Syllabus Document

B. Tech. in CSE (Data Science & Analytics)

For 2022 Batch Onwards

1st Semester

Course Code	MAL105	Course Title	Calculus for Data Science			
Category	Core	Credit Assigned	L	T	P	C
			3	1	0	4
Prerequisite (If any)	-	Type of Course	Basic Science			

Course Outcomes:

1. To analyze the nature (convergence or divergence) of a sequence or series.
2. To apply mean value theorems in the study of motion of an object.
3. To use integration in the calculation of area, volume, mass, and centre of gravity.
4. To apply multivariable calculus to study the nature of multivariable functions.
5. To understand the concept of Differential equation and its application

Course Contents:

Module 1:
Sequences and series: Sequences of real numbers, Series, ratio and root test.

Module 2:
Calculus of functions of single variable: Review of limits, continuity, and differentiability. Mean value theorems: Rolle's theorem, Lagrange's theorem, Cauchy's theorem, Taylor's theorem with remainders, indeterminate forms, curvature, curve tracing. Fundamental theorem of Integral calculus, mean value theorems of integral calculus, evaluation of definite integrals, applications in area, length, volumes and surface of solids of revolutions, Improper integrals: Beta and Gamma functions, differentiation under integral sign.

Module 3:
Calculus of Functions of Several Variables: Limit, continuity and differentiability of functions of several variables, partial derivatives and their geometrical interpretation, Tangent plane and normal line. Total differentiation, chain rules, Taylor's formula, maxima and minima, Lagrange's method of undetermined multipliers. Double and triple integrals, Jacobian, change of order of integration, change of variables, application to area, volumes, Mass, Centre of gravity.

Module 4:
Differential equation and its modelling with curve fitting: Modelling with Differential Equations, Direction Fields and Euler's Method, Linear and Bernoulli's differential equations, Nonlinear differential equations, Polar curves, angle between the radius vector and the tangent, angle between two curves. Pedal equations. Curvature and Radius of curvature - Cartesian, Parametric, Polar and Pedal forms. Problems Canter and circle of curvature, evolutes and involutes.

Text Books:

1. Kreyszig, E., Advanced Engineering Mathematics, John Wiley & Sons

Reference Books:

1. Piskunov, N., Differential and Integral calculus, Mir publishers Moscow (Vol. 1, Vol. 2)

Course Code	CSL109	Course Title	Introduction to Data and Analytics			
Category	Core	Credit Assigned	L	T	P	C
			3	0	2	4
Prerequisite (If any)	-	Type of Course	Computer Science and Engineering			

Course Outcomes:

1. Identify and describe the methods and techniques commonly used in data science.
2. Demonstrate proficiency with the methods and techniques for obtaining, organizing, exploring, and analyzing data.
3. Recognize how data analysis, inferential statistics, modeling, machine learning, and statistical computing can be utilized in an integrated capacity.
4. Create and modify customizable tools for data analysis and visualization per the evaluation of characteristics of the data and the nature of the analysis.
5. Demonstrate the ability to clean and prepare data for analysis and assemble data from a variety of sources.

Course Contents:

Module – 1: Introduction

Introduction to Data Science – Evolution of Data Science – Data Science Roles – Stages in a Data Science Project – Applications of Data Science in various fields – Data Security Issues.

Module – 2: Data Collection and Data Pre-Processing

Data Collection Strategies – Data Pre-Processing Overview – Data Cleaning – Data Integration and Transformation – Data Reduction – Data Discretization.

Module – 3: Exploratory Data Analytics

Descriptive Statistics – Mean, Standard Deviation, Skewness, and Kurtosis – Box Plots – Pivot Table – Heat Map – Correlation Statistics – ANOVA.

Module - 4: **Data Definitions and Analysis Techniques**

Elements, Variables, and Data categorization, Levels of Measurement, Data management and indexing, Introduction to statistical learning

Module -5: **Descriptive Statistics**

Measures of central tendency, Measures of the location of dispersions, Practice, and analysis Statistical hypothesis generation, and testing, Chi-Square test, t-Test, Analysis of variance, Correlation analysis, Maximum likelihood test, Practice, and analysis

Text Books:

1. An introduction to Data Science by Jeffrey Stanton
2. The Elements of Data Analytic Style by Jeff Leek
3. Exploratory Data Analysis with R, by Roger Peng
4. OpenIntro Statistics, by Diez, Barr, and Centinkaya-Rundel
5. R Programming for Data Science, by Roger Peng

Reference Books:

1. UC Irvine Machine Learning Repository https://archive.ics.uci.edu/ml/index.php
2. Variety of consumer datasets https://www.kaggle.com/datasets
3. World Bank https://data.worldbank.org/data-catalog/
4. US Government Data https://www.data.gov/

Course Code	**HUL304**	**Course Title**	**Professional Ethics**			
Category	**Core**	**Credit Assigned**	**L**	**T**	**P**	**C**
			3	**0**	**0**	**3**
Prerequisite (If any)	-	**Type of Course**	**Basic Science**			

Course Outcomes:

After the successful completing of this course the students will be able to:

1. Define professional ethics associated with engineering profession.
2. Identify various types of ethics
3. Recognize the essential complimentary nature of ethics -professions, and human-computer interactions.
4. Illustrate the workplace responsibilities and ethical dilemmas associated with the engineering profession.
5. Demonstrate broad framework of responsible technology development and social impact of engineering solutions.

Course Contents:

Module 1:

Basic concepts to understand Professional Ethics: society, values, ethics, tradition and modernization, social organization and disorganization, power vs. social justice, society and engineering profession, technology, digitalization and non-personal data.

Module 2:

Types of Ethics: the difference between professional ethics, and general ethics. Legal ethics, environmental ethics, and computer ethics, duty ethics vs. rights ethics, data ethics.

Module 3:

Professional responsibility and Ethical dilemmas: The conflict of interests: individual rights and social responsibility, Meaningful work, Whistle- blowing, ethical relativism, issue of privacy, honesty and research integrity, safety at work-place, surveillance.

Module 4:

Technology development and Professional ethics: appropriate technology, technology transfer and global justice, social impact of technology development and engineering solutions, interactions between human and internet, harnessing data for world poor
Case studies will be discussed to provide practical experiences to students.

Text Books

1. Martin, M. W., & Schinzinger, R. (1989). *Ethics in engineering*. McGraw-Hill.
2. Camenisch, P.F. (1983). Grounding Professional Ethics in a Pluralistic Society, N.Y.: Haven Publications.

3. Gaur, R. R., Sangal, R., & Bagaria, G. P. (2010). *A Foundation Course in Human Values and Professionals Ethics*. Excel Books India.
4. World Bank. World development report 2021: Data for better lives. The World Bank; 2021 Jun 15.
5. Srinivasan, S., Comini, N. and Minges, M., 2021. The Importance of National Data Infrastructure for Low and Middle-Income Countries. *Available at SSRN 3898094*.

Reference Books:

1. E.F. Schumacher, (1973). Small is Beautiful: a study of economics as if people mattered, Blond & Briggs, Britain.
2. Sussan George, (1976). How the Other Half Dies, Penguin Press
3. PL Dhar, RR Gaur, (1990). Science and Humanism, Commonwealth Publishers.
4. Donella H. Meadows, Dennis L. Meadows, Jorgen Randers, William W. Behrens III, (1972). Limits to Growth- Club of Rome's report, Universe Books.
5. E G Seebauer & Robert L. Berry, (2000). Fundamentals of Ethics for Scientists and Engineers, Oxford University Press.
6. R R Gaur, R Sangal, G P Bagaria, (2009). A Foundation Course in Value Education.
7. Koehn, D. (1995). The Ground of Professional Ethics, Routledge.
8. N. Tripathy, (2003). Human Values, New Age International Publishers.
9. J. Timmons Roberts and Amy Bellone Hite, Eds. The Globalization and Development Reader: Perspectives on Development and Global Change, Blackwell: London, 2007 Amartya Sen, Development as Freedom, Anchor Books: New York, 1999
10. IT Governance: How Top Performers Manage IT Decision Rights for Superior Results Kindle Edition by Peter Weill (Author), Jeanne W. Ross

Course Code:	**CSL 101**	**Course Title:**	**Computer Programming**
Category:	**Core**	**Credit Assigned**	**L** | **T** | **P** | **C** **3** | **0** | **2** | **4**
Prerequisite (if Any)	**NONE**	**Type of Course**	**Computer Science and Engineering**

Course Outcomes:

1. Recognise basics of programming and develop logical thinking.
2. To illustrate how to model real world problems into the software and develop practical programming skills.
3. To use mathematical and statistical applications into programming.
4. To analyse and develop solutions for the general as well as scientific problems.

Course Contents:

Module 1:
Introduction – Computer generation and evolution, flowcharts, algorithm, What is C?, constants, variables, scope of variable, data types, operators, arithmetic expression, Hierarchy of operators, control flows, conditional operator, loops, switch concept.
Program Structure – Basic programs to illustrate structure of C program and its flow in execution.

Module 2:
Function – Introduction to function and parameter passing, returning value, recursive functions, macros.

Module 3:
Arrays – One-dimension and multi-dimension arrays, array initialization, how arrays are stored in memory, array as parameter in functions, programs based on arrays.

Module 4:
Pointers – Initialization, accessing a variable through pointers, pointers as function arguments, pointer to array, arrays of pointers, pointers to pointers.

Module 5:
Structure and Union – Defining a structure, accessing structure members, Array of structure, unions.

Module 6:
File Handling- reading from and writing to a file.

Text books:
1) The C Programming Language by Brian W. Kernighan and Dennis M. Ritchie, PHI.
2) Programming in C by E. Balguruswamy, Tata Mcgraw Hill Publishing.

List of Lab Assignments / Experiments
1. Programs using function.
2. Programs using arrays.
3. Programs on structures.
4. File Handling

Course Code:	**HUL 101**	**Course Title:**	**Communication Skills**
Category:	**Core**	**Credit Assigned**	**L** | **T** | **P** | **C** **2** | **0** | **2** | **3**
Prerequisite (if Any)	**None**	**Type of Course**	**Humanities**

Course Outcomes:

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

1. Utilize functional English grammar for accurate and enhanced language skills.

2. Construct and use effective interpersonal and workplace communication
3. Acquire better reading comprehension, pronunciation and reading skills
4. Introspect and illustrate the personality traits and soft skills
5. Develop the skills for better pre and post placement communication through effective presentations, personal interviews and group discussions

Course Contents:

Module 1
Communication:-
Definition of Communication, Process of Communication, Stages of Communication, Content of the message, Types of communication, Transmission, Medium/Modes of Communication, Verbal and Non-verbal Communication (Kinesics, Proxemics, Chronemics, Haptics, Paralinguistic Feature), Levels of Communication, Flow of Communication, Communication Networks, Grapevine, Barriers to Communication, Choice of Medium,

Module 2
Listening Skills:-
Art of Listening, Listening vs Hearing, (Poor Listening vs Effective Listening), Advantages of Good Listening, Barriers to Effective Listening, Techniques of Effective Listening
Reading Skills:-
Reading Comprehensions, Process of Reading, Techniques of Reading, Techniques for Good Comprehension, Reading Skills(Skimming, Scanning, Intensive Reading, SQ3R), Orientation in Literary and Scholarly Article

Module 3
Speaking Skills:-
Types of Speech, Public Speaking, Components of Effective speech, Stage Presence & Personality Development, Clarity and Fluency, Body Language, , Barriers to Effective Speaking
Presentation Skills:-
Characteristics of a Successful Presentation, Power Point Presentation, Using Audio Visual Aids

Module 4
Group Discussion:-
Do's and Don'ts of GD, Essential Skills for GD, Evaluation Pattern
Personal Interview:-
Objectives of Interview, Types of Interview, Job Interviews, Employer's Expectations, Do's & Don'ts of Social Media Profile, Success Factors, Failure Factors

Module 5
Grammar:-
Transformation of Sentences, Punctuation, Spellings and Mechanics of Writing

List of Lab Assignments/Experiments

1. Speaking Skills (Verbal/Non verbal Skit, Role Play, Extempore, Story Telling, Word Wheel, Debate)
2. Presentation Skills (Film/Book Review, PPT Presentation)
3. Group Discussion (Practice GD, Mock GD)
4. Personal Interview/ SWOT Analysis (SWOT Analysis, Mock PI)
5. Comprehending a Technical Report/News Paper Article.
6. Presenting a Book Chapter using PowerPoint slides

Text Books:

1. Orient Longman, A Textbook of English for Engineers and Technologists
2. M. Ashraf Rizvi, Effective Technical Communication. Tata Mc Grwa-Hill Publishing Company Limited, 2009

Reference Books:

1. Quirk R. and Greenbaum S., A University Grammar of English.
2. Krishnaswamy N., English Grammar (Longman Publication) (Macmillan India Ltd)
3. Sanjay Kumar and PushpaLata, Communication Skills. Oxford Publication
4. Meenakshi Raman and Sangita Sharma. Technical Communication. Second Edition. Oxford Publication,2011

<table>
<tr><td>Course Code:</td><td>SAP 101</td><td>Course Title:</td><td colspan="4">Health, Sports & Safety</td></tr>
<tr><td>Category:</td><td>Core</td><td>Credit Assigned</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td colspan="3"></td><td>0</td><td>0</td><td>2</td><td>0</td></tr>
<tr><td>Prerequisite (if Any)</td><td>NONE</td><td>Type of Course</td><td colspan="4">Basic Science</td></tr>
<tr><td colspan="7">Course Outcomes:
1. To provide physical fitness and good health.
2. Create awareness among the students about their health status by conducting various tests and measurements and suggest them suitable remedial physical fitness program so that they can improve physical and physiological health status.
3. To improve productivity, foster social harmony, inculcate sense of discipline and dedication in general life, develop the spirit of team work, through various sports activities.</td></tr>
<tr><td colspan="7">Course Contents:
Development of components of fitness through conditioning exercises: Strength: (Strength Endurance, Maximum Strength, explosive strength), Endurance: (aerobic endurance, anaerobic endurance, speed endurance and strength endurance), Speed, Co-coordinative ability, Flexibility

Physical Efficiency Test Level 1(Testing and Evaluation of Physical Fitness): Cooper Test 12 minute run or walk test, Sit and reach test, 100 meter run, one minute sit up test, Push up/Bent knee push up test

Teaching and development of sports skills: Cognitive, Perceptual, Motor, Perceptual motor. First Aid training

Intramural phase 1: Identification of sports talent through exposing students to inter- section tournament. Football, Volleyball, throw ball, table tennis & Chess.

Yoga, Meditation and Personal Safety.</td></tr>
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Course Code:	HUL 102	Course Title:	Environmental Studies
Category:	Core	Credit Assigned	L: 2, T: 0, P: 0, C: 0
Prerequisite (if Any)	NONE	Type of Course	Humanities

Course Outcomes:

1. Identify natural resources, ecosystem, and biodiversity, their structure and functions.
2. Describe the importance of environmental components, and their role in human life.
3. Illustrate the possible causes of various forms of environmental pollution, their consequences, and methods of prevention.
4. Define the concept of sustainable development and mechanism to attain it.
5. Recognize the integration of social issues and environmental problems.

Course Contents:

Module 1: Natural resources: Forest resources, Water resources, Mineral resources, Food resources, Energy resources, Land resources.

Module 2: Ecosystem: Concept of an ecosystem, Structure and functions of an ecosystem, Producers, consumers and decomposers, Ecological succession, Food chain, food webs and pyramids.

Module 3: Biodiversity and its conservation: Introduction, definitions: genetics, species and diversity, Value of biodiversity, Biodiversity at global, national and local level, India as a mega-diversity nation, Hot-spot of biodiversity, Threat to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts, Conservation of biodiversity: in-situ and ex-situ conservation.

Module 4: Environmental pollution: Definition, Causes, effects and control measures of: Air pollution, Water pollution, Soil pollution, Marine pollution, Noise pollution, Thermal pollution, Nuclear hazards. Solid waste management: Causes, effects and control measures of urban and industrial wastes.

Module 5: Social issues and environment: Sustainable development, Water conservation, Rain water harvesting, Watershed management, Climate change, Global warming, Ozone layer depletion, Nuclear accident, Environmental rules and regulations, Human population and environment. Role of information technology in environment and human health.

Case studies related to ecosystem, environmental pollution, sustainable development will be discussed in a class.

Text Books:

1. Rajagopalan, Raghavachari. *Environmental studies: from crisis to cure*. No. Ed. 3. Oxford University Press, 2015.

Reference Books:

1. Joseph, Benny. *Environmental studies*. Tata McGraw-Hill Education, 2005.

2. Chopra, Kanchan and G. K. Kadaekodi, Operationalizing Sustainable Development: Economic- Ecological Modeling for Developing Countries: Sage, Chapter 1, 1999.

3. Kolstad, Charles, D., *Environmental Economics*, Press, 2000.
4. Reed, David (Ed.), *Structural Adjustments, the Environment and Sustainable Development*, Earthscan, Chapters 1, 12, 13 and 14, 1996.
5. Bharucha, Erach. *Textbook of Environmental Studies for Undergraduate Courses*. Universities Press, 2005.

2nd Semester

Course Code	MAL107	Course Title	Introduction to Linear Algebra			
Category	Core	Credit Assigned	L	T	P	C
			3	1	0	4
Prerequisite (If any)	NONE	Type of Course	Basic Science			

Course Outcomes:

1. Describe properties of linear systems using vectors and Solve systems of linear equations and interpret their results
2. Demonstrate an understanding of linear transformations and Perform and interpret matrix operations
3. Compute and interpret determinants of matrices and Demonstrate an understanding of vector spaces and sub-spaces
4. Demonstrate an understanding of eigenvalues and eigenvectors

Course Contents:

Module-1

Introduction to Vectors, Vectors and Linear Combinations, Lengths and Dot Products, Matrices, Solving Linear Equations,Vectors and Linear Equations,The Idea of Elimination, Elimination Using Matrices, Rules for Matrix, Operations, InverseMatrices, Elimination = Factorization: $A = LU$, Transposes and Permutations Vector Spaces and Subspaces, Spaces of Vectors,The Nullspace of A: Solving $Ax = 0$ and $Rx =$ The Complete Solution to $Ax = b$.

Module-2

Independence, Basis and Dimension, Dimensions of the Four Subspaces, Orthogonality, Orthogonality of the Four Subspaces, Projections, Least Squares Approximations, Orthonormal Bases and Gram-Schmidt Determinants, The Properties of Determinants, Permutations and Cofactors, Cramer's Rule, Inverses, and Volumes, Eigenvalues and Eigenvectors, Introduction to Eigenvalues

Module-3

Diagonalizing a Matrix, Systems of Differential Equations, Symmetric Matrices, Positive Definite Matrices, The Singular Value Decomposition (SVD), Bases and Matrices in the SVD, Principal Component Analysis (PCA by the SVD) The Geometry of the SVD Linear Transformations,The Idea of a Linear Transformation

Module-4

The Matrix of a Linear Transformation, The Search for a Good Basis, Complex Vectors and Matrices, Complex Numbers, Hermitian and Unitary Matrices, The Fast Fourier Transform, Applications, Graphs and Networks, Matrices in Engineering, Markov Matrices, Population, and Economics, Linear Programming, Fourier Series: Linear Algebra for Functions.

Module-5

Numerical Linear Algebra, Gaussian Elimination in Practice, Norms and Condition Numbers, Iterative Methods and Preconditioners, Mean, Variance, and Probability, Covariance Matrices and Joint Probabilities,Multivariate Gaussian and Weighted Least Squares, Matrix Factorization

Text Books:

1. Kenneth Hoffman and Ray Kunze: Linear Algebra, Prentice Hall of India limited, New Delhi, 1971.
2. Gilbert Strang : Linear Algebra And Its Applications (Paperback) , Nelson Engineering (2007).
3. Introduction to Linear Algebra: Gilbert Strang

Reference Books:

1. Gilbert Strang: Introduction to Linear Algebra, Wellesley- Cambridge Press, Fourth Edition, 2011.
2. Jin Ho Kwak and Sungpyo Hong, Linear Algebra, Springer, Second edition, 2004.
3. V. Krishnamoorthy et. al., An introduction to linear algebra, New Delhi.
4. Elementary of Linear Algebra Howard Anton

Course Code	**MAL106**	**Course Title**	**Probability and Statistics**			
Category	**Core**	**Credit Assigned**	**L**	**T**	**P**	**C**
			3	**1**	**0**	4
Prerequisite (If any)	**NONE**	**Type of Course**	**Basic Science**			

Course Outcomes:

At the end of the course, students will be able to :

1. Solve problems of basic probability, two types of random variables and their probability functions.
2. Observe and analyze the behaviour of various discrete and continuous probability distributions.
3. Formulate an appropriate null and alternative hypothesis. Perform test of Hypothesis for decision making and validation.
4. Perform Regression and correlation analysis.
5. Apply sampling distributions to testing of hypotheses.

Course Contents:

Module 1:

Sample space and events – Probability – The axioms of probability, Calculating probability: sets, counting, tree diagram, Conditional probability – Baye's theorem, Bayesian reasoning, Bayesian inference, Priors, Conjugate priors, Random variables – Discrete and continuous, probability density function; probability distribution function for discrete and continuous random variable. Combinatorics: Permutation and combination.

Module 2:

Definition of mathematical expectation, functions of random variables, mean, moments, variance and standard deviations, moment generating function.

Module 3:
Discrete Random Variables(RVs): Bernoulli, Binomial, Geometric, Poisson. Sampling distributions –Sampling distribution of means (known and Unknown). Continuous Random Variable, Uniform, Exponential, Random variable for Normal Distribution, Joint probability distribution, Linearity (and product) of expectation, Conditional expectation, Sum of a random number of RVs, Probability inequalities, Markov's Inequality, Chebyshev's inequality, Weak Law of Large Numbers, Central Limit Theorem.

Module 4:
Tests of hypothesis, point estimations – interval estimations, Bayesian estimation. Large samples, Null hypothesis – Alternate hypothesis type I, & type II errors – critical region confidential interval for mean testing of single variance. Difference between the mean. Confidential interval for the proportions. Tests of hypothesis for the proportions single and difference between the proportions.

Module 5:
Regression and Correlation Analysis: Introduction, Basics of Regression, Simple Linear Regression, Multiple Linear Regression, estimation and analysis of simple regression models, correlation coefficients, analysis of correlation coefficients, Hypothesis tests associated with regression and correlation coefficients, curvilinear regression models, Multiple regression models, multiple and partial correlation coefficients. EWMA Time Series modeling, AR Time Series modelling.

Text Books:

1. D. K. Murugesan & P. Guru Swamy, "Probability & Statistics", Anuradha Publications.

2. G. S. S. Bhisma Rao, "Probability & Statistics for Engineers", Scitech Publications.

3. Spiegel, Murray, "Probability and Statistics", Schaum's series,.

Reference Books:

1. K.V. Iyengar & B. Krishna Gandhi , "Probability & Statistics", S.Chand.

2. William Mendenhall & Others, " Probability & Statistics", Cengage Publications.

3. P. Billingsley, *"*Probability and Measure*"*, John Wiley & Sons (SEA) Pvt. Ltd.

4. W. Feller, *"*An introduction to probability theory and its applications", John Wiley and Sons.5.

5. Levin, Rubin, Rastogi, "Statistics For Management", 8th edition, Pearson.

Course Code:	**CSL 102**	**Course Title:**	**Data Structures**
Category:	**Core**	**Credit Assigned**	**L** | **T** | **P** | **C** **3** | **0** | **2** | **4**
Prerequisite (if Any)	**CSL 101 (Computer Programing)**	**Type of Course**	**Computer Science and Engineering**

Course Outcomes:
Students will be able to:

1. Design and differentiate the recursive and iterative versions of the program.
2. Implement and analyse algorithms using dynamic memory allocation.
3. Apply, implement and evaluate various concepts of linear data structures for solving real life problems.
4. Apply, implement and evaluate non-linear data structures in solving various problems.

Course Contents:
Module 1: Types and operations, Iterative constructs and loop invariants, Quantifiers and loops, Structured programming and modular design, Illustrative examples, Scope rules, parameter passing mechanisms, recursion, program stack and function invocations including recursion, Overview of arrays and array based algorithms - searching and sorting, Mergesort, Quicksort, Binary search, Introduction to Program complexity (Big Oh notation)

Module 2: Implementation of Structures (Records) and array of structures (records). Database implementation using array of records. Dynamic memory allocation and deallocation. Dynamically allocated single and multi-dimensional arrays.

Module 3: Lists as dynamic structures, operations on lists, implementation of linked list using arrays pointers and its operations. Introduction to Overview of linked list implementation using self-referential-structures/pointers. Stack, Queues and its operations. Concept of an Abstract Data Type (ADT),Implementation of stacks and queues using both array-based and pointer-based structures. Uses of stacks in simulating recursive procedures/ functions. Applications of stacks and queues.

Module 4: Lists - Singly-linked lists, doubly linked lists and circular linked lists. List traversal, insertion, deletion at different positions in the linked lists, concatenation, list-reversal etc. Mergesort for linked lists.

Module 5: Trees, binary trees, binary trees- basic algorithms and various traversals. Binary Search Trees (BSTs) and insertion, deletion in BSTs.

Module 6: Generalization of trees to graphs – their representation & traversals. Directed Acyclic Graphs and topological sort, Dijkstra‟s shortest path algorithm,

Text Books:

1. Data Structures & Program Design in C: Robert Kruse, G. L. Tondo and B. Leung PHI-EEE.
2. Fundamentals of Data Structures in C : E. Horowitz, S. Sahni, and S. Anderson-Freed, University Press

Reference Books:

1. Aho, Hopcroft and Ullmann, ―Data Structures and Algorithms,‖ Addison Wesley, 1983.

Course Code	**CSP101**	**Course Title**	**Web Programming**			
Category	**Core**	**Credit Assigned**	**L**	**T**	**P**	**C**
			0	**0**	**4**	**2**
Prerequisite (If any)	**NONE**	**Type of Course**	**Computer Science and Engineering**			
Course Outcomes:						

1. Build awesome front-end features.
2. Architect scalable back-end infrastructure.
3. Test features with minimal effort and deploy features seamlessly to production.
4. Build a working industry application from scratch.

Ready for the Role of **Full stack developer.**

Module 1: HTML

Introduction to HTML 5, Browsers and HTML, Editor's Offline and Online, Tags, Attribute and Elements, Doctype element, Comments, Headings, Paragraphs,Formatting text, Lists and Links Images , Table.

Module 2: CSS

Introduction CSS, Applying CSS to HTML, Selectors, properties and values, CSS Colors, Backgrounds, CSS Box Model, CSS Margins,Padding,Borders, CSS Text and Font Properties, CSS General Topics.

Module 3: JavaScript

Introduction to JavaScript, Applying JavaScript (internal, external), Understanding JS Syntax, Introduction to Document and Window Object, Variables,Operators, Data Types,Num Type Conversion, Math,String , Manipulation, Objects,Arrays, Date and Time, Conditional Statements, Switch Case, Looping in JS, Functions.

Module 4: ReactJS

Introduction, Templating using JSX, Components, State and Props, Lifecycle of Components, Rendering List, Portals, , Error Handling, Routers, Redux, Redux Saga, Immutable.js, Service side rendering, Unit testing, Webpack.

Module 5: Node.js

Node.js overview, Node.js – basics and setup, Node.js console, Node.js command utilities, Node.js modules, Node.js concepts, Node.js events, Node.js with Express.js, Node.js database access.

Module 6: MongoDB

SQL and NoSql concepts, Create and manage MongoDB, Migration of data into MongoDB, MongoDB with PHP, MongoDB with NodeJS, Services offered by MongoDB.

Module7: Python

Python installation & configuration, Developing a Python application, Connect MongoDB with Python.

Reference books :

1. The Full Stack Developer: Your Essential Guide to the Everyday Skills Expected of a Modern Full Stack Web Developer
2.Modern Full-Stack Development: Using TypeScript, React, Node.js, Webpack, and Docker
3.Full-Stack React, TypeScript, and Node: Build Cloud-ready Web Applications Using React 17 with Hooks and GraphQL
4.Full-Stack React Projects: Learn MERN Stack Development by Building Modern Web Apps Using MongoDB, Express, React, and Node.js, 2nd Edition.

Course Code	ECL103	Course Title	Applied Electronics			
Category	Core	Credit Assigned	L	T	P	C
			3	0	2	4
Prerequisite (If any)	NONE	Type of Course	Electronics Engineering			

Course Contents:

Module 1: ELECTRONIC DEVICES

Theory of P-N Junction Diode, Junction Transistors Theory of Operation, Static Characteristics, Break Down Voltages, Current Voltage Power Limitations, Field Effect Transistor & MOSFET, Principle of Operation & Characteristics.

Module 2: APPLICATIONS of ELECTRONIC DEVICES

Rectifiers, Zener Diode as Regulators, Biasing of BJT Different Biasing Arrangements, Stability Factor, Small Signal Analysis & High Frequency Analysis of BJT, Power Amplifiers, Push Pull Configuration, Complimentary Symmetry, Feedback Amplifiers, RC, LC & Crystal Oscillators.

Module 3: COMBINATIONAL and SEQUENTIAL LOGIC

Logic minimization using K-map method, multiplexers, demultiplexers, decoders, encoders, Arithmetic circuits, Adders, Combinational multiplier and code converters. Basic latches, master-slave latch, Flip flops, Registers, Counters.

Module 4: MEMORIES

Introduction to PLA, PAL and ROM, Programmable Logic Devices and FPGAs.

Module 5: INTRODUCTION TO MICROPROCESSORS

Architecture, bus structure, timing diagrams, T-states, machine cycle, instruction cycle. Memory and IO devices interfacing.

Reference Books:

1) Electronic devices and circuit theory / Robert L. Boylestad, Louis Nashelsky
2) Milman and Halkias, “Integrated Electronics”, Second Edition, 2011, McGraw Hill.
3) Digital Design by M. Morris Mano and Michael D. Ciletti
4) Microprocessor Architecture, Programming, and Applications with the 8085 by Ramesh Gaonkar

Course Code	HUL103	Course Title	Introduction to Entrepreneurship			
Category	Core	Credit Assigned	L	T	P	C
			3	0	0	3
Prerequisite (If any)	-	Type of Course	Humanities			

Course Outcomes:

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

1. Define entrepreneurship and its association with engineering profession, and create basic understanding of conceiving, creating, and managing an entrepreneurial venture.
2. Identify various characteristics of Entrepreneurship, entrepreneurial culture and India's status with respect to entrepreneurship development.
3. Recognize the essential complimentary nature of ethics/ values and creativity for entrepreneurship development
4. Describe the MSMEs, SEZ and entrepreneurship development schemes and financial resources
5. Demonstrate broad framework of opportunities for smart entrepreneurial efforts and start-up development

Course Contents:

Module 1:

Meaning and Importance, Evolution of term 'Entrepreneurship', Factors influencing entrepreneurship'. Characteristics and types of an entrepreneur, New generations of entrepreneurship viz. social entrepreneurship, Barriers to entrepreneurship.

Module 2:

Motivation theory, Achievement Theory, Culture and Society, Values / Ethics- national entrepreneurial culture, make in India concept and practices, creativity and entrepreneurship, Decision making and Problem Solving (steps in decision making), entrepreneurship and employment.

Module 3:

Special Economic Zone (Meaning, features & examples), Export-oriented units, Small Scale Industries, Make in India initiated by the government of India and Support for Industries. Scheme and packages, Financial and legal assistance for entrepreneurial development.

Module 4:

Opportunity for smart entrepreneurial efforts, branding, the management of property rights,

social value, technological innovation, online commerce, emerging markets and entrepreneurial solutions

Module 5:

Introduction to Idea Selection, Selection of the Product / Service, Phases of a Project, Project Report, and Contents of a Project Report. Case studies to provide real knowledge.

Text Books:

1. Gordon, E., Natarajan, K., & Arora, A. (2009). Entrepreneurship development. Himalaya publishing house.
2. Megginson, W.L., Byrd, M.J. and Megginson, L.C., 2000. Small business management: an entrepreneur's guidebook.
3. Watson, J., Gatewood, E.J. and Lewis, K., 2014. A framework for assessing entrepreneurial outcomes: an international perspective. *International Journal of Gender and Entrepreneurship*.
4. Katz, J.A. and Green, R.P., 2021. Entrepreneurship Small Business.
5. Blomberg, J., Burrell, M., and Guest, G. An Ethnographic Approach to Design, Human-Computer Interaction Handbook, L. Erlbaum Associates Inc. Hillsdale, NJ, USA, 2003

6. Lerner, J. and Schoar, A. eds., 2010. *International differences in entrepreneurship*. University of Chicago Press.

Reference Books:

1. Oughton, E. J., Comini, N., Foster, V., & Hall, J. W. (2022). Policy choices can help keep 4G and 5G universal broadband affordable. *Technological Forecasting and Social Change*, *176*, 121409.
2. Sterling, B. The Epic Struggle of the Internet of Things, Moscow: Strelka Press, 2014.
3. Castells, Manuel (2001): Internet Galaxy. Oxford University Press
4. J. Timmons Roberts and Amy Bellone Hite, Eds. The Globalization and Development Reader: Perspectives on Development and Global Change, Blackwell: London, 2007
5. Udyamita (in Hindi) by Dr. MMP. Akhouri and S.P Mishra, pub. By National Institute for Entrepreneurship and Small Business Development (NIESBUD), NSIC-PATC Campus, Okhla
6. Amartya Sen, Development as Freedom, Anchor Books: New York, 1999
7. IT Governance: How Top Performers Manage IT Decision Rights for Superior Results Kindle Edition by Peter Weill (Author), Jeanne W. Ross
8. Science Tec. Entrepreneur (A Bi Monthly Publication), Centre for Entrepreneurship Development, M.P (CEDMAP)

2nd Year Syllabus

3rd Semester

Course Code	MAL202	Course Title	Advanced Probability & Statistics			
Category	Core	Credit Assigned	L	T	P	C
			3	1	0	4
Prerequisite (If any)	NONE	Type of Course	Basic Sciences			

Course Outcomes:

At the end of the course students will be able to:

1. Develop problem-solving techniques needed to calculate probability and conditional probability.
2. Formulate fundamental probability distribution and density functions, as well as functions of random variables, derive the probability density function of transformations.
3. Derive the expectation and conditional expectation, and describe their properties.
4. Describe commonly used univariate and multivariate discrete and continuous probability distributions.
5. Compute and interpret the results of Bivariate and Multivariate Regression and Correlation Analysis, for prediction and forecasting.

Course Contents:

Module 1:

Multivariate Statistics: Samples and Populations, Orthogonality, Data appropriate for multivariate statistics, Degree of relationship among variables, Significance of Group differences.

Module 2:

Prediction of Group membership, bi-variate statistics: correlation and regression, data screeing and transformation, multiple regression, multiway frequency analysis, analysis of co-variance.

Module-3

Discriminant function analysis, limitations, fundamental equations, types of discriminant function analysis, Principlal components, factor analysis.

Module 4:

Markov Chain, Stochastic processes, Setting up Markov chains, Balance equations, Non-parametric interference, Empirical Distribution Function (or eCDF), Kernel Density Estimation (KDE), Statistical Functionals, Plug-in estimator, confidential interval, Percentiles, quantiles, Normal-based confidence intervals, DKW inequality, Parametric Interference, Consistency, Asymptotic Normality, Basics of parametric inference, Method of Moments Estimator (MME)

Module 5:

Properties of Method of Moments Estimator (MME),, Basics of MLE, Maximum Likelihood Estimator (MLE), Properties of MLE, Basics of hypothesis testing, The Wald test, t-test, Kolmogorov-Smirnov test (KS test), p-values, Permutation test.

Text Books:

1. An Introduction to Probability and Statistics. Vijay K Rohatgi and A.K.Md. Ehsanes Saleh, 2nd edition, Wiley.
2. Using Multivariate Statistics, 7/e by Linda S. Fidell, Barbara G. Tabachnick.
3. Mathematical Statistics. Suddhendu Biswas and G.L. Sriwastav. Narosa
4. Probability and Statistics for Data Science: Math + R + Data (Chapman & Hall/CRC Data Science Series)

Reference Books:

1. K.V. Iyengar & B. Krishna Gandhi , "Probability & Statistics", S.Chand.

2. William Mendenhall & Others, " Probability & Statistics", Cengage Publications.

3. P. Billingsley, *"*Probability and Measure*"*, John Wiley & Sons (SEA) Pvt. Ltd.

4. W. Feller, *"*An introduction to probability theory and its applications", John Wiley and Sons.

Course Code:	**CSL202**	**Course Title:**	**Introduction to Object Oriented Programming**
Category:	**Core**	**Credit Assigned**	**L** | **T** | **P** | **C** **3** | **0** | **2** | **4**
Prerequisite (if Any)	**None**	**Type of Course**	**Computer Science and Engineering**
Course Outcomes:			

1. Evaluate various object-oriented paradigms like abstraction, encapsulation, inheritance, polymorphism, information hiding, exception handling, etc.
2. Identify the implementational differences between different object-oriented programming languages.
3. Analyse a problem description and design and develop object-oriented software using best coding practices.
4. Assess object-oriented solutions for various real-world problems.

Students will be able to:

1. Design solution for small and large systems or organizations using object oriented concepts.
2. Evaluate procedural and object oriented paradigms.
3. Apply the concepts of object oriented programming for developing software.

Course Contents:

Module 1: Object Oriented Programming, Features of object oriented programming languages like data encapsulation, inheritance, polymorphism and late binding.

Module 2: Concept of a class, Access control of members of a class, instantiating a class, static and non-static members, overloading a method. Deriving a class from another class, access control of members under derivation, different ways of class derivation, overriding of a method, run time polymorphism.

Module 3: Concept of an abstract class. Concept of an interface. Implementation of an interface. Exception and exception handling mechanisms. Study of exception handling mechanisms inobject-oriented languages

Module 4: Introduction to streams, use of stream classes. Serialization and de-serialization of objects. Templates, Implementation of data structures like linked lists, stacks, queues, trees, graphs, hash table etc. using object oriented programming languages.

Module 5: Introduction to concept of refactoring, modeling techniques like UML, Design patterns.

Text Books:

1. BjaneStrostrup, "The C++ programming language", Addison-Wesley
2. Herbert Shildt, "C++: The Complete Reference", 4th Edition
3. Arnold Ken, Gosling J, "The Java Programming Language", Addison Wesley
4. Matt Weisfeld, "The Object-Oriented Thought Process", Pearson
5. Cox Brad, "Object –Oriented Programming: An Evolutionary Approach", Addison – Wesley

Course Code:	**CSL 204**	**Course Title:**	**Maths and Graph Theory**
Category:	**Core**	**Credit Assigned**	**L** | **T** | **P** | **C** **3** | **1** | **0** | **4**
Prerequisite (if Any)	**None**	**Type of Course**	**Computer Science and Engineering**

Course Outcomes:

1. Student should be able to use different proof techniques.
2. Students would be able to argue about limits by using Pigeon Hole principle.
3. Solve problems based on set theory, Permutations and Combinations, as well as Discrete Probability.
4. Students will be able to solve mathematical problems on partial orders, and group theory.
5. Students would be able to model and analyze computational problems in graph theoretical framework.

Course Contents:

Module 1:
Set Theory: Definition of sets, countable and uncountable sets, Venn Diagrams, proofs of some general identities on sets Relation: Definition, types of relation, composition of relations, Pictorial representation of relation, Equivalence relation, Partial ordering relation, Job-Scheduling problem.

Module 2:
Algebraic Structures: Definition, Properties, types: Semi Groups, Monoid, Groups, Abelian group, properties of groups, Subgroup, cyclic groups, Cosets, factor group, Permutation groups, Normal subgroup, Homomorphism and isomorphism of Groups, example and standard results, Rings and Fields: definition and standard results.

Module 3:
Propositional Logic: Proposition, First order logic, Basic logical operation, truth tables, tautologies, Contradictions, Algebra of Proposition, logical implications, logical equivalence, predicates, Normal Forms, Universal and existential quantifiers. Introduction to finite state machine Finite state machines as models of physical system equivalence machines, Finite state machines as language recognizers.

Module 4:
Graph Theory: Introduction and basic terminology of graphs, Planer graphs, Multigraphs and weighted graphs, Isomorphic graphs, Paths, Cycles and connectivity, Shortest path in weighted graph, Introduction to Eulerian paths and circuits, Hamiltonian paths and circuits, Graph coloring, chromatic number, Isomorphism and Homomorphism of graphs. Graphs, hypergraphs, transitive closure, trees, spanning trees. Eulerian tours, Hamiltonian cycles, Planar Graphs, Connectivity, Colorability, Line Graphs

Module 5:
Posets, Hasse Diagram and Lattices: Introduction, ordered set, Hasse diagram of partially, ordered set, isomorphic ordered set, well ordered set, properties of Lattices, bounded and complemented lattices.
Combinatorics: Introduction, Permutation and combination, Binomial Theorem, Multimonial Coefficients Recurrence Relation and Generating Function, Recurrence Relation and Recursive algorithms , Linear recurrence relations with constant coefficients, Homogeneous solutions, Particular solutions, Total solutions .

Text Books:

1. C.L.Liu, “Elements of Discrete Mathematics” Tata Mc Graw-Hill Edition.
2. Trembley, J.P & Manohar; “Discrete Mathematical Structure with Application CS”, McGraw Hill.
3. Kenneth H. Rosen, “Discrete Mathematics and its applications”, McGraw Hill.
4. Lipschutz; Discrete mathematics (Schaum); TMH
5. Deo, Narsingh, “Graph Theory With application to Engineering and Computer Science.”, PHI.

Course Code:	CSL 210	Course Title	Data Structures with Applications
Category:	Core	Credit Assigned	L T P C 2 0 2 3
Prerequisite (if Any)	None	Type of Course	Computer Science and Engineering

Course Outcomes:

1. Ability to design and analyze the applications based on dynamic memory allocation such as linked lists.
2. Ability to apply and relate the concepts of height balanced trees for comparative analysis, and their applications to real world.
3. Ability to incorporate the knowledge of tries and skip lists for different applications.
4. Ability to apply the knowledge of graph data structures for various applications and algorithm design paradigms.

Course Contents:

Module 1:

Applications of lists in polynomial representation, multi-precision arithmetic, Hash-tables, Radix Sort etc. Multi linked structures and an example application like sparse matrices. Implementation of priority queues.

Module 2:

Overview of Binary Search Tree (BST), Height-balanced (AVL) trees, insertion/deletion and rotations. Heaps and heapsort.

Multi-way trees and external sorting - B-trees – insertion and deletion, Introduction to B+ trees with insertion and deletion algorithms. Red-black trees, Splay trees.

Module 3:

Tries, Multi-way tries, Suffix trees, Segment trees. Applications of the above mentioned trees. Introduction to Skip lists, Data structures for disjoint set representation

Module 4 :

Overview and definition of Graph as data structure, Traversals (BFT, DFT, Topological Sort), Data structures for Dijkstra's Shortest Path Algorithm, All-pairs shortest paths, Minimum spanning trees – Algorithms (Kruskal, Prim) and data structures. Huffman coding. Introduction to network flow problem.

Text Books:

1. Data Structures & Program Design in C: Robert Kruse, G. L. Tondo and B. Leung PHI-EEE.
2. Fundamentals of Data Structures in C : E. Horowitz, S. Sahni, and S. Anderson-Freed, University Press

Reference:

1. Aho, Hopcroft and Ullmann, ―Data Structures and Algorithms,‖ Addison Wesley, 1983.

Course Code	CSP205	Course Title	Tools and Practices for Data Science - I			
Category	Core	Credit Assigned	L	T	P	C
			0	0	4	2
Prerequisite (If any)	NONE	Type of Course	Computer Science & Engineering			

Course Outcomes:

Upon successful completion of this course, the students shall be able to
1. Use basic excel functions to manipulate data in worksheets.
2. Summarize and plot the results from spreadsheets.
3. Learn step-by-step statistical analysis from descriptive statistic.
4. Gain efficiency in analyzing the statistical procedures.
5. Learn to interpret and visualize the results

Course Contents:

● Excel and advanced operations:

Introduction to spreadsheets, basic data manipulation in excel, spreadsheet functions in excel, Descriptive statistics using excel, formulas and pivot tables for data analysis, charts and graphs, data visualization using excel.

● Using open source tools, like R or Python for Statistical Analysis of Data:

Describing Data through Statistics, Probability Distribution: Discrete and Continuous, Sampling distribution, Estimation Parameters, Testing of Hypothesis, Analysis of Variance. Correlation, Simple Linear Regression, and Multiple Regression.

NOTE: The contents of the course may be modified based on the requirements of the current technology.

Text Books:

1. "Excel Data Analysis for Dummies", Stephen L. Nelson and E. C. Nelson, 1st Edition, Wiley, 2015.
2. "A Basic Guide to Data Exploration and Visualization Using R", Alain F. Zuur, 1st Edition, Highland Statistics Ltd., 2015.
3. "Python for Everybody: Exploring Data in Python 3", Dr. Charles Russell Severance, 1st Edition, CreateSpace Independent Publishing, 2016.
4. "Business Statistics: For Contemporary Decision Making – An Indian Adaptation", Ken Black and Sanjeet Singh, 10th Edition, Wiley & Sons (Singapore), 2022.

Reference Books:

1. "Data Analysis with Microsoft Excel", Kenneth Berk and Patrick Carey, 1st Edition, Duxbury Press, 2003.
2. "SAS for Data Analysis: Intermediate Statistical Methods", Mervyn G. Marasinghe and William J. Kennedy, 1st Edition, Springer, 2008.

CO-PO mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	1		1	3	1	2		3		2
CO2	3	2	3	1	2	3	2	2	3	3	1	2
CO3	3	2	3	1	2	3	2	2	3		1	2
CO4	3	2	3		1	3	2	2		1	1	2
CO5	3	2	3		1	3	2	2	3	3	1	2

Note:
3: High
2: Medium
1: Low

Course Code:	**CSL214**	**Course Title:**	**Data Handling and Visualization**
Category:	**Core**	**Credit Assigned**	**L** **T** **P** **C** **1** **0** **2** **2**
Prerequisite (if Any)	**None**	**Type of Course**	**Computer Science and Engineering**

Course Outcomes:
By the completion of this course, students will be able to:

1. Design and create data visualizations.
2. Conduct exploratory data analysis using visualization.
3. Design and evaluate color palettes for visualization based on principles of perception.
4. Apply data transformations for visualization.
5. Acquire, analyze and provide observations from the data using different tools.

Course Contents:
Module 1: Data Acquisition

Gather information from different sources. Web APIs, Open Data Sources, Data APIs, Web Scrapping.

Module 2: Data Pre-processing and Transformation

Data Munging, Wrangling, Cast/Melt, Data imputation, Data Transformation (minmax, log transform, z-score transform etc.). Binning, Classing and Standardization. Outlier/Noise& Anomalies.

Module 3: Overview of Data Visualization, Advantages and applications, visualization design, visualization using Python/R: Scatter Plot, Bar Chart, Vertical & Horizontal Pie Chart and Coxcomb Plot, Line Chart, Area Chart, etc.

Module 4: Visualizing Amounts: Bar Plots, Grouped and Stacked Bars, Dot Plots and Heatmaps, Visualizing Distributions: Histograms and Density Plots- Visualizing a Single Distribution,

Visualizing Multiple Distributions at the Same Time, Visualizing Distributions: Empirical Cumulative Distribution Functions and Q-Q Plots-Empirical Cumulative Distribution Functions.

Module 5: Tools for data handling like Power BI and other tools. Case studies.

Text book:

1. Sosulski, K. "Data Visualization Made Simple: Insights into Becoming Visual", New York: Routledge. CRC Press, 2018.
2. Claus Wilke, "Fundamentals of Data Visualization: A Primer on Making Informative and Compelling Figures", 1st edition, O'Reilly Media Inc, 2019.

Reference Books:

1. Tamara Munzner, Visualization Analysis and Design (VAD), CRC press, 2014.
2. The Visual Display of Quantitative Information by Edward Tufte, Graphics Press.
3. Visualizing Data by Ben Fry, Oreilly

4th Semester

Course Code:	**CSL 205**	**Course Title:**	**Design and Analysis of Algorithms**
Category:	**Core**	**Credit Assigned**	**L** | **T** | **P** | **C** **3** | **0** | **2** | **4**
Prerequisite (if Any)	**Advanced Data Structures , Mathematics**	**Type of Course**	**Computer Science and Engineering**

Course Outcomes:

1. Student will be able to derive the recurrence relations for algorithms and analyze the performance of algorithms using asymptotic notations.
2. Student will be able to perform the amortized analysis and evaluate the cost of various operations on the data structure.
3. Student will be able to analyze and apply various algorithm design paradigms for real world applications. Also, evaluate the performance of algorithm based on various parameters.
4. Student will be able to apply and relate various algorithms to solve the problems based on Graphs.

Course Contents:

Module 1:

Mathematical foundations, summation of arithmetic and geometric series, n, n^2, bounding summations using integration, recurrence relations, and solutions of recurrence relations using technique of characteristic equation and generating functions.

Module 2:

Asymptotic notations of analysis of algorithms, analyzing control structures, worst case and average case analysis, amortized analysis, sorting algorithms such as selection sort, insertion sort, bubble sort, heap sort, lower bound proof, elementary and advanced data structures with operations on them and their time complexity.

Module 3:
Divide and conquer basic strategy, binary search, quick sort, merge sort, Fast Fourier Transform etc. Greedy method - basic strategy, application to job sequencing with deadlines problem, minimum cost spanning trees, single source shortest path etc.

Module 4:
Dynamic Programming basic strategy, multistage graphs, all pairs shortest path, single source shortest paths, optimal binary search trees, traveling salesman problem.

Module 5:
Basic Traversal and Search Techniques, breadth first search and depth first search, connected components. Backtracking basic strategy, 8-Queen's problem, graph colouring, Hamiltonian cycles etc. NP-hard and NP-complete problems, basic concepts, nondeterministic algorithms, NP-hard and NP-complete, Cook's Theorem, decision and optimization problems, polynomial reduction.

Text:
1. Introduction to Algorithms : Cormen T.H. et.al : Prentice Hall of India
2. Computer Algorithms : Horowitz, Sahani, Rajsekharan , Galgotia Publications Pvt.Ltd
3. Fundamentals of Algorithms : Brassard, Bratley , Prentice Hall

Course Code:	**CSL 207**	**Course Title:**	**Operating Systems**
Category:	**Core**	**Credit Assigned**	**L** **T** **P** **C** **3** **0** **2** **4**
Prerequisite (if Any)	**Data Structures (CSL 102)**	**Type of Course**	**Computer Science and Engineering**

Course Outcomes:
Students should be able to

1. Identify the structure and design issues of operating systems.
2. Summarise the concepts of process management and relate the underlying programming constructs.
3. Analyse and evaluate the memory management techniques, I/O management and file systems.
4. Implement general operating system concepts using modern operating systems like Unix and others.

Course Contents:

Module 1:
Introduction, basic h/w support necessary for modern operating systems - Services provided by OS, system programs and system calls - brief discussions of evolution of OS - real time and distributed systems: a brief overview of issues. Processes and 3 levels of scheduling - process control block and context switch - goals of scheduling and different scheduling algorithms - threads: user-level and kernel level.

Module 2:
Process cooperation and synchronization - mutual exclusion and implementation - semaphores, conditional critical regions and monitors - classical inter – process communication problems -

message passing. Deadlocks and strategies for handling them - protection and security issues - access lists, Capabilities.

Module 3:
Memory management techniques - contiguous and non-contiguous - paging and segmentation - translation look-aside buffers (TLB) and overheads - virtual memory and demand paging- page faults and instruction restart - problems of large address spaces – page replacement algorithms and working sets - miscellaneous issues.

Module 4:
File systems, user interface - disk space management and space allocation strategies - examples from UNIX, DOS, Windows etc - directory structures - disk caching - file system consistency and logs - disk arm scheduling strategies.

Module 5:
Linker and Loader - Concept of static and dynamic relocation, external symbols, design of linker, design of object file for different loading schemes.
Common Object file format - Structure of object file and executable file, section or segment headers, symbol table, concept of storage class, string various, data types line insert,
character, arrays structures.
Device Drivers - Device programming, system drivers, non-system drivers, virtual drivers, Incorporation of driver routines, Basic device driver operation, character and block drivers.

Text:
1. Silberchatz & Galvin, “Operating System Concepts”, Addison Wesley
2. Tanenbaum A, “Modern Operating Systems”, PHI 2 nd Ed
3. William Stallings, “Operating Systems”, Pearson Publications

Course Code :	**CSL215**	**Course Title :**	**Sensor Data Analytics**			
Category :	**DC**	**Credit Assigned :**	**L**	**T**	**P**	**C**
			3	**0**	**2**	**4**
Prerequisite (if Any) :	**None**	**Type of Course :**	**Computer Science and Engineering**			

Course Outcomes:
On completion of the course, students will be able to:
1. Identify and describe different sensor types and its usage in Sensor based applications.
2. Implement sensor data acquisition using microcontrollers and Python programming.
3. Understand the advantages and challenges of using cloud-based platforms.
4. Implement data transformation techniques to enhance the quality and usability of sensor data.
5. Construct end-to-end machine learning pipelines for sensor data analysis.

Course Contents:

Module 1
Introduction to Sensors and Sensor based Systems: Introduction to the design and behaviour of common sensors, highlighting their proper use and physical limitations. Introduction to types of sensors and actuators (e.g., accelerometers, gyroscopes, and temperature sensors), Sensor characteristics and specifications, sensor outputs, sensor networks, sensor signals. Introduction to the role of communications in sensor networks.

Module 2

Sensor Data Acquisition using Microcontroller and Python: Introduction to controllers (e.g. Arduino, Raspberry Pi, Node MCU), Python programming with microcontroller, Basic Python Programs such as blink a led, Weather 'monitoring UTH - 1 Temperature sensor, Installation of Testing sketch for various DHT humidity temperature sensors, Ultrasonic Sensor etc. Introduction to PySerial library, USB communication, Hardware communication protocols. Methods of Encryption & Encoding.

Module 3

Cloud Based platforms for Sensor Data Communication: Role of Cloud for sensor data communication in DAQ. Introduction to different cloud platforms used for sensor data communication (Examples: IBM watson, Blynk, Google firebase), Communication of google firebase with DAQ system through arduino IDE, Introduction of various databases such as Realtime Database, MySQL, MongoDB etc), APIs and its working, various Internet protocols.

Module 4

Data Transformation Techniques: Challenges in Sensor Data Pre-processing, Basics of Signal Processing for Sensor Data Filtering Techniques (Low-pass, High-pass, Band-pass), Fourier Transform and Frequency Domain Analysis, Time-Frequency Analysis for Non-Stationary Signals Denoising. Methods for Sensor Data. Feature Extraction Methods for Sensor Data, Statistical Features, Time-Domain Features, Frequency-Domain Features, Importance of Feature Selection. Time Series Analysis: Understanding time-stamped sensor data, Time series visualisation and exploration, Trends and seasonality in sensor data.

Module 5

Case Study: Real-world examples from different domains, such as healthcare, IoT, and environmental monitoring, of successful machine learning applications in sensor data analysis. Python libraries such as Numpy, Scipy, Sk learn, Matplotlib, Seaborn, Plotly, Pandas, Keras etc.

Text Books:

1. Internet of Things (IoT): A Hands-On Approach" by Arshdeep Bahga and Vijay Madisetti
2. Internet of Things with Python by Gastón C. Hillar, Packet Publishing
3. Feature Engineering for Machine Learning: Principles and Techniques for Data Scientists by Alice Zheng and Amanda Casari

Reference Books:

1. Peter Waher, 'Learning Internet of Things', Packt Publishing, 2015 3. Editors Ovidiu Vermesan
2. T. Hastie, R. Tibshirani, J. Friedman. The Elements of Statistical Learning, 2e, 2008.
3. Christopher Bishop. Pattern Recognition and Machine Learning. 2e, 2006.

Course Code	**CSL216**	**Course Title**	**Foundations of Computing**			
Category	**Core**	**Credit Assigned**	**L**	**T**	**P**	**C**
			3	**0**	**0**	**3**
Prerequisite (If any)	**NONE**	**Type of Course**	**Computer Science and Engineering**			

Course Outcomes:

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

1. Design an appropriate machine for the recognition of a given language.
2. Prove the grammar, language, and automata by using formal mathematical methods.
3. Analyse the lexical, syntactic, and semantic structures of a language.

4. Design a scanner, parser, and semantic analyzer for language translation.

Course Contents:

Module 1:

Concept of language - grammars and production rules- Chomsky hierarchy, Regular grammars, deterministic finite automata, non-determinism, conversion to deterministic automata ∈-closures, minimization of automata, regular expressions, regular sets, Pump lemma for regular sets closure properties of regular sets, decision properties for regular sets.

Module 2:

Context free languages, parse trees and ambiguity, reduction of CFGS, Chomsky and Griebach normal forms, push down Automata (PDA), non-determinism, CFLs and PDAs Pumping lemma for context free languages, Closure and decision properties of CFLs. Introduction of Turning machine.

Module 3:

Compilers and translators, phase structure of a typical compiler, Number of passes, ideas about lexical analysis, syntax analysis, code optimization and code generation, design of lexical analyzer. Lexical Analysis: Role of lexical analyzer, recognition of tokens, A language of specifying lexical analyzers, Design of a lexical analyzer generator and tool for study of lex.

Module 4:

Design of top-down parser, bottom-up parsing technique, LR parsing algorithm, Design of SLR, LALR, LR parsers.

Module 5:

Study of syntax-directed definitions and syntax-directed translation schemes as a notational frame work to specify the translations.

Text books:

1. Martin John, "Introduction to languages and the theory of compu tation", TM
2. Hotwani Hopcroft, Ullman, "Introduction to Automata Theory, Languages and computation", Pearson Education
3. Principles of Compiler Design: Aho A. V., Ullman J. D., Addison Wesley.

Reference books:

1. Michael Sipser, "Introduction to the theory of Computation", 3rd edition, Cengage Learning
2. Principles and practice of compiler writing: Aho, Sethi , Ullman , Addison Wesley
3. Compiler Design in C: Alan Holub , PHI
4. Crafting a compiler: Fischer and LeBlanc , Addison Wesley

Course Code :	**CSL217**	**Course Title :**	**Web Analytics**			
Category :	**CORE**	**Credit Assigned :**	**L**	**T**	**P**	**C**
			3	**0**	**0**	**3**
Prerequisite (if Any):	**Data Analytics Basics**	**Type of Course :**	**Computer Science and Engineering**			

Course Outcomes:

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

1. Understand how website visitors view and interact with website pages and features.
2. Analyze data on customer purchasing patterns and demographics leading to business intelligence.
3. Understand demanding trends to make effective strategic decisions.
4. Perform web and text analytics.

Course Contents:

Module 1:

An Overview of Business Intelligence, Analytics, and Decision Support, Changing Business Environments and Computerized Decision Support, Information Systems Support for Decision Making, The Concept of Decision Support Systems (DSS), Business Analytics Overview, Brief Introduction to Big Data Analytics.

Module 2:

Text Analytics and Text Mining: Watson, Concepts and Definitions, Introduction to Natural Language Processing, Text Mining Applications, Text Mining Process, Text Mining Tools.

Module 3:

Web Analytic fundamentals: Capturing data: Web logs or JavaScripts tags, Separate data serving and data capture, Type and size of data, Innovation, Integration, Selecting optimal web analytic tool, Understanding clickstream data quality, Identifying unique page definition, Using cookies, Link coding issues.

Module 4:

Web Metrics: Common metrics**:** Hits, Page views, Visits, Unique visitors, Unique page views, Bounce, Bounce rate, Page/visit, Average time on site, New visits; Optimization (e-commerce, non-e-commerce sites): Improving bounce rates, Optimizing adwords campaigns; Real time report, Audience report, Traffic source report, Custom campaigns, Content report, Introduction to Google analytics, Introduction to KPI, characteristics, Need for KPI, Perspective of KPI, Uses of KPI.

Module 5:

Web analytics 2.0: Web analytics 1.0, Limitations of web analytics 1.0, Introduction to analytic 2.0, Competitive intelligence analysis : CI data sources, Toolbar data, Panel data ,ISP data, Search engine data, Hybrid data, Website traffic analysis: Comparing long term traffic trends, Analyzing competitive site overlap and opportunities.

Google Analytics: Brief introduction and working, Adwords, Benchmarking, Categories of traffic: Organic traffic, Paid traffic; Google website optimizer, Implementation technology, Limitations, Performance concerns, Privacy issues.

Text Books:

1. Clifton B., Advanced Web Metrics with Google Analytics, Wiley Publishing, Inc. (2010), 2nd ed.
2. Ramesh Sharda, Dursun Delen, Efraim Turban, Business Intelligence and Analytics: Systems for decision support, Pearson Education.

Reference Books:

1. Rajiv Sabherwal, Irma Becerra-Fernandez," Business Intelligence – Practice, Technologies and Management", John Wiley 2011.
2. Lariss T. Moss, ShakuAtre, "Business Intelligence Roadmap", Addison-Wesley It Service.
3. Kaushik A., Web Analytics 2.0 The Art of Online Accountability and Science of Customer Centricity, Wiley Publishing, Inc. (2010),1st ed.

Course Code :	**CSP206**	**Course Title :**	**Tools and Practices for Data Science – II**			
Category :	**CORE**	**Credit Assigned :**	**L**	**T**	**P**	**C**
			0	**0**	**4**	**2**
Prerequisite (if Any) :	**None**	**Type of Course :**	**Computer Science and Engineering**			

Course Outcomes:

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

1. Understand different types of data.
2. Apply various data preprocessing techniques.
3. Extract features from different types of data.
4. Perform spatial data analysis.

Course Contents:

Types of data – Structured and unstructured data, Image, Video, Audio, Numerical, Text, Temporal data.

Data representation

Image data- Binary, grayscale, Colour images, Raw pixel values, colour channels, Image rescaling, Normalization, Image file formats – Jpeg, Bitmap, PNG, etc.
Audio data- Audio signal discretization, Sampling and quantization, Audio file formats – WAV, MP3, etc.
Text data – Plain text format, Binary format, ASCII and Unicode formats, CSV, JSON, etc.
Video data – Video frames, Frame rate, MP4, AVI format, etc.
Numerical data – tabular ordering of data, categorical data, numerical data, CSV, Excel formats, etc.

Data pre-processing & Feature Engineering

Image data- Image Augmentation, Histogram equalization, Gamma correction, Image labelling, Image sharpening, Image filtering – spatial domain and frequency domain.
Audio data – Audio sampling, quantization, Audio feature extraction - Frame Segmentation, normalization, windowing, Fourier Transform, Spectrograms, Mel-Frequency Cepstral Coefficients, Noise Reduction, Filtering, band energy ratio.
Text data – Stemming, tokenization, lemmatization, text normalization, Text feature extraction - Bag-of-Words (BoW), Term Frequency-Inverse Document Frequency (TF-IDF), Word

Embeddings (Word Vectors), Word2Vec Skip-gram and Continuous Bag-of-Words (CBOW), GloVe (Global Vectors for Word Representation).
Video Data – resizing, object recognition, object detection.
Tabular data – Scaling- standardization, normalization, feature transformation, Binning, label encoding, one-hot encoding, handling missing values, data balancing techniques.

Visualization of different types of data: Selecting appropriate graph or chart for data, Types of data visualizations, tools for visualization.

Spatial Data Analysis: Learning about spatial data, Location data, Spatial data model, types, Use of QGIS for spatial data analysis.

Text Books:

1. Gonzalez, R. C., Woods, R. E. (2018). Digital Image Processing, Global Edition. United Kingdom: Pearson Education.
2. Spanias, A., Painter, T., Atti, V. (2006). Audio Signal Processing and Coding. Germany: Wiley.
3. Kulkarni, A., Shivananda, A. (2019). Natural Language Processing
4. Zheng, A., Casari, A. (2017). Feature Engineering for Machine Learning: Principles and Techniques for Data Scientists. Italy: O'Reilly.
5. Jafari, R. (2022). Hands-On Data Preprocessing in Python: Learn how to Effectively Prepare Data for Successful Data Analytics. United Kingdom: Packt Publishing.

Reference Books:

1. Osborne, J. W. (2013). Best Practices in Data Cleaning: A Complete Guide to Everything You Need to Do Before and After Collecting Your Data. United Kingdom: SAGE Publications.
2. Recipes: Unlocking Text Data with Machine Learning and Deep Learning Using Python. Germany: Apress.
3. Zölzer, U. (2008). Digital Audio Signal Processing. Germany: Wiley.
4. Coulter, D. (2000). Digital Audio Processing. United Kingdom: Taylor & Francis.
5. Bovik, A. C. (2010). Handbook of Image and Video Processing. Netherlands: Elsevier Science.
6. Bird, S., Klein, E., Loper, E. (2009). Natural Language Processing with Python. United States: O'Reilly Media.

3rd Year Syllabus-

5th Semester

Course Code:	**CSL 422**	**Course Title:**	**Machine Learning**			
Category :	**CORE**	**Credit Assigned :**	**L**	**T**	**P**	**C**
			3	**0**	**2**	**4**
Prerequisite (if Any) :	**None**	**Type of Course :**	**Computer Science and Engineering**			

Course Outcomes:

Student will be able to:

1. Understand the working of various supervised and unsupervised machine learning models
2. Apply classification and regression models to solve real world problems.
3. Apply unsupervised learning to solve real world problems.
4. Evaluate the performance of various machine learning models.

Course Contents:

Module 1:

Introduction to ML, Linear Regression, Logistic Regression, Inductive Classification

Module 2:

Decision Trees: Representing concepts as decision trees. Recursive induction of decision trees. Picking the best splitting attribute: entropy and information gain. Searching for simple trees and computational complexity. Occam's razor. Overfitting, noisy data, and pruning.

Module 3

Artificial Neural Networks: Neurons and biological motivation. Linear threshold units.
Perceptrons: representational limitation and gradient descent training. Multilayer networks and Backpropagation.

Module 4:

SVM, Multiclass & Ordinal Classification, Kernel Methods, Bayesian Learning: Naive Bayes learning algorithm. Parameter smoothing. Bayes nets and Markov nets for representing dependencies. Hidden Markov Model, and Bayesian networks.

Module 5:

Clustering and unsupervised learning: Clustering. Hierarchical Aglomerative Clustering. k-means partitional clustering. Expectation maximization (EM) for soft clustering. Semi-supervised learning with EM using labelled and unlabelled data.

Module 6:

Evaluating hypothesis: Training and test splits, k-fold cross validation, confusion matrix, Estimating hypothesis accuracy, sample and true error.

Text Books:

1. Machine Learning, Tom Mitchell, McGraw Hill, 1997.
2. Ethem Alpaydin, Introduction to Machine Learning, PHI, 2016.

Reference Books:

1. T. Hastie, R. Tibshirani, J. Friedman. The Elements of Statistical Learning, 2e, 2008.
2. Christopher Bishop. Pattern Recognition and Machine Learning. 2e, 2006.
3. Richard O. Duda, Peter E. Hart, David G. Stork. Pattern classification, Wiley, New York, 2001.

Course Code :	**CSL311**	**Course Title :**	**Data Privacy and Security**			
Category :	**CORE**	**Credit Assigned :**	**L**	**T**	**P**	**C**
			3	**0**	**2**	**4**
Prerequisite (if Any) :	**Linear Algebra and probability**	**Type of Course:**	**Computer Science and Engineering**			

Course Outcomes:

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

1. Understand the state of the art in differential privacy.
2. Understand about the actual difference in data privacy and data security.
3. Extract both the high-level ideas and low-level details when reading a mathematical model of data privacy and security.
4. Understand about the importance of data hiding and methods.

Course Contents:

Module 1:

Basic differentially private mechanisms, Randomized response, The Laplace mechanism, Composition theorems, The exponential mechanism, Multiparty differential privacy Computational differential privacy Secure multiparty computation Lower bounds for information-theoretic differential privacy Connection to communication complexity, Differential privacy & learning theory Privacy of learning tasks Boosting and differential privacy Query release vs. agnostic learning.

Module 2:

Privacy for streaming algorithms, Pan-private streaming algorithms, Privacy under continual observation , Privacy for graph analysis Attacks on anonymized social networks Edge-level privacy vs. node-level privacy Releasing graph cuts Restricted sensitivity Differential privacy & mechanism design Mechanism design via differential privacy Modelling privacy in mechanism design, Private equilibrium computation , Auctioning private data.

Module 3:

Differential privacy & statistics Privacy-preserving statistical estimation, SVMs, and regression Robust statistics Alternative privacy, definitions Zero-knowledge privacy, Crowd-blending privacy, Natural differential privacy Concentrated differential privacy ,k-anonymity and variants Query auditing Privacy for the analyst.

Module 4:

Basic of Cipher, Caesar Cipher, Monoalphabetic Cipher, Homophonic Substitution, Beaufort Cipher, Polyphonic Ciphers and Ambiguity, Cyclic Notation and Keys, Transposition by Turning Template Columnar Transposition Cipher, Stream Ciphers, Linear Shift Registers, Cellular Automata , Nonlinear Shift Registers , Diffie-HeIlman-Merkle Keys, Data Hiding in MPEG Video , Public-Key Cryptography, RSA Cryptography

Module5:

LSB Encoding , BPCS Steganography, Lossless Data Hiding ,Spread Spectrum Steganography, Data Hiding by Quantization , Signature Casting in Images, Transform Domain Methods ,Robust Data Hiding in JPEG Images, Robust Frequency Domain Watermarking, Data Hiding in Binary Images, Public-Key Steganography

Text Books:

1. Differential Privacy Techniques-Based Information Security for Cyber Physical System Applications: An Overview.
2. Data Privacy And Security (Hb) by Salomon D.

Reference Books:

1. Navigating the Data Age: Governance Privacy and Security Simon Haykin, “Communication Systems”, John Wiley 4th Edition.
2. Data Protection and Privacy Volume 12: Data Protection and Democracy by Edited by Dara Hallinan Edited by Ronald E. Leenes Edited by Serge Gutwirth Edited by Paul De Hert, Bloomsbury Publishing (UK) Peterson, Simon, “Computer Networks: A Systems Approach”, Pearson Education, Asia

Course Code:	**CSL 301**	**Course Title:**	**Database Management Systems**			
Category :	**CORE**		**L**	**T**	**P**	**C**

		Credit Assigned :	3	0	2	4
Prerequisite (if Any) :	**NONE**	**Type of Course :**	**Computer Science and Engineering**			

Course Outcomes:

1. Student will be able to design and develop database using ER model with various SQL constraints and apply normalization for consistency in database.
2. Student will be able to write queries using relational algebra, tuple and domain relational calculus, and SQL to retrieve information from database based on data centric applications.
3. Student will be able to analyze and apply the concept of storage management and query processing to fine tune the performance of database at the time of information retrieval.
4. Student will be able to analyze and apply the conception of transaction processing, concurrency control and recovery mechanism in database.

Course Contents:

Module 1:
Database system concepts and Architecture - concept of relational database, Relational data model, Relational algebra, SQL-the relational database standard, ER and EER model.

Module 2:
Database design theory - Functional dependencies and normalization, relational database design algorithms, practical database design and demoralization, Relational constants, programmatic ways for implementing constraints, triggers, Chase algorithm.

Module 3:
Physical database design - Concept of physical and logical hierarchy, storage structures like cluster, index organized table, partitions, various table storage parameters and block storage parameters, concept of index, B-trees, hash index, function index, bitmap index.

Module 4:
Process and memory management in database - Various types of tasks in database, database buffer management, log buffer management code reuse, concept of two tier and N-tier architecture, data dictionary and catalog information database recovery technique. Arier Algorithm for recovery.

Module 5:
Query optimization and performance tuning - Various techniques for query optimization, strong and weak equivalence, cost base optimization, Use of different storage structures in query optimization.

Module 6:
Transaction Processing - Transaction and system concepts, Desirable properties of transaction, Schedules and recoverability, serializability of schedules, concurrency control, lock base protocols and time stamp based protocols, read consistency.

Text Books:

1.Fundamentals of Database Systems : Elmasiri and Navathe, Addisson Wesley, 2000
2.Principles of Database Systems : Ullman , Golgotia Publications 1988

Course Code:	**CSL 421**	**Course Title:**	**Artificial Intelligence**			
Category :	**CORE**	**Credit Assigned :**	**L**	**T**	**P**	**C**
			3	**0**	**2**	**4**

Prerequisite (if Any) :	NONE	Type of Course :	Computer Science and Engineering

Course Outcomes:

1. Formulate problems so that exploratory search can be applied.
2. Apply and implement various search techniques to solve real world problems
3. Apply algorithms for designing games and solving constraint satisfaction problem
4. Represent knowledge using formal logic and apply algorithms to deuce conclusion
5. Design and develop practical algorithms for solving planning and uncertainty problems

Course Contents:

Module 1:

Introduction: What is AI? , History, Overview, Intelligent Agents, Performance Measure, Rationality, Structure of Agents, Problem-solving agents, Problem Formulation, Uninformed Search Strategies

Module2:

Informed (Heuristic) Search and Exploration, Greedy best first search, A* search, Memory bounded heuristic search, Heuristic functions, inventing admissible heuristic functions, Local Search algorithms, Hill-climbing, Simulated Annealing, Genetic Algorithms, Online search

Module 3:

Constraint Satisfaction Problems, Backtracking Search, variable and value ordering, constraint propagation, intelligent backtracking, local search for CSPs, Adversarial Search, Games, The minimax algorithm, Alpha-Beta pruning, Imperfect Real-Time Decisions, Games that include an Element of Chance.

Module 4:

Knowledge Based Agents, Logic, Propositional Logic, Inference, Equivalence, Validity and Satisfiability, Resolution, Forward and Backward Chaining, DPLL algorithm, Local search algorithms, First Order Logic, Models for first order logic, Symbols and Interpretations, Terms, Atomic sentences, complex sentences, Quantifiers, Inference in FOL, Unification and Lifting, Forward Chaining, Backward Chaining, Resolution

Module 5:

Planning, Language of planning problems, planning with state-space search, forward and backward state-space search, Heuristics for state-space search, partial order planning, planning graphs, planning with propositional logic

Module 6:

Uncertainty, Handing uncertain knowledge, rational decisions, basics of probability, axioms of probability, inference using full joint distributions, independence, Baye's Rule and conditional independence, Bayesian networks, Semantics of Bayesian networks, Exact and Approximate inference in Bayesian Networks

Text:

1. Artificial Intelligence a Modern Approach : Russel and Norvig , Pearson Education, 2nd
2. Artificial Intelligence – A Practical Approach : Patterson , Tata McGraw Hill, 3rd

Course Code :	CSL302	Course Title :	Computer Networks			
Category :	CORE		L	T	P	C

		Credit Assigned :	**3**	**0**	**2**	**4**
Prerequisite (if Any) :	**None**	**Type of Course :**	**Computer Science and Engineering**			

Course Outcomes:

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

1. Analyse various issues and their solutions at different layers of network architecture
2. Design and develop various networking algorithms
3. Apply networking protocols on a given network to analyze their working
4. Apply networking concepts to build real world networking systems using most important protocols in use today

Course Contents:

Module 1:

Introduction to Computer Networks, Network Architecture: Layering and Protocol, Internet architecture, Implementing Network Software: Application Programming Interface (Socket), Delay x bandwidth product.

Module 2:

Classes of Links, Framing, Error Detection: cyclic redundancy check, Internet checksum algorithm. Reliable transmission: Stop-and-wait, Sliding Window, Ethernet and Multiple Access Networks (802.3), Wi-Fi/802.11

Module 3:

Datagram and virtual circuit switching, Bridges and LAN switches, Basic Internetworking (IP): Internetwork, Global addresses, Datagram forwarding in IP, Subnetting and Classless addressing,

Module 4: Address Translation (ARP), Host Configuration (DHCP), Error Reporting (ICMP), Virtual Networks and tunnels, Distance-vector (RIP), Link-state (OSPF), Routing areas, Interdomain routing (BGP).

Module 5:

Simple demultiplexer (UDP), Reliable byte stream (TCP): End-to-end issues, segment format, Connection establishment and termination, Sliding window, Triggering transmission and Adaptive retransmission, TCP Congestion Control: Additive increase/ Multiplicative decrease, Slow start, Fast retransmission and fast recovery. Resource allocation in TCP

Module 6: Introduction to applications and related Protocols: Electronic mail (SMTP, MIME, IMAP), World Wide Web (HTTP), Name service (DNS).

Text Books:

4. Larry L. Peterson, Bruce S. Davie, “Computers Networks: A systems approach”, Morgan Kaufmann, 5th Edition.

Reference Books:

1. Tanenbaum A. S, "Computer Networks", PHI
5. James F. Kurose and Keith W. Ross: Computer Networking: A Top-Down Approach Featuring the Internet, 3rd Edition.
6. William Stallings, "Data and Computer Communications", PHI 6th Edition
7. Behrouz A Forouzan, "Data Communication and Networking", 4th Edition
8. Simon Haykin, "Communication Systems", John Wiley 4th Edition
9. Douglas Comer, "Computer Networks and Internets", Addison Wesley 2nd Edition
10. Peterson, Simon, "Computer Networks: A Systems Approach", Pearson Education, Asia

Course Code :	**CSP 301**	**Course Title :**	**Tools and Practices for Data Science - III**			
Category :	**CORE**	**Credit Assigned :**	**L**	**T**	**P**	**C**
			0	**0**	**4**	**2**
Prerequisite (if Any) :	**None**	**Type of Course :**	**Computer Science and Engineering**			

Course Outcomes:

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

1. Develop web/mobile application with front end and back-end tools.
2. Learn to deploy applications using various methodologies/tools

Course Contents:

Module 1:

Dashboard designing: Working with open-source dashboard tools like Tableau, Deep diving with data and connection, Creating charts

Mapping data in Tableau/Power-BI/ open-source tool, Dashboards and deployment.

Module 2:

Front end development**:** Designing responsive user interfaces and design patterns for front end development, Designing of screen and detailed design of UI controls and dialogs for web and mobile applications, Learning to use the Bootstrap/Flutter or any open source tool to build responsive interfaces and UI frameworks.

Module 3:

Back-end development: Understanding the basics of Web Servers and HTTP requests, Use of different databases such as SQL and its types, and SQL Server, Learning to use JavaScript environments such as NodeJS and ExpressJS.

Module 4:

Introduction to GIT and deployment: Learning Git to manage your code, Creating an entire website and manage the source code using GIT, Learning push/pull code from GIT, Deploy the project using the open-source platforms, Dockerization, deployment on different cloud platforms.

Text Books:

1. "HTML and CSS: Design and Build Websites" by Jon Duckett
2. "CSS: The Definitive Guide" by Eric Meyer and Estelle Weyl:
3. Learning Web Design" by Jennifer Niederst Robbins - A comprehensive guide that covers HTML, CSS, and web design principles, suitable for beginners.

Reference Books:

1. The Full Stack Developer: Your Essential Guide to the Everyday Skills Expected of a Modern Full
2. Designing Data-Intensive Applications" by Martin Kleppmann

6th Semester

Course Code:	**CSL 313**	**Course Title:**	**Computer Vision and Deep Learning**			
Category:	**Core**	**Credit Assigned:**	**L**	**T**	**P**	**C**
			3	**0**	**2**	**4**
Prerequisite (if Any):	**None**	**Type of Course:**	**Computer Science and Engineering**			

Course Outcomes:

On successful completion of the course, students will be able to:

1. Apply fundamental image processing and computer vision techniques.
2. Implement feature extraction, segmentation, and object detection algorithms.
3. Develop and apply deep learning models for image classification and segmentation.
4. Evaluate the performance of Vision Transformers and generative models in computer vision tasks.

Course Contents:

Module 1:

Introduction to Computer Vision and Image Processing: Basics of computer vision, image representation, transformations (affine, perspective, orthogonal), gradients (first order and second order) and image filtering (blurring, sharpening).

Module 2:

Feature Extraction and Image Segmentation: Edge detection (Sobel, Canny, LoG), corner detection (Harris corner, Hessian Affine), feature descriptors (SIFT, SURF, HoG), image segmentation (thresholding, region-based methods, edge-based methods).

Module 3:

Convolutional Neural Networks (CNNs), Modern Convolutional Neural Networks, Object detection techniques (R-CNN, YOLOs), semantic segmentation (U-Net, Mask R-CNN).

Module 4:

Generative Models and Image Synthesis: Auto Encoder, Variational Auto Encoder, Generative Adversarial Networks (GANs), deep generative models (DCGAN, CycleGAN), applications in image synthesis, style transfer.

Module 5:

Transformers in Computer Vision: Introduction to Transformers, self-attention mechanisms, Vision Transformers (ViTs), with applications in image classification, object detection, and segmentation.

Text Books:

1. "Deep Learning", Goodfellow, I., Bengio, Y., & Courville, A., MIT Press, 2016.
2. "Dive into Deep Learning", Aston Zhang, Zachary C. Lipton, Mu Li, and Alexander J. Smola, Cambridge Univ Pr, 2023.

Reference Books:

1. "Digital Image Processing", Gonzalez, R. C., & Woods, R. E., 4th edition, Pearson, 2018.
2. "Programming Computer Vision with Python", Jan Erik Solem, O'Reilly Media, 2012.
3. "Computer Vision: Algorithms and Applications", Richard Szeliski, Second edition, Springer, 2022.

Course Code	**CSL 444**	**Course Title:**	**Big Data Analytics**
Category:	**ELECTIVE**	**Credit Assigned**	**L** | **T** | **P** | **C** **3** | **0** | **2** | **4**
Pre-Requisite (if Any)	**NONE**	**Type of Course**	**Computer Science and Engineering**

Course Outcomes:

1. Work with big data platform and explore the big data analytics techniques business applications.
2. Design efficient algorithms for mining the data from large volumes.
3. Analyze the HADOOP and Map Reduce technologies associated with big data analytics.
4. Understand the fundamentals of various big data analytics techniques.
5. Build a complete business data analytics solution

Course Contents:

MODULE - I **Introduction**: Introduction to big data : Introduction to Big Data Platform ,Challenges of Conventional Systems - Intelligent data analysis ,Nature of Data ,Analytic Processes and Tools ,Analysis vs Reporting

MODULE - II **Mining data streams** : Introduction To Streams Concepts, Stream Data Model and Architecture ,Stream Computing ,Sampling Data in a Stream ,Filtering Streams ,Counting Distinct Elements

in a Stream ,Estimating Moments ,Counting Oneness in a Window, Decaying Window Real time Analytics Platform(RTAP) Applications ,Case Studies ,Real Time Sentiment Analysis- Stock Market Prediction

MODULE - III **Hadoop**: History of Hadoop- the Hadoop Distributed File System ,Components of Hadoop Analyzing the Data with Hadoop-,Scaling Out- Hadoop Streaming- Design of HDFS,HDFS Basics-Developing a Map Reduce Application-How Map Reduce Works-Anatomy of a Map Reduce Job run-Failures-Job Scheduling, Shuffle and Sort, Task execution - Map Reduce Types and Formats- Map Reduce Features Hadoop environment.

MODULE - IV **Frameworks**: Applications on Big Data Using Pig and Hive, Data processing operators in Pig, Hive services, HiveQL, Querying Data in Hive ,fundamentals of HBase and ZooKeeper - IBM InfoSphere BigInsights and Streams.

MODULE - V **Predictive Analytics** Simple linear regression, Multiple linear regression Interpretation 5 of regression coefficients. Visualizations ,Visual data analysis techniques interaction techniques - Systems and applications

Text:

1. Chris Eaton, Dirk DeRoos, Tom Deutsch, George Lapis, Paul Zikopoulos, "Understanding Big Data: Analytics for Enterprise Class Hadoop and Streaming Data", McGrawHill Publishing, 2012

2. Bill Franks, "Taming the Big Data Tidal Wave: Finding Opportunities in Huge Data Streams with Advanced Analytics", John Wiley& sons, 2012

3. Glenn J. Myatt, "Making Sense of Data", John Wiley & Sons, 2007.

4. Tom White "Hadoop: The Definitive Guide" Third Edition, O'reilly Media, 2012.

5. Michael Berthold, David J. Hand, "Intelligent Data Analysis", Springer, 2007.

Course Code:	**CSL 436**	**Course Title:**	**Data Mining and Warehousing**			
Category :	**ELECTIVE**	**Credit Assigned :**	**L**	**T**	**P**	**C**
			3	**0**	**2**	**4**
Pre-Requisite (if Any) :	**NONE**	**Type of Course :**	**Computer Science and Engineering**			

Course Outcomes:

1. Identify the scope and necessity of Data Mining & Warehousing for the society.
2. Describe the designing of Data Warehousing so that it can be able to solve the root problems.
3. To understand various tools of Data Mining and their techniques to solve the real time problems.
4. To develop ability to design various algorithms based on data mining tools.
5. To develop further interest in research and design of new Data Mining techniques.

Course Contents:

1. Introduction to Data warehousing - Application of Data warehousing and mining, Data warehouse development life cycle, Data warehouse analysis, CUBE, ROLL UP and STAR queries.

2. Data Warehouse Design - Massive denormalisation, STAR schema design , Data warehouse Architecture, OLAP, ROLAP and MOLAP , concepts of Fact and dimension table
3. Space Management in Data warehouse - Schemas for storing data in warehouse using different storage structures, B-tree index, hash index, clusters, Bitmap index functional index, domain index, Data partitions.
4. Performance and Tuning - Query optimization, memory management, process management. I/o management for Data warehouse.
5. Data Mining Tools –Association rules, a priori algorithm, Fp-trees algorithm, constraints and solution.
6. Cluster analysis- paradigms, DBSCAN, cluster algorithms.
7. Mining tools- decision trees and applications.

Text Books:

1. Jiawei Han, Micheline Kamber, "Data mining- Concepts & Techniques", Morgan Kaufmann
2. Michale Corey, Michale Abbey; Oracle 8i Data Warehousing; Tata McGraw Hill.
3. Navathe and Elmasry; Fundamentals of Database Systems; Addison Wesley, 2000
4. Arun Pujari; Data Mining; Orient Longman, 2003

Course Code:	**CSL314**	**Course Title:**	**Design Thinking**
Category:	**Core**	**Credit Assigned**	**L** **T** **P** **C** **3** **0** **0** **3**
Pre-Requisite (if Any)	**Nil**	**Type of Course**	**CSE with DSA**

Course Outcomes:

1. Appreciate various design process procedures
2. Generate and develop design ideas through different techniques
3. Identify the significance of reverse Engineering to Understand products
4. Draw technical drawing for design ideas

Course Contents:

Module 1-PROCESS OF DESIGN
Understanding Design thinking
Shared model in team-based design – Theory and practice in Design thinking – Explore presentation signers across the globe – MVP or Prototyping

Module 2- Tools for Design Thinking

Real-Time design interaction capture and analysis – Enabling efficient collaboration in digital space, Empathy for design – Collaboration in distributed Design

Module 3- Design Thinking in IT

Design Thinking to Business Process modelling – Agile in Virtual collaboration environment – Scenario based Prototyping

Module 4- DT For strategic innovations

Growth – Story telling representation – Strategic Foresight - Change – Sense Making - Maintenance Relevance – Value redefinition - Extreme Competition – experience design Standardization – Humanization - Creative Culture – Rapid prototyping, Strategy and Organization – Business Model design.

Module 5- Design thinking workshop

Design Thinking Work shop Empathize, Design, Ideate, Prototype and Test

Text books:

1. John.R.Karsnitz, Stephen O'Brien and John P. Hutchinson, "Engineering Design",Cengage learning (International edition) Second Edition, 2013.
2. Roger Martin, "The Design of Business: Why Design Thinking is the Next Competitive Advantage", Harvard Business Press , 2009.
3. Hasso Plattner, Christoph Meinel and Larry Leifer (eds), "Design Thinking: Understand Improve, Apply", Springer, 2011
4. Idris Mootee, "Design Thinking for Strategic Innovation: What They Can't Teach You at Business or Design School", John Wiley & Sons 2013.

References:

1. Yousef Haik and Tamer M.Shahin, "Engineering Design Process", CengageLearning, Second Edition, 2011.
2. Book - Solving Problems with Design Thinking - Ten Stories of What Works (Columbia Business School Publishing) Hardcover – 20 Sep 2013 by Jeanne Liedtka (Author), Andrew King (Author), Kevin Bennett (Author).