	Design and conduct effective on boarding programs for new employees
CO-4:	Implement performance management systems to evaluate and improve employee performance
CO-5:	Analyze and design compensation and benefits packages to attract and retain talent
CO-6:	Understand labor relations and the legal aspects of human resource management.HRM in Service Sector

COURSE CONTENT :

MODULE 1:	**HUMAN RESOURCE MANAGEMENT**	**6 Hours**
Concept and Challenges, HR Philosophy, Policies, Procedures and Practices.		
MODULE 2:	**Human Resource System Design**	**6 Hours**
HR Profession, and HR Department, Line Management Responsibility in HRM, Measuring HR, Human resources accounting and audit; Human resource information system		
MODULE 3:	**Functional Areas of HRM**	**6 Hours**
recruitment and staffing, benefits, compensation, employee relations, HR		

compliance, organizational design, training and development, human resource information systems (H.R.I.S.) and payroll.		
MODULE 4:	**Human Resource Planning**	**6 Hours**
Demand Forecasting, Action Plans– Retention, Training, Redeployment & Staffing, Succession Planning		
MODULE 5:	**Strategic Management of Human Resources**	**6 Hours**
SHRM, relationship between HR strategy and overall corporate strategy, HR as a Factor of Competitive Advantage, Managing Diversity in the Workplace		
MODULE 6:	**Human Resource Management in Service Sector**	**6 Hours**
Managing the Customer – Employee Interaction,Employee Empowerment and Customer Satisfaction,Service Failure and Customer Recovery – the Role of Communication and Training,Similarities and Differences in Nature of Work for the Frontline Workers and the Backend,Support Services - Impact on HR Practices Stressing Mainly on Performance,Flexible Working Practices – Implications for HR.		
TOTAL LECTURES		**36 Hours**

Text Books:

T1. Human Resource Management: V.Aswathapa.
R1.Human Resource Management: R.K.Ghai,S.P.S. Bedi.

Cognitive Science & Analytics +Lab (Elective V) (TIU-UCBCS-C453C)

Program: B. Tech. in CSBS	**Year, Semester:** 4th Yr., 7th Sem.
Course Title: Cognitive Science & Analytics +Lab (Elective V)	**Subject Code:** TIU-UCBCS-C453A
Contact Hours/Week: 3–0–2 (L–T–P)	**Credit:** 4

COURSE OBJECTIVE:

Enable the student to:

1. **Understand** the foundational concepts of cognitive science, including key theories of human cognition, perception, memory, and learning, and how they relate to analytics in decision-making processes.
2. **Apply** cognitive science principles to analyze and interpret complex data sets, leveraging analytics techniques to simulate cognitive processes and improve understanding of human behavior and decision-making.
3. **Perform** data-driven cognitive analyses using advanced analytics tools and models, such as machine learning and statistical methods, to derive actionable insights from human-centric data in various contexts.
4. **Conduct** independent research in cognitive science and analytics, designing experiments, collecting data, and analyzing findings to contribute to the advancement of knowledge in understanding cognitive processes and their application in real-world scenarios.

COURSE OUTCOME:

The student will be able to:

CO-1:	**Understand** the foundational concepts of analytics, including its evolution, key fields like data mining, machine learning, AI, and emerging areas such as mathematical programming and evolutionary computation, as well as their integration into business value chains.
CO-2:	**Apply** principles of cognitive science, including the understanding of brain functions, sensory motor processing, language knowledge, and memory processing theories, to analyze and interpret human cognitive behaviors in relation to analytics.
CO-3:	**Analyze** and categorize different types of data (structured, unstructured, quantitative, and qualitative), utilizing measurement, scaling, and categorization techniques to process both qualitative and quantitative data for various analytics applications.
CO-4:	**Evaluate** and apply multivariate data analytics techniques, such as factor analysis, PCA, cluster analysis, and regression models, to solve real-world problems using interdependence and dependence relationship techniques in analytics.
CO-5:	**Develop** and implement artificial intelligence (AI) and machine learning (ML) models, including text analytics, natural language processing, image and video analytics, and intelligent automation, to enhance decision-making and cognitive engagement in automated systems.
CO-6:	**Conduct** analytics projects using industry-standard methodologies (CRISP-DM, SEMMA) and tools, applying multivariate, AI, and deep learning techniques (such as ANN, CNN, RNN, and their architectures) to real-life scenarios and challenges across various domains.

COURSE CONTENT:

Theory		
MODULE 1	**FOUNDATIONAL AREAS OF ANALYTICS**	**7 Hours**
Introduction to Analytics: Definition, Description & Evolution of Analytics, History of Analytics, and Applicability of Analytics with development of Technology and Computer, How Analytics entered mainstream **Concepts of Analytics**: Various overlapping concepts and fields of Analytics such as Data Mining, Machine Learning, Artificial Intelligence and Simulation **Emerging Areas in Analytics**: Understanding of emerging research areas of Analytics: Mathematical programming, Evolutionary computation, Simulation, Machine learning/data mining, Logic-based models, and Combinations of categories **Value Chain of Analytics**: Descriptive Analytics Covering Exploratory Data Analysis & Basic of Statistics, Diagnostics Analytics: BI/Analysis, Trend, Pattern, Simultaneous Relationship, Predictive Analytics: Cause-Effect Relationship and Futuristic prediction in terms of probabilities, Continuous & Categorical Predictions, Simulation, Optimization, Multi-faceted Intelligent Technology driven Analytics combining Machine Intelligence with Human Brain Processing Abilities		
MODULE 2	**FOUNDATIONAL AREAS OF COGNITIVE SCIENCE**	**7 Hours**
Introduction & Evolution of Cognitive Science: Introduction to the study of cognitive sciences, Brief history of cognitive science development and Methodological concerns in philosophy **Understand Brain and Sensory Motor Information:** Fundamentals of Neuro Science, Processing of sensory information in the brain, and Brain Imaging Elements		

Language & Linguistic Knowledge: Background and details of Syntax & Semantics, Understanding of Generative Linguistic Memory & Processing: Theory of Information Processing, Fundamentals of Short term Memory		
MODULE 3	**DATA THEORY & TAXONOMY OF DATA**	**7 Hours**
Data as a whole: Understanding of Data for distinguishing and relating various types of data and Categorization of Data: Structured, Unstructured Data, Quantitative & Qualitative Data. **Views of Data**: Understanding Data as an interdisciplinary framework for learning methodologies: covering statistics, neural networks, and fuzzy logic **Measurement & Scaling Concepts**: Measurement of variables and commonly used statistical tools: Number of procedures for measurement of the variables, Categorization procedures, Scale construction procedures and Techniques of data processing for qualitative as well as quantitative data; Various types of Scales: Nominal, Ordinal, Interval & Ratio Scales		
MODULE 4	**MULTIVARIATE DATA ANALYTICS & COGNITIVE ANALYTICS**	**8 Hours**
Overview: High level overview of Categorization of Techniques: Inter-dependence Relationship Techniques and Dependence Relationship Techniques **Overview of Commonly Used Inter-dependence Techniques**: Factor Analysis, Principal Component Analysis (PCA), Cluster Analysis **Overview of Commonly Used Dependence Techniques**: Regression, Logistic Regression **Analytics Value Chain &Application of Analytics across Value Chain**: **a**. Basic statistical concepts such as Descriptive & Diagnostics statistics, concept of random variables, discrete and continuous random variables, confidence interval, hypothesis testing, analysis of variance and correlation. **b**. Predictive analytics techniques such as multiple linear regression, logistic regression, decision tree learning Clustering and forecasting techniques. **c**. Prescriptive analytics Concepts: linear programming, integer programming, goal programming & stochastic models **d**. Cognitive analytics Concepts: Text Analytics, Learning Analytics, Data Mining, Cognitive Systems, Cognitive Computing, Learning Data Science, Machine Learning, Big data Analytics and Business analytics		
MODULE 5	**ARTIFICIAL INTELLIGENCE & MACHINE LEARNING**	**8 Hours**
Fundamentals of Artificial Intelligence: Various areas of AI: **a**. Knowledge: Text Analytics, Topic Modelling, Natural Language Processing (NLP), Natural Language Generation (NLG), Natural Language Understanding (NLU), Named-entity recognition (NER) **b**. Perception: Image Analytics, Video Analytics & Audio Analytics **c**. Memory: Cognitive Engagement: BOTs, Virtual & Digital Assistants, Augmented Reality, Virtual Reality, Mixed Reality **d**. Learning: Intelligent Automation **Spectrum of AI** **a**. Reactive Machine: Low memory, works on Known rules, such as Object Detection/Games/Recommendations specific to known Rules **b**. Limited Memory: Memory used to learn and improve continuously such as Most ML Models, Automated Vehicles **c**. Theory of Mind: Machine Understands and responds such as BoTs/Virtual/Digital Assistants **d**. Self-Aware: Human like intelligence such as Super Robots in Space etc.		
MODULE 6	**APPROACH & METHODOLOGY**	**8 Hours**
World Standard Methodology: CRISP-DM Methodology, SEMMA Methodology		

Real Life Work around Multi-Variate Analytics: A few Selected Commonly used Techniques: Predictive & Classification Models, Regression, Clustering **Real Life Work around Multi-Variate Analytics**: A few Selected Commonly used Techniques: Predictive & Classification Models, Regression, Clustering Real Life Work around Artificial Intelligence, Machine Learning and Deep Learning: A few Selected Commonly used Techniques & Algorithms: ANN (Artificial Neural Network), CNN (Convolutional Neural Network), RNN (Recurrent Neural Network); RN Architecture: LSTM, Bidirectional LSTM, Gated Recurrent Unit (GRU), CTRNN (Continuous Time RNN) CNN Architectures: VGG16, Alexnet, InceptionNet, RestNet, Googlenet **Object Detection models**: R-CNN, Fast R-CNN, Faster R-CNN, cascade R-CNN. Mask RCNN, Single Shot MultiBox Detector (SSD) ,You Only Look Once (YOLO), Single-Shot Refinement Neural Network for Object Detection (RefineDet), Retina-Net **Autoencoders**: Denoising Autoencoder, GAN **Transformers**: Attention based Encoder and Decoder: Eg- BERT(Bidirectional Encoder Representations from Transformers), Generative Pretrained Transformers GPT-3, GPT-2, BERT, XLNet, and RoBERTa	
TOTAL LECTURE	**45 Hours**

Laboratory		
MODULE-1:	**STRUCTURED DATA ANALYTICS**	**5 Hours**
Segmentation & Clustering, Classification & Prediction, Forecasting Association Mining & Sequence Mining		
MODULE-2:	**TEXTUAL DATA ANALYTICS**	**6 Hours**
Natural Language Processing (NLP), Natural Language Generation (NLG), Natural Language Understanding (NLU), Named-entity recognition (NER) driven Analytics: Key Word Extraction, Text Summarization, Insight Generation		
MODULE-3:	**IMAGE ANALYTICS**	**6 Hours**
Malaria/Carcinoma/COVID detection, Visual inspection for QA/QC		
MODULE-4:	**VIDEO ANALYTICS**	**5 Hours**
Motion based Behavior Recognition, Behavioral Observations, and Parkinson's Disease Prediction		
MODULE-5:	**AUDIO ANALYTICS**	**4 Hours**
Speech to Text, Text to Speech, Transcript Services		
MODULE -6:	**ARTIFICIAL INTELLIGENCE, MACHINE LEARNING DRIVEN AUTOMATION**	
Banking Process Automation, Hospital Triage Process Automation AR/VR enabled Guided Operations		
MODULE-7:	**CONVERSATIONAL ANALYTICS**	**4 Hours**
Artificial Intelligence, Machine Learning, Augmented Reality, Virtual Reality, Robotics, Digital/Virtual Assistant, Chat-BOT/ Program BOT, Email-BOT		
TOTAL PRACTICAL		**30 Hours**

Books:

Text Books:

1. Hall, P., Phan, W., & Whitson, K. (2016). Evolution of Analytics. O'Reilly Media Incorporated.

2. Cognitive Science: An Introduction to the Science of the Mind by José Luis Bermúdez

3. Cognitive Computing and Big Data Analytics by Judith S. Hurwitz (Author), Marcia Kaufman (Author), Adrian Bowles (Author) 3. Cognitive Science and Artificial Intelligence Advances and Applications: Authors: Gurumoorthy, Sasikumar, Rao, B Narendrakumar, Gao, Xiao-Zhi.

Introduction to IoT + Lab (Elective V) (TIU-UCBCS-C453C)

Program: B. Tech. in CSBS	**Year, Semester:** 4th Yr., 7th Sem.
Course Title: Introduction to IoT + Lab (Elective V)	**Subject Code:** TIU-UCBCS-C453B
Contact Hours/Week: 3–0–2 (L–T–P)	**Credit: 4**

COURSE OBJECTIVE:

Enable the student to:

1. **Understand** the fundamental concepts, architecture, and components of the Internet of Things (IoT), including sensors, actuators, communication protocols, and data management systems.
2. **Apply** IoT technologies to build simple IoT-based systems, utilizing programming languages, IoT platforms, and tools to gather, process, and transmit sensor data.
3. **Perform** hands-on lab experiments to configure, troubleshoot, and optimize IoT devices, ensuring seamless integration between hardware and software components.
4. **Conduct** research and development activities related to IoT, evaluating real-world IoT applications, identifying challenges, and proposing innovative solutions in areas such as smart homes, healthcare, or industrial IoT.

COURSE OUTCOME:

The student will be able to:

CO-1:	Understand IoT Architecture
CO-2:	Design Simple IoT Systems
CO-3:	Hands-on Experience with IoT Tools and Platforms
CO-4:	Analyze IoT Data for Decision-Making
CO-5:	Evaluate IoT Security Risks
CO-6:	Implement IoT Solutions for Real-World Problems

COURSE CONTENT:

Theory		
MODULE 1	**INTRODUCTION TO IOT CONCEPTS AND ARCHITECTURE**	**7 Hours**

Introduction to IoT

Definition of IoT, its significance, and evolution, The IoT ecosystem: devices, communication networks, cloud computing, and data analytics.

IoT Architecture

Layers of IoT: Perception Layer, Network Layer, and Application Layer, Key components: Sensors, actuators, communication protocols, and embedded systems

IoT Communication Protocols

Overview of communication protocols like MQTT, CoAP, HTTP, and WebSockets, Characteristics and usage of different protocols for IoT applications

IoT Standards and Ecosystem

Discussion of IoT standards such as Zigbee, LoRaWAN, and NB-IoT, Key IoT platforms (AWS IoT, Google Cloud IoT, Microsoft Azure)

MODULE 2	EMBEDDED SYSTEMS FOR IOT	7 Hours

Overview of Embedded Systems in IoT

Introduction to embedded systems, microcontrollers, and microprocessors, Working with hardware: sensors, actuators, GPIO pins, ADCs, and PWM

Arduino and Raspberry Pi Overview

Introduction to Arduino and Raspberry Pi as development boards for IoT, Differences between microcontrollers (e.g., Arduino) and single-board computers (e.g., Raspberry Pi)

Programming IoT Devices

Introduction to embedded C/C++ programming for microcontrollers, Basics of interfacing sensors (temperature, light, distance, etc.) with microcontrollers

Real-time Operating Systems (RTOS)

Concept of real-time operating systems in IoT for time-critical applications

Lab Activity:

MODULE 3	IOT COMMUNICATION PROTOCOLS AND NETWORKING	7 Hours

Topics Covered:

IoT Communication Protocols

Detailed discussion on protocols like MQTT, CoAP, and HTTP for IoT communications, Benefits of lightweight protocols like MQTT for IoT applications

Wireless Communication Technologies

Introduction to wireless communication technologies: Wi-Fi, Bluetooth, Zigbee, LoRaWAN, and NB-IoT, Comparing different wireless technologies for IoT use cases (e.g., range, power consumption, bandwidth)

IoT Network Architectures

Point-to-Point, Star, Mesh, and Hybrid IoT network architectures, IoT Gateway: Purpose, protocols, and deployment

Cloud Integration for IoT

Sending and receiving data from IoT devices to cloud platforms (AWS, Azure, etc.)

MODULE 4	DATA MANAGEMENT AND PROCESSING IN IOT	8 Hours

IoT Data Collection and Storage
Methods of data collection (sensor readings, device-generated data), Data storage options: Local storage, cloud storage, and databases (SQL/NoSQL)
Data Processing and Analysis
Real-time data processing vs. batch processing, Using edge computing for data pre-processing, Introduction to data analytics and visualization tools.
Big Data and IoT
The relationship between IoT and Big Data, IoT data analysis techniques for making business decisions
Introduction to Machine Learning in IoT
Use of machine learning algorithms for predictive analytics in IoT

MODULE 5	**SECURITY AND PRIVACY IN IOT**	**8 Hours**

IoT Security Challenges
Security risks in IoT: Device security, data security, and network security, Common attacks on IoT devices: DDoS, man-in-the-middle, and physical attacks.
Security Protocols in IoT
Introduction to encryption protocols (SSL/TLS, AES) for secure communication, Implementing security in communication protocols like MQTT and HTTP
Authentication and Authorization
User and device authentication in IoT systems, Role-based access control (RBAC) for IoT devices and platforms
Privacy Issues in IoT
Privacy concerns: Data collection, storage, and sharing, Regulations for IoT privacy: GDPR and IoT security standards

MODULE 6	**REAL-WORLD APPLICATIONS AND FUTURE OF IOT**	**8 Hours**

IoT Applications in Different Sectors
Smart Homes: Automation of lighting, heating, and security systems, **Healthcare IoT**: Wearable health devices, remote monitoring, **Industrial IoT (IIoT)**: Smart factories, predictive maintenance, and logistics, **Agriculture IoT**: Precision farming, environmental monitoring
Emerging Trends in IoT, Integration of IoT with Artificial Intelligence (AI) and Machine Learning (ML), The role of 5G in advancing IoT capabilities, IoT and Edge Computing: Processing data closer to the source
IoT Challenges and Opportunities
Challenges: Scalability, interoperability, security, Future opportunities in IoT development and innovation.

	TOTAL LECTURE	**45 Hours**

Laboratory		
MODULE-1:	**INTRODUCTION TO IOT DEVICES AND BASIC SENSOR INTERFACING**	**7 Hours**
Introduction to IoT Hardware, Sensor Interfacing with Arduino, Controlling Actuators, Basic IoT Program		
MODULE-2:	**COMMUNICATION PROTOCOLS – MQTT**	**8 Hours**

Introduction to MQTT Protocol, MQTT Communication Setup, Data Exchange with MQTT, Cloud Integration with MQTT		
MODULE-3:	**IOT DATA VISUALIZATION AND CLOUD INTEGRATION**	**8 Hours**
Cloud Platforms Overview, Sending Data to Cloud, Data Visualization, Real-Time Monitoring		
MODULE-4:	**IOT SECURITY AND PRIVACY IMPLEMENTATION**	**7 Hours**
IoT Security Concepts, Securing IoT Communication, Authentication Mechanisms, Privacy Considerations		
	TOTAL PRACTICAL	**30 Hours**

Text Books:

1. "Internet of Things: A Hands-On Approach" by Arshdeep Bahga and Vijay Madisetti
2. "Internet of Things: Principles and Paradigms" edited by Rajkumar Buyya, Amir Vahid Dastjerdi
3. "The Internet of Things: Enabling Technologies, Platforms, and Use Cases" by Dieter Uckelmann, Mark Harrison, Florian Michahelles

Reference Books:

4. "Internet of Things: Architecture and Design Principles" by Rajesh Singh, A. K. M. A. Siddique
5. "IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things" by David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Robert Barton
6. "Practical Internet of Things Security" by Brian Russell and Drew Van Duren

Cryptology + Lab (Elective V) (TIU-UCBCS-C453C)

Program: B. Tech. in CSBS	**Year, Semester:** 4th Yr., 7th Sem.
Course Title: Cryptology + Lab (Elective V)	**Subject Code:** TIU-UCBCS-C453C
Contact Hours/Week: 3–0–2 (L–T–P)	**Credit:** 4

COURSE OBJECTIVES:

Enable the student to:

1. F**undamental cryptographic principles** by covering elementary number theory, pseudo-random bit generation, and basic cryptosystems to establish a strong foundation in cryptography.

2. **To explore and analyze security services** such as confidentiality, integrity, availability, non-repudiation, and privacy, along with their role in secure communication and data protection.

3. **To examine the design and application of symmetric and asymmetric cryptosystems** including stream ciphers, block ciphers, hash functions, authentication mechanisms, RSA, and ECC, as well as their implementation in real-world scenarios.

4. **To provide insights into advanced cryptographic applications and future challenges** by studying key management, zero-knowledge protocols, quantum cryptanalysis, and post-quantum cryptographic techniques.

COURSE OUTCOMES:

The student will be able to:

CO-1:	**Understand fundamental concepts of cryptography:** Explain elementary number theory, pseudo-random bit generation, and basic cryptosystems used in modern cryptography.
CO-2:	**Analyze basic security services** : Identify and evaluate key security principles, including confidentiality, integrity, availability, non-repudiation, and privacy in cryptographic applications.
CO-3:	**Apply symmetric key cryptosystems** – Demonstrate an understanding of stream ciphers (e.g., A5/1, RC4, Salsa, ChaCha) and block ciphers (e.g., DES, AES, different modes of operation), along with hash functions and authentication mechanisms.
CO-4:	**Evaluate public key cryptosystems and digital signatures** – Explain RSA and ECC algorithms and their role in encryption, key exchange, and digital signatures.
CO-5:	**Explore security applications in real-world scenarios** – Examine cryptographic applications such as electronic commerce, key management, zero-knowledge protocols, and their role in secure communication, including cryptology in contact tracing.
CO 6:	**Investigate post-quantum cryptography** – Discuss challenges posed by quantum computing to classical cryptosystems and analyze two post-quantum cryptographic algorithms from the NIST standardization list.

COURSE CONTENT:

MODULE 1:	**Introduction to Cryptography:**	**7 Hours**
Elementary number theory, Pseudo-random bit generation, Elementary cryptosystems		
MODULE 2:	**Basic security services:**	**2 Hours**
confidentiality, integrity, availability, non-repudiation, privacy		
MODULE 3:	**Symmetric key cryptosystems:**	**7 Hours**
Stream Cipher: Basic Ideas, Hardware and Software Implementations, Examples with some prominent ciphers: A5/1, Grain family, RC4, Salsa and ChaCha, HC128, SNOW family, ZUC; Block Ciphers: DES, AES, Modes of Operation; Hash Functions; Authentication		
MODULE 4:	**Public Key Cryptosystems:**	**8 Hours**
Public Key Infrastructure (PKI): Digital signatures, message integrity, and authenticity. Elliptic Curve Cryptography (ECC): Basics of ECC, benefits over RSA, Zero-Knowledge Proofs: Concept of zero-knowledge proofs, and their role in blockchain security and privacy.		
MODULE 5:	**Security Applications (Selected Topics):**	**8 Hours**

Electronic commerce (anonymous cash, micro-payments), Key management, Zero-knowledge protocols, Cryptology in Contact Tracing Applications, Issues related to Quantum Cryptanalysis. block ciphers, Data Encryption Standard (DES) and Advanced Encryption Standard (AES). Modes of operation for block ciphers and their security implications.

MODULE 6:	**Introductory topics in Post-Quantum Cryptography:**	**8 Hours**
Shor's algorithm for factoring and discrete logarithms. Analysis of Grover's algorithm and its effect on brute-force search problems. Exploration of the hidden subgroup problem and its relevance to breaking existing cryptosystems. Lattice-based cryptography: Learning With Errors (LWE), Shortest Vector Problem (SVP), Code-based cryptography: McEliece and Niederreiter encryption schemes. Multivariate polynomial cryptography: Unbalanced Oil and Vinegar (UOV) and Rainbow schemes. Hash-based signatures: Merkle trees and related constructions.		

TOTAL LECTURES	**40 Hours**

COURSE CONTENT: LABORATORY

MODULE 1:	**Foundations of Cryptography and Number Theory**	**5 Hourss**
Modular Arithmetic Operations: Implement algorithms for modular addition, multiplication, and exponentiation. **Prime Number Generation:** Develop an algorithm to generate prime numbers using the Sieve of Eratosthenes. **Implementing the Caesar Cipher:** Encrypt and decrypt text using the Caesar cipher and evaluate its weaknesses. **Vigenère Cipher Encryption:** Implement the Vigenère cipher and compare its security to the Caesar cipher.		
MODULE 2:	**Core Security Services in Cryptography**	**2 Hours**
Implementing Hash Functions: Work with SHA-256 to analyze how it ensures integrity and non-repudiation. **Digital Signature Creation:** Use RSA to sign and verify digital signatures, exploring non-repudiation in practice. **Symmetric Encryption and Integrity Check:** Use AES encryption and implement a hash for data integrity. **Service Analysis in Cryptographic Systems:** Examine various real-world applications (e.g., online banking, secure messaging) to see how each security service is implemented.		
MODULE 3:	**Hands-On with Symmetric Cryptosystems**	**6 Hours**
Stream Cipher Implementation: Implement a stream cipher like RC4 or Salsa and evaluate its security. **AES Encryption and Decryption:** Explore AES encryption in various modes of operation (e.g., ECB, CBC) and analyze their vulnerabilities. **Message Authentication using HMAC:** Implement HMAC (Hash-based Message Authentication Code) with SHA-256 for ensuring data integrity.		

MODULE 4:	Public Key Cryptography and Digital Signatures	6 Hours

SA Key Generation and Encryption: Implement RSA to perform key generation, encryption, and decryption of messages.

Elliptic Curve Cryptography (ECC): Compare RSA and ECC by implementing a simple ECC encryption and signature verification system.

Digital Signature Workflow: Generate digital signatures and perform signature verification using both RSA and ECC.

MODULE 5:	Real-World Cryptographic Applications	6 Hourss

SSL/TLS Handshake Simulation: Simulate an SSL/TLS handshake to understand how cryptography secures online transactions.

Public Key Infrastructure (PKI): Implement a simple PKI system, including certificate generation and validation.

Zero-Knowledge Proof (ZKP): Implement a basic ZKP protocol and simulate authentication without revealing sensitive data.

MODULE 6:	Exploring Post-Quantum Cryptography	5 Hours

Introduction to Quantum Algorithms: Implement and analyze the impact of quantum algorithms like Grover's and Shor's on cryptographic security.
Post-Quantum Cryptographic Algorithms: Implement one or two NIST standard post-quantum algorithms, such as Kyber (a lattice-based encryption scheme) or NTRU.

TOTAL LECTURES	30 Hours

Text Books:

1. *Cryptography, Theory and Practice.* D. R. Stinson, CRC Press.
2. *Handbook of Applied Cryptography.* A. J. Menezes, P. C. van Oorschot, and S. A. Vanstone, CRC Press

Reference Books:

1. *A course in number theory and cryptography.* N. Koblitz:, GTM, Springer.
2. *Cryptography and Network Security.* W. Stallings, Prentice Hall.
3. *Security Engineering,* R. Anderson, Wiley
4. *RC4 Stream Cipher and Its Variants.* G. Paul and S. Maitra: CRC Press, Taylor
5. & Francis Group, A Chapman & Hall Book, 2012
6. *Design & Cryptanalysis of ZUC - A Stream Cipher in Mobile Telephony.* C. S. Mukherjee, D. Roy, S. Maitra, Springer 2020
7. *Contact Tracing in Post-Covid World - A Cryptologic Approach.* P. Chakraborty, S. Maitra, M. Nandi, S. Talnikar, Springer 2020
8. Presskil Lecture notes: Available online: http://www.theory.caltech.edu/~preskill/ph229/

Quantum Computation & Quantum Information +Lab (TIU-UCBCS-C455C)

Program: B. Tech. in CSBS	**Year, Semester:** 4th Yr., 7th Sem
Course Title: Quantum Computation & Quantum Information +Lab	**Subject Code:** TIU-UCBCS-C455A
Contact Hours/Week: 3–0–2 (L–T–P)	**Credit:** 4

Course Outcome(s):

CO-1:	Demonstrate understanding of quantum information fundamentals including states, operators, measurements, and entanglement through mathematical formulations and circuit representations
CO-2:	Implement and analyze quantum algorithms (Deutsch-Jozsa, Simon, Grover, Shor) to evaluate their computational advantages over classical approaches
CO-3:	Design and simulate quantum communication protocols (teleportation, super-dense coding, QKD) using quantum programming frameworks
CO-4:	Construct quantum circuits using standard gates and verify their operation through simulation and experimental implementation
CO-5	Assess the impact of quantum algorithms on classical cryptosystems and examine post-quantum cryptographic alternatives
Co-6	Develop practical quantum applications including QTRNGs and analyze commercial quantum technologies for real-world deployment

Course Objectives :

- To provide students with foundational knowledge of quantum bits (qubits), quantum states, and quantum gate operations.
- To develop practical skills in designing, implementing, and simulating quantum circuits using platforms such as IBM Qiskit.
- To enable students to understand and simulate key quantum algorithms including Deutsch-Jozsa, Grover's, and Shor's algorithms.
- To familiarize students with quantum communication protocols such as quantum teleportation, superdense coding, and quantum key distribution (QKD).
- To introduce students to quantum error correction and post-quantum cryptographic principles through hands-on experimentation.
- To bridge the gap between theoretical quantum principles and real-world quantum computing applications through project-based learning.

Course Content:

Module - 1	**Introduction to Quantum Information**	**9 Hours**
States, Operators, Measurements, Quantum Entanglement: Quantum Teleportation, Super-dense coding, CHSH Game, Quantum gates and circuits		
Module - 2	**Quantum Algorithms**	**11 Hours**
Deutsch-Jozsa, Simon, Grover, Shor, Implication of Grover's and Simon's algorithms towards classical symmetric key cryptosystems, Implication of Shor's algorithm towards factorization and Discrete Logarithm based classical public key cryptosystems		
Module - 3	**Quantum key distribution (QKD)**	**14 Hours**
Detailed design and issues of quantumness, Commercial products and applications		
Module - 4	**Introductory topics in Post-Quantum Cryptography**	**11 Hours**
BB84, Ekert, Semi-Quantum QKD protocols and their variations, Issues of Device Independence, Commercial products		
Total		**45 Hours**

Laboratory		
MODULE-1:	Introduction to Quantum Information	**6 Hours**
Qubits and Bloch Sphere Visualization, Pauli-X, Y, Z, H, S, T Gate Implementation, Create Bell states using CNOT gate, Quantum Teleportation & Superdense Coding, CHSH Game Implementation		
MODULE-2:	**Text Mining and Natural Language Processing**	**6 Hours**
Demonstration of Algorithm Speedup, Named Entity Recognition (NER) and Part-of-Speech tagging with spaCy Search Implementation in 2/3 Qubit System, Demonstration and Analysis , Conceptual Simulation of Factorization Steps.		
MODULE-3:	**Sentiment Analysis & Opinion Mining**	**6 Hours**
Quantum Key Distribution Simulation, Entanglement-Based QKD Simulation, Conceptual Modeling & Simulation,3-qubit Bit-flip Code Implementation		
MODULE-4:	**Social Network Analysis (SNA)**	**6 Hours**
Simulation/Conceptual Model of Device-Independent QKD, Case Study on Quantum-Safe Protocol / Commercial Use Case.		

TOTAL PRACTICAL **30 Hours**

Text Books:

1. *Quantum Computation and Quantum Information.* M. A. Nielsen and I. L. Chuang, Cambridge University Press
2. Presskil Lecture notes: Available online: http://www.theory.caltech.edu/~preskill/ph229/

Reference Books:

1. *An Introduction to Quantum Computing.* P. Kaye, R. Laflamme, and M. Mosca, Oxford University Press, New York
2. *Quantum Computer Science.* N. David Mermin:, Cambridge University Press
3. *Quantum Cryptography.* D. Unruh:, Available online: https://courses.cs.ut.ee/all/MTAT.07.024/2017_fall/uploads/
4. *NIST Post Quantum Cryptography*, Available online: https://csrc.nist.gov/projects/post-quantum-cryptography/round-2-submissions
5. *Quantum Algorithms for Cryptographically Significant Boolean Functions - An IBMQExperience*. SAPV Tharrmashastha, D. Bera, A. Maitra and S. Maitra, Springer 2020.
6. *Quantum Algorithm Zoo.* https://quantumalgorithmzoo.org/

Handbook of Applied Cryptography. A. J. Menezes, P. C. van Oorschot, and S. A. Vanstone. CRC Press

Advanced Social, Text and Media Analytics +Lab (TIU-UCBCS-C455C)

Program: B. Tech. in CSBS	**Year, Semester: 4th** Yr., 7th Sem
Course Title: Advanced Social, Text and Media Analytics +Lab	**Subject Code:** TIU-UCBCS-C455B
Contact Hours/Week: 3–0–2 (L–T–P)	**Credit:** 4

Course Outcome(s):

CO-1:	Understand the foundational concepts of social, text, and media analytics and their relevance in modern digital ecosystems.
CO-2:	Apply computational techniques for processing and analyzing social media data, text corpora, and multimedia content.
CO-3:	Employ tools and frameworks (e.g., NLP, ML, sentiment analysis, computer vision) for extracting actionable insights.

CO-4:	Analyze real-time data from platforms like Twitter, Facebook, news feeds, and multimedia sources.
CO-5	Use Python and open-source libraries for building and evaluating models.
CO-6	Evaluate ethical concerns and interpret results for informed decision-making in business and societal contexts.

Course Objectives :

- To introduce students to advanced techniques in text, social, and media analytics using real-world data sources.
- To develop proficiency in natural language processing (NLP) methods for extracting insights from unstructured textual data.
- To enable students to perform sentiment analysis and opinion mining on social media data using both lexicon-based and machine learning approaches.
- To familiarize learners with social network analysis concepts and tools to understand online relationships and influence patterns.
- To provide hands-on experience in mining and analyzing media content and engagement metrics from platforms such as YouTube and news websites.
- To equip students with the ability to build interactive dashboards and visualizations for presenting analytics results effectively.

Course Content:

Theory		
Module - 1	**Introduction to Social, Text, and Media Analytics**	**9 Hours**
Overview of Social, Text, and Media Analytics, Applications in business, journalism, public policy, entertainment, Introduction to data types: structured vs. unstructured, Key challenges: volume, velocity, veracity		
Module - 2	**Text Analytics and Natural Language Processing**	**9 Hours**
Basics of NLP: tokenization, stemming, lemmatization, POS tagging, Vector Space Model, TF-IDF, Word Embeddings ,Named Entity Recognition, Topic Modeling (LDA), Text classification and sentiment analysis		
Module - 3	**Social Media Analytics**	**8 Hours**
Structure and content of social media platforms, Hashtag and network analysis, Community detection and influence analysis, Real-time social stream mining, Case studies: Twitter, Reddit, Instagram		
Module - 4	**Media and Multimedia Analytics**	**9 Hours**

Image and Video content analysis, Introduction to deep learning for image/text fusion, Metadata extraction from media, Computer vision basics for media understanding, Fake media detection		
Module - 5	**Tools, Ethics and Applications**	**10 Hours**
Tools: Python, NLTK, spaCy, Scikit-learn, TensorFlow, OpenCV, Visualization: WordCloud, matplotlib, seaborn, Gephi, Legal & Ethical Issues: bias, misinformation, data privacy, Applications: brand monitoring, political analysis, crisis management		
Total		**45 Hours**

Laboratory		
MODULE-1:	**Introduction to Social, Text & Media Analytics**	**3 Hours**
Setting up Python environment with Jupyter, NLTK, spaCy Basic text cleaning: tokenization, stop word removal, stemming, lemmatization Introduction to media data (e.g., tweets, YouTube comments, news articles)		
MODULE-2:	**Text Mining and Natural Language Processing**	**6 Hours**
Word frequency, n-gram generation, TF-IDF Named Entity Recognition (NER) and Part-of-Speech tagging with spaCy Text similarity and topic modeling using LDA		
MODULE-3:	**Sentiment Analysis & Opinion Mining**	**6 Hours**
Lexicon-based sentiment analysis (TextBlob/VADER) Machine learning-based sentiment analysis (SVM/Naive Bayes) Real-time sentiment analysis using Twitter API		
MODULE-4:	**Social Network Analysis (SNA)**	**6 Hours**
Graph basics using NetworkX – nodes, edges, degree Centrality, communities, and visualization using Gephi Extracting and analyzing social graphs from social media data		
Module-5:	**Media**	**6 Hours**
Media content extraction using APIs (YouTube, News API) Media engagement metrics (views, likes, shares) Interactive dashboard creation with Plotly/Streamlit		
Module -6	**Project and Case Studies**	**3 Hours**
Capstone mini-project – integrating text, social, and media analytics Case study presentation (e.g., political sentiment, brand analysis)		
		TOTAL PRACTICAL 30 Hours

Recommended Textbooks:

1. Text Analytics with Python: A Practical Real-World Approach to Gaining Actionable Insights from Your Data
   Author: Dipanjan Sarkar
   Publisher: Apress
   Why Recommended: Covers end-to-end text mining, NLP, sentiment analysis, topic modeling, and visualization using Python libraries like NLTK, spaCy, and Scikit-learn.
2. Mining the Social Web: Data Mining Facebook, Twitter, LinkedIn, Instagram, GitHub, and More (3rd Edition)
   Author: Matthew A. Russell & Mikhail Klassen
   Publisher: O'Reilly Media
   Why Recommended: Hands-on guide for scraping, processing, and analyzing data from real social media platforms using Python.
3. Social Media Mining: An Introduction
   Authors: Reza Zafarani, Mohammad Ali Abbasi, Huan Liu
   Publisher: Cambridge University Press
   Why Recommended: Strong theoretical foundation on social media structure, network theory, and mining techniques.
4. Multimedia Analytics: A Machine Learning Perspective
   Authors: Aarushi Kalra & Mohan S. Kankanhalli
   Publisher: Springer
   Why Recommended: Covers image, video, and audio content analysis with machine learning and deep learning techniques.

Mobile Computing (Elective-VI) + Lab (TIU-UCBCS-C455C)

Program: B. Tech. in CSBS	**Year, Semester:** 4th Yr., 7th Sem.
Course Title: Mobile Computing (Elective-VI) + Lab	**Subject Code:** TIU-UCBCS-C455C
Contact Hours/Week: 3–0–2 (L–T–P)	**Credit:** 4

COURSE OBJECTIVES:

Enable the student to:

1. Understand the principles of wireless communication, cellular networks, and resource management strategies.
2. Analyze mobility models, handoff mechanisms, and location management strategies in mobile networks.
3. Explore wireless transmission techniques, multiple access methods, and advanced networking paradigms such as cognitive radio and 5G technologies.
4. Develop hands-on skills for configuring, simulating, and analyzing mobile network protocols, wireless communication systems, and mobility solutions.

COURSE OUTCOMES:

The student will be able to:

CO-1:	Identify the architecture, principles, and challenges of mobile communication systems.
CO-2:	Recognize multiple access techniques, IP, and transport layer requirements for mobile computing.
CO-3:	Analyze different classes of mobile computing techniques across various operating domains.
CO-4:	Evaluate security, scalability, and energy efficiency of modern mobile computing techniques.
CO-5:	Examine key aspects of modern wireless technologies, including 5G networks, millimeter-wave communication, and device-to-device (D2D) communication.
CO-6:	Implement and simulate wireless communication setups, network configurations, and protocol performance in mobile computing environments.

COURSE CONTENT:

Theory		
MODULE 1:	**INTRODUCTION**	**7 Hours**
Overview of wireless and mobile infrastructure; Preliminary concepts on cellular architecture; Design objectives and performance issues; Radio resource management and interface; Propagation and path loss models; Channel interference and frequency reuse; Cell splitting; Channel assignment strategies; Overview of generations:- 1G to 5G.		
MODULE 2:	**Location and handoff management**	**7 Hours**
Introduction to location management (HLR and VLR); Mobility models characterizing individual node movement (Random walk, Fluid flow, Markovian, Activity based); Mobility models characterizing the movement of groups of nodes. (Reference point-based group mobility model, Community based group mobility model); Static and Dynamic location management schemes (Time, Movement, Distance, Profile Based); Terminal Paging (Simultaneous paging, Sequential paging); Location management and Mobile IP; Overview of handoff process; Factors affecting handoffs and performance evaluation metrics; Handoff strategies; Different types of handoffs (soft, hard, horizontal, vertical).		
MODULE 3:	**Wireless transmission fundamentals**	**7 Hours**
Introduction to narrow and wideband systems; Spread spectrum; Frequency hopping; Introduction to MIMO; MIMO Channel Capacity and diversity gain; Introduction to OFDM; MIMO-OFDM system; Multiple access control (FDMA, TDMA, CDMA, SDMA); Wireless local area network; Wireless personal area network (Bluetooth and ZigBee)		
MODULE 4:	**Mobile Ad-hoc networks & WSN**	**8 Hours**

Characteristics and applications; Coverage and connectivity problems; Routing in MANETs. Concepts, basic architecture, design objectives and applications; Sensing and communication range; Coverage and connectivity; Sensor placement; Data relaying and aggregation; Energy consumption; Clustering of sensors; Energy efficient Routing (LEACH).

MODULE 5:	**Cognitive radio networks**	**8 Hours**
Fixed and dynamic spectrum access; Direct and indirect spectrum sensing; Spectrum sharing; Interoperability and co-existence issues; Applications of cognitive radio networks		

MODULE 6:	**D2D communications in 5G cellular networks**	**8 Hours**
Introduction to D2D communications; High-level requirements for 5G architecture; Introduction to radio resource management, power control, and mode selection problems; Millimeter wave communication in 5G.		
TOTAL LECTURES		**45 Hours**

Laboratory		
MODULE-1:	**ANTENNA DESIGN AND ANALYSIS USING HFSS**	**6 Hours**
Introduction to HFSS simulation environment for electromagnetic analysis. Design of a rectangular microstrip patch antenna for 2.4 GHz using HFSS. Performance analysis: Return loss, bandwidth, gain, efficiency, and radiation pattern. Effect of different substrate materials on antenna performance and parametric variation		
MODULE-2:	**WIRELESS NETWORK ANALYSIS USING inSSIDer HOME**	**4 Hours**
Overview of wireless networking concepts and spectrum utilization. Practical use of inSSIDer Home for analyzing Wi-Fi networks. SSID identification, signal strength monitoring, and channel interference mapping. Insights on network performance and real-world implications of wireless congestion.		
MODULE-3:	**NETWORK DESIGN AND CONFIGURATION USING CISCO PACKET TRACER – BASICS**	**10 Hours**
Familiarization with Packet Tracer environment and networking components. Creating a simple LAN with end devices, switches, routers. Assigning static IP addresses and verifying connectivity with Ping and Traceroute. Subnetting exercises and addressing schemes		
MODULE-4:	**VLANS AND ROUTING PROTOCOLS IN PACKET TRACER**	**6 Hours**
Understanding VLAN concepts and segmentation benefits. Implementing VLANs across multiple switches and port assignments. Configuration of inter-VLAN routing. Static routing setup between different networks. Dynamic routing using RIP and OSPF – configuration and verification.		
MODULE-5:	**SECURE WIRELESS NETWORKING AND NAT CONFIGURATION**	**4 Hours**
Design and setup of a wireless network with security (WPA2) features in Packet Tracer. Configuration of wireless routers, SSID, and device authentication.		

Network Address Translation (NAT) configuration for private-to-public IP mapping. Testing NAT functionality and packet behavior using simulation mode.	
TOTAL PRACTICAL	**30 Hours**

Text Books:

1. Mobile Communications. Jochen Schiller, Pearson Education.
2. Wireless Communications. Andrea Goldsmith, Cambridge University Press.

Reference Books:

1. Wireless Communications: Principles and Practice. Theodore Rappaport, Pearson Education.
2. Wireless Communications. Ezio Biglieri, MIMO, Cambridge University Press.
3. Handbook of Wireless Networking and Mobile Computing. Ivan Stojmenovic, Wiley.
4. Dynamic Location Management in Heterogeneous Cellular Networks. James Cowling, MIT Thesis. http://people.csail.mit.edu/cowling/hons/jcowling-dynamic-Nov04.pdf
5. Location Management in Wireless Cellular Networks. Travis Keshav, https://www.cse.wustl.edu/~jain/cse574-06/ftp/cellular_location.pdf
6. Location Management in Wireless Data Networks. Fahd A. Batayneh, https://www.cse. wustl.edu/~jain/cse574-06/ftp/wireless_location.pdf
7. Principles of Mobile Communication. Gordon L. Stber, Springer.
8. Wireless Device-to-Device Communications and Networks. Lingyang Song, Dusit Niyato, Zhu Han, and Ekram Hossain, Cambridge University Press.
9. Principles of Cognitive Radio. Ezio Biglieri, Andrea J. Goldsmith, Larry J. Greenstein,

Services Science and Service Operational Management + LAB (TIU-UCBCS-C405)

Program: B. Tech. in CSBS	**Year, Semester:** 4th Yr, 7th Sem.
Course Title: Services Science And Service Operational Management + LAB	**Subject Code:** TIU-UCBCS-C405
Contact Hours/Week: 3–0–2 (L–T–P)	**Credit:** 4

COURSE OBJECTIVE :

Enable the student to:

1. To understand the foundational concepts and nature of services, and their impact on business and technology.
2. To develop skills for designing and managing service systems, including service process modeling, innovation, and customer value.
3. To equip students with analytical and operational techniques for effective service delivery and project-based implementation.

COURSE OUTCOME :

The student will be able to:

CO-1:	Describe the evolution and characteristics of service systems and the key enablers of service economy.
CO-2:	Apply service-dominant logic and service system modeling to solve real-world problems.
CO-3:	Analyze service innovation, customer co-creation, and value networks in various industries.
CO-4:	Apply IT-based tools and concepts such as cloud, AI, and digital platforms in service operations.
CO-5:	Design efficient service processes and apply operations strategies like lean, Six Sigma, and capacity planning.
CO-6:	Evaluate and implement service quality, performance metrics, and customer experience strategies through project-based lab work.

COURSE CONTENT

Theory		
MODULE 1:	**INTRODUCTION TO SERVICE SCIENCE**	**10 Hours**
Introduction: Introduction to the course, Introduction to service operations, Role of service in economy and society, Introduction to Indian service sector Nature of Services and Service Encounters: Differences between services and operations, Service package, characteristics, various frameworks to design service operation system, Kind of service encounter, importance of encounters **Service-Dominant Logic:** From Goods-Dominant logic to Service-Dominant logic, Value Co-creation		
MODULE 2:	**SERVICE STRATEGIS**	**9 Hours**
Service Strategy and Competitiveness: Development of Strategic Service Vision (SSV), Data Envelopment Analysis **New Service Development:** NSD cycle, Service Blueprinting, Elements of service delivery system Service Design: Customer Journey and Service Design, Design Thinking methods to aid Service Design **Locating facilities and designing their layout:** models of facility locations (Huff's retail model), Role of service-scape in layout design Service Quality: SERVQUAL, Walk through Audit, Dimensions of Service quality & other quality tools		

MODULE 3:	**SERVICE GUARANTEE & SERVICE RECOVERY**	8 **Hours**
Service Guarantee & Service Recovery: How to provide Service guarantee? How to recover from Service failure?		
MODULE 4:	**SERVICE SCIENCE: FORECASTING AND MANAGEMENT**	**6 Hours**
Forecasting Demand for Services: A review of different types of forecasting methods for demand forecasting. Managing Capacity and Demand: Strategies for matching capacity and demand, Psychology of waiting, Application of various tools used in managing waiting line in services. **Managing Facilitating Goods:** Review of inventory models, Role of inventory in services **Managing service supply relationship:** Understanding the supply chain/hub of service, Strategies for managing suppliers of service Vehicle Routing Problem: Managing after sales service, Understanding services that involve transportation of people and vehicle, Techniques for optimizing vehicle routes		
MODULE 5:	**SERVICE INNOVATIONS**	**5 Hours**
Service Innovation: Services Productivity, Need for Services Innovation		
TOTAL LECTURES		**45 Hours**

Laboratory		
MODULE 1:	**FOUNDATIONS OF SERVICE SYSTEMS**	6 **Hours**
Exp1: Service Audit and Classification Exp2: Service Blueprint Design Exp3: Service Co-Creation Workshop		
MODULE 2:	**MODELING AND VALUE NETWORKS**	8 **Hours**
Exp4: Service System Modeling Using Draw.io Exp5: Value Network Analysis Exp6: Digital Platform Analysis		
MODULE 3:	**SERVICE TECHNOLOGY & PROCESS OPTIMIZATION**	**8 Hours**
Exp7: AI & Cloud in Services (Simulation)		

Exp8: Lean Service Process Redesign Exp9: Capacity Planning and Queuing Case		
MODULE 4:	**SERVICE QUALITY AND INTEGRATION PROJECT**	**8 Hours**
Exp10: Service Quality Metrics using SERVQUAL Exp11: Real-time Feedback & CX Measurement Exp12: Final Project: End-to-End Service Model		
TOTAL LECTURES		**30 Hours**

Text Books:

1. Fitzsimmons, J. A., & Fitzsimmons, M. J. (2013). Service Management: Operations, Strategy, Information Technology (8th Edition). McGraw-Hill Education.
2. Maglio, P. P., Kieliszewski, C. A., & Spohrer, J. C. (Eds.). (2010). Handbook of Service Science. Springer.
3. Lovelock, C., & Wirtz, J. (2016). Services Marketing: People, Technology, Strategy (8th Edition). Pearson.
4. Shostack, G. L. (1984). Designing Services that Deliver. Harvard Business Review.
5. Bitner, M. J., Ostrom, A. L., & Morgan, F. N. (2008). Service Blueprinting: A Practical technique for Service Innovation. California Management Review, 50(3), 66–94.

IT Project Management Lab (TIU-UCBCS-L405)

Program: B. Tech. in CSBS	**Year, Semester:** 4th Yr., 7th Sem.
Course Title: IT Project Management Lab	**Subject Code:** TIU-UCBCS-L405
Contact Hours/Week: 0–1–2 (L–T–P)	**Credit:** 2

COURSE OBJECTIVE :

Enable the student to:

1. Develop competency in project planning and execution by applying project management principles, including feasibility studies, cost estimation, scheduling techniques (PERT & CPM), and resource management to effectively initiate, plan, monitor, and close IT projects.
2. Enhance risk assessment and quality management skills by implementing risk analysis, project control mechanisms, cost control strategies, and stakeholder engagement techniques to ensure the successful completion of IT projects.

3. Gain proficiency in modern Agile and DevOps methodologies by exploring Scrum frameworks, continuous integration and deployment strategies, automated testing, and other Agile practices to optimize software development and IT service management.

COURSE OUTCOME :

The student will be able to:

CO-1:	Applies the PM processes to initiate, plan, execute, monitor and control, and close projects and to coordinate all the elements of the project.
CO-2:	Manages projects effectively including the management of scope, time, costs, and quality, ensuring satisfying the needs for which the project was undertaken.
CO-3:	Applies processes required to manage the procurement of a project, including acquiring goods and services from outside the organization.
CO-4:	Manages project risk, including identifying, analyzing and responding to risk.
CO-5:	Analyzes and manages stakeholder expectations and engagement to ensure a successful project outcome.
CO-6	Strategically applies project management practices in a variety of organizational and international settings.

LABORATORY:

MODULE 1:	**PROJECT OVERVIEW AND FEASIBILITY STUDIES**	**3 Hours**
Identification, Market and Demand Analysis, Project Cost Estimate, Financial Appraisal.		
MODULE 2:	**PROJECT SCHEDULING**	**4 Hours**
Project Scheduling, Introduction to PERT and CPM, Critical Path Calculation, Precedence Relationship, Difference between PERT and CPM, Float Calculation and its importance, Cost reduction by Crashing of activity.		
MODULE 3:	**COST CONTROL AND SCHEDULING**	**4 Hours**
Project Cost Control (PERT/Cost), Resource Scheduling & Resource Leveling		
MODULE 4:	**PROJECT MANAGEMENT FEATURES**	**4 Hours**
Risk Analysis, Project Control, Project Audit and Project Termination		
MODULE 5:	**AGILE PROJECT MANAGEMENT**	**5 Hours**
Introduction, Agile Principles, Agile methodologies, Relationship between Agile Scrum, Lean, DevOps and IT Service Management (ITIL).		
MODULE 6:	**SCRUM**	**6 Hours**
Various terminologies used in Scrum (Sprint, product backlog, sprint backlog, sprint review, retro perspective), various roles (Roles in Scrum), Best practices of Scrum.		
MODULE 7:	**DevOps**	**2 Hour**
Overview and its Components, Containerization Using Docker, Managing Source Code and Automating Builds, Automated Testing and TestDriven Development, Continuous Integration, Configuration Management, Continuous Deployment, Automated Monitoring.		
MODULE 8:	**OTHER AGILE METHODOLOGIES**	**2 Hour**
Introduction to XP, FDD, DSDM, Crystal		
TOTAL LECTURES		**30 Hours**

Text Books:

1. “Project Management: A Systems Approach to Planning, Scheduling, and Controlling” – Harold Kerzner
2. “Information Technology Project Management” – Kathy Schwalbe
3. “Agile Project Management with Scrum” – Ken Schwaber
4. “The DevOps Handbook: How to Create World-Class Agility, Reliability, and Security in Technology Organizations” – Gene Kim, Jez Humble, Patrick Debois, John Willis

Reference Books:

1. “Project Management for IT-Related Projects” – Bob Hughes
2. “Agile Estimating and Planning” – Mike Cohn
3. “Continuous Delivery: Reliable Software Releases through Build, Test, and Deployment Automation” – Jez Humble & David Farley

SEMESTER 8

Project Evaluation (TIU-UCS-P404)

Program: B. Tech in CSBS	**Year, Semester:** 4th Year, 8th Sem.
Course title: Project Evaluation	**Subject Code:** TIU-UCS-P404
Contact Hours/ Weeks: 0-1-6 (L-T-P)	**Credit:** 4

COURSE OBJECTIVE:

1. Equip students with the knowledge and skills necessary to plan, manage, and execute a final-year project, ensuring they understand project management methodologies and the full project lifecycle.
2. Enable students to analyze and identify real-world problems, formulate problem statements, and develop a structured project plan that aligns with project requirements and objectives.
3. Enhance students' ability to conduct a thorough literature review, identify existing solutions, and gather system requirements, enabling them to design innovative and efficient systems.
4. Provide students with the skills needed to implement, test, debug, and optimize a system, ensuring that they can apply their theoretical knowledge to practical real-world problems.

COURSE OUTCOME:

CO	Bloom's Taxonomy Level
CO1: Understand project guidelines, objectives, and the project lifecycle.	**Understand**
CO2: Identify the project scope, formulate problem statements, and develop a project plan.	**Analyze**
CO3: Conduct a thorough literature review, gather requirements, and analyze existing solutions.	**Evaluate**
CO4: Design the system architecture, user interfaces, and document the entire process.	**Create**
CO5: Implement, test, debug, and optimize the system with a focus on integration.	**Evaluate**
CO6: Utilize appropriate technologies and tools for implementation, testing, and deployment.	**Create**

COURSE CONTENT:

Module 1	**Introduction to Final Year Project**	4 Hours
• Overview of the project structure • Selecting project topic, forming teams		
Module 2	**Problem Definition & Research**	4 Hours
• Defining the problem and project scope • Research methodology and resource gathering		

Module 3	**Feasibility Study & Requirement Gathering**	12 Hours
• Feasibility study (technical, economic, legal) • System requirements gathering from stakeholders		
Module 4	**Literature Review**	9 Hours
• Review of existing research papers, technologies, and tools • Identifying gaps and improvements from current solutions		
Module 5	**System Design & Architecture**	10 Hours
• Designing overall system architecture (UML, DFD, ER diagrams) • Selecting appropriate tools, languages, and frameworks		
Module 6:	**Technology & Tool Selection**	6 hours
• Discussion of various tools and technologies (e.g., databases, frameworks, cloud)		
Total		45 Hours

Books:

1. "The Art of Project Management" by Scott Berkun
2. "Research Methods for Computer Science" by Rocco P. L. Gennaro
3. "Software Architecture in Practice" by Len Bass, Paul Clements, and Rick Kazman
4. "Code Complete: A Practical Handbook of Software Construction" by Steve McConnell
5. "How to Write a Thesis" by Umberto Eco