B.TECH - ARTIFICIAL INTELLIGENCE AND DATA SCIENCE CURRICULUM

Semester III										
Course Code	**Course Title**	**Category**	**Periods / Week**				**C**	**Maximum Marks**		
			L	**T**	**P**	**S**		**CIA**	**ESE**	**Total**
Theory										
ADB1201	Computer Organization	PC	3	0	0	3	3	40	60	100
AGI1241	Data Analytics	PC	3	0	0	1	3	40	60	100
AGB1201	Operating Systems Concepts	PC	2	1	0	3	3	40	60	100
CGB1202	Design and Analysis of Algorithms	PC	2	1	0	3	3	40	60	100
Theory Cum Practical/Practical Cum Theory										
GEA1201	Engineering Mathematics III(TCPL)	BS	2	1	2	3	4	50	50	100
CGB1201	Java Programming (TCPR)	PC	2	0	4	2	4	50	50	100
ADI1201/ ADI1221/ AGI1242	Data Exploration and Visualization (MKCE)/ Principles of Artificial Intelligence(KRCE) / Machine Learning Techniques(KRCT)	PC	2	0	4	2	4	50	50	100
Practical										
CGB1211	Design and Analysis of Algorithms Laboratory	PC	0	0	2	0	1	60	40	100
AGB1211	Design Thinking	PC	0	0	4	0	2	60	40	100
Mandatory/Employability Enhancement										
GEA1202	Career Skill Development II	HS	1	0	0	1	1	40	60	100
	Total Credits						**25**			

Course Code	Course Title	Sem	Category	Periods/Week				C
				L	T	P	S	
ADB1201	**COMPUTER ORGANIZATION**	III	PC	3	0	0	3	**3**
Pre-requisite	Basics of Engineering	**Course Type**	Theory	**QP TYPE**				QP2

Course Objectives:

Develop your ability to analyze sequential and combinational circuits. Understand the basic architecture and operation of digital computers, explore the details of processor data route and control unit design while learning about related risks, and gain an understanding of the ideas behind different memory types and I/O interfaces.

Course Outcomes:

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

CO Number	Course Outcomes	Max BTL
CO1	Learn about the different logic gate-based combinational digital circuits.	5
CO2	Understand sequential circuits and evaluate the process of design.	4
CO3	Describe the foundations of computer systems and examine how an instruction is carried out.	4
CO4	Examine several control design models and pinpoint potential risks.	5
CO5	Determine the features of different memory systems and I/O connectivity.	4

Syllabus

Module I	COMBINATIONAL LOGIC	9	5

Combinational Circuits – Karnaugh Map – Analysis and Design Procedures – Binary Adder – Subtractor – Decimal Adder

Magnitude Comparator – Decoder – Encoder – Multiplexers – Demultiplexers

Guided Self Study Topics

- BCD to seven-segment display decoder
- Implementation of code converters

Module II	SYNCHRONOUS SEQUENTIAL LOGIC	9	4

Introduction to Sequential Circuits – Flip-Flops – operation and excitation tables, Triggering of FF, Analysis and design of clocked sequential circuits

Design – Moore/Mealy models, state minimization, state assignment, circuit

implementation - Registers – C4ounters			
Guided Self Study Topics			
● XOR function using only 4 two-input NAND gates ● Design a 2-bit synchronous counter of the general form counts in the sequence 0, 3, 1, 2, 0, using D flip-flops.			
Module III	**COMPUTER FUNDAMENTALS**	**9**	**4**
Functional Units of a Digital Computer: Von Neumann Architecture – Operation and Operands of Computer Hardware Instruction – Instruction Set Architecture (ISA): Memory Location, Address and Operation Instruction and Instruction Sequencing – Addressing Modes, Encoding of Machine Instruction – Interaction between Assembly and High Level Language			
Guided Self Study Topics			
● RISC-style program that computes the expression ● CISC-style program for the task			
Module IV	**PROCESSOR**	**9**	**5**
Instruction Execution – Building a Data Path – Designing a Control Unit – Hardwired Control Microprogrammed Control – Pipelining – Data Hazard – Control Hazards			
Guided Self Study Topics			
● Superscalar Operation ● Pipelining in ColdFire Processors & Intel Processors			
Module V	**MEMORY AND I/O**	**9**	**4**
Memory Concepts and Hierarchy – Memory Management – Cache Memories: Mapping and Replacement Techniques – Virtual Memory – DMA I/O – Accessing I/O: Parallel and Serial Interface – Interrupt I/O – Interconnection Standards: USB, SATA			
Guided Self Study Topics			
● Logic expression for an address decoder that recognizes the 16-bit hexadecimal address. ● Timing diagram for transferring three words to an output device connected to the PCI bus.			
		TOTAL HOURS	**45**

Course Code	Course Title	Sem	Category	Periods/Week				C
				L	T	P	S	
AGI1241	DATA ANALYTICS	III	PC	3	0	0	1	3
Pre-requisite	Python for Data Science	Course Type	Theory	QP TYPE				QP2

Course Objectives:

This course understands the fundamental concept of business & data analytics and to design both static and dynamic tables, data visualizations, dashboards, and stories using Tableau desktop.

Course Outcomes:		Max BTL
Upon completion of the course, the students will be able to:		
CO1	Understand business analytics and its various techniques	2
CO2	Apply the fundamentals of Excel analytics functions and conditional formatting	3
CO3	Implement various visualization techniques in Tableau effectively	4
CO4	Demonstrate proficiency in data blending, creating data extract and efficiently organizing data	4
CO5	Design dashboards using filters, parameters, and sets to manipulate data effectively	5/6

Syllabus			Max BTL
Module I	INTRODUCTION	9	2

Business Analytics- Types of Analytics- Areas of Analytics- Sort and Filter- Group by and Subtotal

Text to Columns- Removing Duplicates- Formatting- Conditional Formatting- Statistical Functions

Guided Self Study Topics

- Anova
- Data Validations

Module II	ANALYTICS WITH EXCEL	9	3

Pivot Table- Grouping in Pivot Table- Slicer- Dashboarding -Principles of Dashboard Design

Multiple Linear Regression - Logistic Regression Normal Distribution -Using Macros for Analytics			
Guided Self Study Topics			
▪ E-Commerce Sales Dashboard ▪ Restaurant tips			
Module III	**CREATION OF CHART IN TABLEAU**	**9**	**4**
Data Visualization- Examples of effective visualizations- Storytelling with Data- Introduction to Tableau- Tableau products- Tableau Workspace Charts-Creating Charts -Horizontal or Vertical Bar Chart -Line Chart- Horizontal or Vertical Stacked Bar Charts- Map Charts- Pie Charts- Tree maps- Highlight Tables			
Guided Self Study Topics			
▪ Dashboards and distribution ▪ Independent Axes and Date Hierarchies			
Module IV	**DATA PREPARATION**	**9**	**4**
Data Preparation and Data Extracts- Extracts vs. Live Connection and their Advantages- Calculated Fields: Different Types of Calculations- Table Calculations Introduction to Preparation Techniques- Filters and LOD Expressions- Pivoting Data- Creating Parameters- Using Parameters to Create Calculated Fields			
Guided Self Study Topics			
● Methodology Using Custom Shape Palettes ● Framework for Data Visualization			
Module V	**FILTERS AND DASHBOARDS**	**9**	**5/6**
Filters-Types of Filters in Tableau-Filters on Dimension and Measures -Analysis using Parameters Analytics in Tableau - Dashboards Layout and Design- Stories in Tableau			
Guided Self Study Topics			
● Firewall log visualization ● Security visualization system			
		Total Hours	**45**
Learning Resources:			
Text Books:			

1	Conrad Calberg, Business Analysis with Microsoft Excel,O-Reilly Media, Fifth Edition,2018
2	Ryan Sleeper, ǁPractical Tableauǁ O_Reilly Media, Inc, First Edition, 2018
Reference Books:	
1	Cole Nussbaumer Knaflic, Storytelling with Data: A Data Visualization Guide for Business Professionals, 1st Edition, Wiley publication, 2015.
2	Joshua N Milligan, Learning Tableau 2019: Tools for Business Intelligence, data prep, and visual analytics, 3rd ed. Edition, Packt publications, 2019.
3	Microsoft Excel Data Analysis and Business Modeling by Wayne L. Winston

Course Code	Course Title	Sem	Category	Periods/Week					C
				L	T	P	S	C	
AGB1201	**OPERATING SYSTEM CONCEPTS**	III	PC	2	1	0	3	3	**3**
Pre-requisite	NIL	**Course Type**	Theory	**QP TYPE**					QP2

Course Objectives:

Explicate the students to understand the interaction between hardware and software. To demonstrate the fundamental Concept and techniques of operating system.

Course Outcomes:

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

CO Number	Course Outcomes	Max BTL
CO1	Analyse the fundamental concepts of operating system to learn how operating system is important for computer system	**2**
CO2	Analyse and implement various processes scheduling and threads.	**4**
CO3	Evaluate the different process of synchronization techniques and to overcome the deadlock.	**5/6**
CO4	Analyse the mechanisms involved in memory management in contemporary OS.	**4**
CO5	Examine the virtual machines and distributed file systems.	**4**

Syllabus			Max BTL
Module I	**INTRODUCTION**	**10**	**4**

Overview –OS Services – System calls.

OS design and implementation. Operating system operations – OS structures**.**

Guided Self Study Topics

- Process creation using Fork() system call
- Introduction to QNX

Module II	**PROCESS MANAGEMENT**	**9**	**4**

Concept – Operations on process – Interprocess communication – Threads – Threading issues.

CPU Scheduling criteria – Scheduling algorithms – Thread scheduling.

Guided Self Study Topics			
▪ Windows embedded POS Ready ▪ Process Scheduling Simulator			
Module III	**PROCESS SYNCHORNIZATION**	**9**	**5/6**
Background - Critical section problem - Peterson's solution – Semaphores – Classic problems of Synchronization.			
Deadlock – System model –Deadlock Detection – Deadlock prevention – Deadlock Avoidance – Deadlock Recovery.			
Guided Self Study Topics			
▪ Aviation OS ▪ Cloud OS			
Module IV	**MEMORY MANAGEMENT AND FILE SYSTEM**	**8**	**4/5**
Main memory – Contiguous memory allocation – paging – virtual memory - Demand paging – Copy-on-write – page replacement algorithms – Thrashing – RAID structure File system – Structures – Operations – Allocation methods – File system mounting – File sharing – Disk Scheduling.			
Guided Self Study Topics			
▪ Cerner OS ▪ Memory Management Game			
Module V	**VIRTUAL MACHINES AND DISTRIBUTED SYSTEMS**	**9**	**4**
Overview – Benefits – Building blocks – Categories of VM and implementation. Network and Distributed OS – Network structure – Distributed file system – Design issues in distributed system – Remote file access.			
Guided Self Study Topics			
▪ File System Explorer ▪ CORBA			
		Total Hours	**45**
Learning Resources:			
Text Books:			
1	"Operating System Concepts", Abraham Silberschatz, Peter Baer Galvin ,Greg Gagne,, Tenth Edition, Wiley ,2018		

Reference Books:	
1	“Modern Operating Systems”, Andrew S. Tanenbaum, Pearson,, Fifth edition, 2022
2	“Operating Systems: Internals and Design Principle”, William Stallings, Seventh Edition, 2018

Course Code	Course Title	Sem	Category	Periods/Week				C
				L	T	P	S	
CGB1202	Design and Analysis of Algorithms	III	PC	2	1	0	3	3
Pre-requisite	C Programming and Data Structures	Course Type	Theory	QP TYPE				QP2

Course Objectives:

This course will made students to critically analyze the efficiency of alternative algorithmic solutions for the same problem. Understand the brute force, divide and conquer, dynamic programming, greedy technique, backtracking and branch bound algorithmic techniques in various problem solving. Identify the P and NP class problems.

Course Outcomes:

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

CO Number	Course Outcomes	Max BTL
CO1	Analyse the efficiency of recursive and non-recursive algorithms mathematically.	4
CO2	Demonstrate the various algorithms in brute force and divide and conquer algorithmic techniques.	4
CO3	Solve the problems using dynamic programming and greedy algorithmic techniques.	4
CO4	Apply backtracking and branch and bound techniques to solve the problems.	4
CO5	Categorize the problems with the classes P and NP	5/6

Syllabus			Max BTL
Module I	INTRODUCTION	8	4

Notion of an Algorithm–Fundamentals of Algorithmic Problem Solving–Important Problem Types – Fundamentals of the Analysis of Algorithm Efficiency

Analysis Framework – Asymptotic Notations and their properties – Mathematical analysis of Recursive and Non-recursive algorithms.

Guided Self-Study Topics

Analysis of algorithm efficiency for GCD of two numbers and to find prime number.

Module II	BRUTE FORCE AND DIVIDE AND CONQUER	10	4

Brute Force: String Matching - Traveling Salesman Problem – Knapsack Problem - Assignment problem.

Divide and Conquer: Merge Sort – Quick Sort – Multiplication of Large Integers.

Guided Self-Study Topics			
Apply divide and conquer technique in Strassen's Matrix Multiplication, Closest-Pair and Convex – Hull Problems.			
Module III	**DYNAMIC PROGRAMMING AND GREEDY TECHNIQUE**	**10**	4
Dynamic programming: Principle of optimality – Warshall's and Floyd's algorithms – Optimal Binary Search Trees - Multi stage graph. Greedy Technique: Dijkstra's algorithm - Huffman Trees and codes - 0/1 Knapsack problem.			
Guided Self-Study Topics			
Using Dynamic Programming approach count all n–digit binary numbers without any consecutive 1's from given a positive integer n and Coin Changing Problem			
Module IV	**BACKTRACKING AND BRANCH AND BOUND**	**8**	**4**
Backtracking: N-Queen problem - Hamiltonian Circuit Problem – Subset Sum Problem. Branch and Bound: Least cost branch and bound solution – FIFO branch and bound solution –Assignment problem – 0/1 Knapsack problem – Traveling Salesman Problem			
Guided Self-Study Topics			
Difference between Backtracking and Branch and Bound, Graph Coloring.			
Module V	**P AND NP PROBLEMS**	**9**	**4**
Deterministic algorithms the class P - Non – deterministic Algorithms – the classes NP Complete and NP Hard Problems. Decision tree algorithms, Chromatic number decision problem, Cook's theorem.			
Guided Self-Study Topics			
Reduction of NP hard problem to NP Complete.			
Total Hours			**45**
Learning Resources:			
Text Books:			
1	Anany Levitin, Introduction to the Design and Analysis of Algorithms, Third Edition, Pearson Education, 2021.		
2	Ellis Horowitz, Sartaj Sahniand Sanguthevar Rajasekaran, Computer Algorithms/C++, Second Edition, Universities Press, 2019.		
Reference Books:			
1	Thomas H.Cormen, Charles E.Leiserson, Ronald L.Rivestand Clifford Stein, Introduction to Algorithms, Third Edition, PHI Learning Private Limited,2012.		
2	S.Sridhar, Design and Analysis of Algorithms, Oxford university press, 2014.		
3	A.A.Puntambekar, "Design and Analysis of Algorithms", Technical Publications, ISBN: 978-93-332-2107-8, January 2019.		

Course Code	Course Title	Sem	Category	Periods/Week				C
				L	T	P	S	
GEA1201	ENGINEERING MATHEMATICS III	III	BS	2	1	2	3	4
Pre-requisite	Probability Theory, Differential and Integral Calculus	Course Type	TCPL	QP TYPE				QP1

Course Objectives:

This course will enable learners to offer knowledge on Random variables, Partial differential equations, Fourier series, Fourier Transform and Z-transform techniques to solve Engineering problems.

Course Outcomes:

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

CO Number	Course Outcomes
CO1	Apply the Fourier series to solve various engineering problems on periodic functions.
CO2	Apply Fourier transform techniques to solve Engineering problems.
CO3	Analyze the one dimensional heat flow and one dimensional wave equations
CO4	Create the knowledge to develop Z transform techniques for discrete time systems.
CO5	Solve Engineering problems by using Discrete and continuous distributions

Syllabus

Module I	FOURIER SERIES	9

Dirichlet's conditions – General Fourier series in the intervals $(0,2\pi),(0,2l)$,.

Odd and even functions Fourier Series $(-\pi, \pi),(-l,l)$. Harmonic Analysis.

Guided Self-Study Topics

Half Range sine and cosine Series

Module II	FOURIER TRANSFORMS	9

Statement of Fourier integral theorem - Fourier transform pair - Properties (Without Proof)

Fourier sine and cosine transforms – Properties (Without Proof)

Guided Self-Study Topics

Parseval's Identity and Convolution theorem

Module III	APPLICATIONS OF PARTIAL DIFFERENTIAL EQUATIONS	9
Introduction to Partial Differential Equations - Classification of PDE - Fourier Series Solutions of one dimensional wave equation: zero velocity and Non zero velocity One dimensional equation of heat conduction: zero boundary and Non-zero boundary		
Guided Self-Study Topics		
Method of separation of variables		
Module IV	**Z – TRANSFORMS**	**9**
Z-transforms - Elementary properties (without proof) – Initial and final value theorems (statement only) Inverse Z-transform: Partial fraction and convolution theorem – Applications: Solution of Difference Equations		
Guided Self-Study Topics		
Shifting Theorems		
Module V	**RANDOM VARIABLE AND DISTRIBUTIONS**	**9**
Random variables - Discrete Distributions: Binomial, Poisson, Geometric distributions Continuous Distributions: Uniform, Exponential and Normal distributions.		
Guided Self-Study Topics		
Gamma Distribution		
	TOTAL HOURS	**45**
List of Experiments / Exercises:		**30**
Software Tool:		
1	Plot a Fourier Series	
2	Fourier Coefficients of functions	
3	Fourier Transform of Exponential function	
4	Fourier sine and cosine transforms of function	
5	Solution of one dimensional wave equation	
6	Solution of one dimensional heat equation	
7	Z transform of functions	
8	Solution of Difference equations	
9	Probability mass function and cumulative distribution function of Binomial distribution	
10	Plot the Normal Distribution curves	

Total Hours	**75**
Learning Resources:	
Text Books:	
1	Johnson, R.A. and Gupta, C.B.,“Miller and Freund"s Probability and Statistics for Engineers”, Pearson Education, Asia, 9th edition, 2020.
2	Grewal, B.S., Higher Engineering Mathematics, Khanna Publishers, 44th Edition, 2021.
Reference Books:	
1	Ramana B.V., Higher Engineering Mathematics, Tata McGraw Hill New Delhi, 11thEdition, Reprint, 2017.
2	James, G., "Advanced Modern Engineering Mathematics", 3rd Edition, Pearson Education, 2007
3	Bali N.P. and Manish Goyal, A Text book of Engineering Mathematics, Laxmi Publications, 10^{th} Edition, Reprint, 2022.
4	Hwei Hsu, "Schaum’s Outline of Theory and Problems of Probability, Random Variables and Random Processes", Tata McGraw Hill Edition, New Delhi, 2004
5	Spiegel, M.R., Schiller,J. and Srinivasan, R.A.,“Schaum’s Outlines Probability and Statistics”, Tata McGraw Hill 4^{th}edition, 2012.
6	Yang Won Y, ”Engineering Mathematics with MATLAB”, Taylor & Francis Ltd, ISBN: 9781138059337

Course Code	Course Title	Semester	Category	Periods/Week				C
				L	T	P	S	
CGB1201	**JAVA PROGRAMMING**	III	**PC**	**2**	**0**	**4**	**2**	**4**
Pre-requisite	C Programming	**Course Type**	TCPR	**QP TYPE**				QP1

Course Objectives:

This course will enable the students to design and implement robust, secure, and reusable software solutions in Java. This includes analyzing and developing applications utilizing Java concepts and graphical user interfaces (GUI), culminating in the ability to build real-time applications that effectively addresses complex problems.

Course Outcomes:

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

Course Outcomes		Max BTL
CO1	Describe the foundational principles of Object-Oriented Programming (OOP).	4
CO2	Analyze Java programs with the concept's inheritance and interfaces	4
CO3	Solve Java applications using exceptions and I/O streams	4
CO4	Demonstrate Java applications with threads and develop graphics programming using AWT & Swing	4
CO5	Build Java Applications for solving real-time problems.	6

Syllabus			Max BTL
Module I	**JAVA PROGRAMMING**	**6+9**	**4**

OOP Concepts- Introduction to Java – JVM – Data types – Variables – Operators – Control statements

Classes and Methods – Constructors - static members - Arrays –String Handling

Guided Self-Study Topics

Comment Line Arguments

Case Study Problems

a. Create a **Student Management System** class to manage the student records. This class should have the following functionalities:
   - Add a new student.

- Display all student information.
- Update student details (name, age, or grade) based on student ID.
- Delete a student based on student ID.

b. Write a Java program to count the number of words in a given string.

c. Write a Java program to check if a given string is a palindrome or not.

Module II	**INHERITANCE, INTERFACE AND PACKAGES**	**6+9**	**4**

Inheritance – Access Specifiers - Super classes- sub classes – final methods and classes

Interfaces - Defining an interface - implementing interface - Polymorphism – Packages

Guided Self-Study Topics

Abstract classes and Methods

Case Study Problems

1. Design a system for a university's personnel management. Create classes for different types of personnel such as professors, staff, and students, with appropriate inheritance relationships. Implement methods to calculate salary for each type of personnel.
2. Develop a java application to implement currency converter (Dollar to INR, EURO to INR, Yen to INR and vice versa), distance converter (meter to KM, miles to KM and vice versa), time converter (hours to minutes, seconds and vice versa) using packages

Module III	**EXCEPTION HANDLING AND I/O STREAMS**	**6+9**	**4**

Exception handling Mechanisms - exception hierarchy - throwing and catching exceptions – built-in exceptions, creating own exceptions.

I/O streams - Reading and Writing Console – Reading and Writing Files

Guided Self-Study Topics

Nested try, Multiple Catch statements

Case Study Problems

1. Develop a calculator application with error handling for arithmetic operations. Implement exception handling to catch divide-by-zero errors, invalid input, and other potential issues that may arise during calculations.
2. Write a program that reads text from a file, counts the occurrences of each word, and displays the word count for each unique word. Use FileReader and BufferedReader to implement this.

Module IV	**MULTITHREADING AND EVENT HANDLING**	**6+9**	**4**

Multithreading - Thread life cycle - Creating threads - Inter-thread communication. Java AWT & Event handling mechanisms–Java Swing

Guided Self-Study Topics

Thread Synchronization, Applet class

Case Study Problems		
1. Write a java program that implements a multi-threaded application that has three threads. First thread generates a random integer every 1 second and if the value is even, the second thread computes the square of the number and prints. If the value is odd, the third thread will print the value of the cube of the number. 2. Develop a simple calculator application using Java AWT components such as Text Field, Button, and Label. Implement event handlers to perform arithmetic operations (addition, subtraction, multiplication, division) when the user clicks on the buttons		
Module V	**PROJECT SPECIMEN** **15**	**6**
1. Attendance Management System 2. Supermarket Billing System 3. Exam Seating Arrangement System 4. ID Card Generator System 5. Email System 6. Online CV/Resume Builder 7. Scientific Calculator in Java		
Total Hours		**75**
Learning Resources:		
Text Books		
1	Herbert Schildt, “Java the Complete Reference”, Ninth edition, McGraw-Hill Osborne Media, 2014.	
2	P.J. Deitel and H.M. Deitel, “JAVA™ HOW TO PROGRAM”, seventh edition, Pearson International Edition, 2009.	
Reference Books		
1	Timothy Budd, —An Introduction to Object-Oriented Programming‖, Third Edition, Pearson Education, 2008.	
2	K. Arnold and J. Gosling, “The JAVA programming language”, Third edition, Pearson Education, 2000.	
3	Timothy Budd, “Understanding Object-oriented programming with Java”, Updated Edition, Pearson Education, 2000.	

Course Code	Course Title	Sem	Cate gory	Periods/Week				C
				L	T	P	S	
AMI1201	DATA EXPLORATION AND VISUALIZATION	III	PC	2	0	4	4	4
Prerequisite	Python, Machine Learning	Course Type	Theory cum Project	QP TYPE				QP2

Course Objectives:

In today's fast-paced world, the data needs to be presented in an abstract and engaging way to attract the audience. Most websites like social media and e-commerce use infographics and dashboards to engage their visitors. By using various data visualization techniques.

Course Outcomes:

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

CO Number	Course Outcomes
CO1	Understand the have the basic knowledge on data collection and various statistical elementary tools.
CO2	Students grasp the fundamental principles and properties of data, marking the inception of the visualization process.
CO3	Comprehend the significance of user engagement in visualizations and grasp the process of visualization design.
CO4	Students familiarize themselves with several commercial data visualization tools and their features.
CO5	Gain a foundational understanding of a data visualization tool with hands-on projects

Syllabus

Module I	INTRODUCTION TO STATISTICS	9+6

Data Collection – Methods of data Collection-Descriptive Statistics: Mean, Median, Mode-Inferential Statistics: Random Variables, Probability Distributions-Normal Distribution-Sampling and Sampling Distribution.

Self-Study Topics

Fundamentals of Supervised Learning-Unsupervised
Learning Techniques-Feature Engineering and Model Optimization.

Module II	VISUALIZATION USING R	9+6

Introduction to R-Exploratory Data Analysis in R-Data Manipulation in R-Data Visualization

in R- Installing R Studio-Data Manipulation in R (using dplyr, data. table, reshape2, tidyr, and Lubridate packages)-Data Visualization in R (utilizing Graphics and ggplot2)		
Self-Study Topics		
Overview of R Programming Environment-Data Cleaning and Preprocessing in R-Statistical Analysis with R-Machine Learning Basics in R - Advanced Data Visualization in R.		
Module III	**WATSON STUDIO & DATA ANALYSIS**	**9+6**
Visualizing Data in Watson Studio-Incorporating Data into Data Refiner in Watson Studio-Data Visualization within Watson Studio- Python Programming - Basics of Python Scripting - Overview of Python Data Types - Exploring Jupyter Notebooks - Installation of Python and Anaconda.		
Self- Study Topics		
Visualizing Data in Watson Studio-Incorporating Data into Data Refiner in Watson Studio-Data Visualization within Watson Studio		
Module IV	**VISUALIZATION USING PYTHON**	**9+6**
NumPy, and Pandas-Pandas Essentials: Handling Text Data, Date Time Columns, Indexing and Selecting Data, Grouping, Merging, and Joining Datasets-Python Data Visualization Tools-Fundamentals of Plotting with Matplotlib-Advanced Plotting Techniques with Matplotlib-Leveraging Seaborn for Advanced Visualization-Spatial Visualization and Analysis with Folium in Python-Exploring Seaborn's Capabilities-Application Examples and Case Studies		
Self-Study Topics		
Exploring Pandas Operations: Dealing with Missing Data, Reshaping, and Pivoting		
Module V	**Project Specimen**	**15**
Build a dashboard that provides a comprehensive overview of the performance of various machine learning models. Include visualizations such as ROC curves, precision-recall curves, confusion matrices, and calibration plots to compare the performance of different models across different metrics.		
Create interactive visualizations to explore time series data and the predictions made by time series forecasting models. Allow users to visualize the original time series data alongside the model's predictions, and provide interactive features for adjusting model parameters and exploring forecast uncertainty.		
	Total Hours	**75**
Learning Resources:		
Text Books:		
1	David M. Lane, “Introduction to Statistics”,Apple Books, 2015	

2	Roger D. Peng, “ R Programming for Data Science”,Leanpub book 2015
3	Dr.Abhinav, “Data Visualization using Python Programming-A Technical Guide For Beginners, Researchers and Data Analyst”, Shashwat publication, 2016
Reference Books:	
1.	Sheldon M. Ross , Introduction to Probability and Statistics for Engineers and Scientists, Academic Press,2014
2.	Andy Field, Discovering Statistics Using R,SAGE Publications Ltd,2019
3.	Mario Dobler, Tim Großmann, Data Visualization with Python: Create an impact with meaningful data insights using interactive and engaging visuals, 2019

Course Code	Course Title	Sem	Category	Periods / Week				C
				L	T	P	S	
ADI1221	PRINCIPLES OF ARTIFICIAL INTELLIGENCE	III	PC	2	0	4	2	4
Pre-requisite	NIL	Course Type	TCPR	QP Type				QP1

Course Objectives:

This module equips students with the fundamental concepts and techniques that form the backbone of Artificial Intelligence by laying a solid foundation for deeper understanding. By exploring diverse topics, students comprehensively understand applications and the crucial skills to excel in this domain.

Course Outcomes:

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

CO Number	Course Outcomes	Max BTL
CO1	Demonstrate a comprehensive understanding of the foundations of artificial intelligence.	3
CO2	Develop a systematic and adaptable approach to problem-solving, equipping them with essential skills for addressing complex search strategies.	4
CO3	Expertise in Constraint Satisfaction Problems (CSP) and Game Theory, encompassing adept problem-solving, strategic analysis, ethical awareness, and effective communication of concepts.	5
CO4	Utilize the limitations and applicability of logical reasoning approaches, including their assumptions, biases, and potential challenges in dealing with uncertainty and incomplete information.	5
CO5	Demonstrate hands-on experience in applying AI concepts and methodologies to solve real-world problems, fostering creativity, innovation, and critical thinking skills essential for success in the field of artificial intelligence.	6

Syllabus		Max BTL
Module I	INTRODUCTION 12	3

Introduction - Foundations of Artificial Intelligence – History of Artificial Intelligence – The state of the Art – Risks and Benefits

Intelligent Agents – Agents and Environment – The concept of Rationality – The nature of Environments – The structure of Agents.

Guided Self Study Topics
▪ Water jug problem ▪ 8 – puzzle problem
Case Study
A vast number of vehicle photos on sale have to be placed at the dealerships' websites. The photos need to have a more professional presentation without the garage backdrop where the photos were taken. The business goal of the project was to provide an automated way to remove the image background and deliver processed images ready to be placed on the website to increase the client for the company. Write a case study challenged to create a solution that does contour analysis for image recognition and background removal.

Module II	PROBLEM SOLVING METHODS	12	4
Problem Solving Approach to Typical AI problems - Search Strategies- Uninformed Informed – Heuristic Functions.			
Guided Self Study Topics			
▪ Online search agents ▪ The erratic vacuum world			
Case Study			
Sports betting company that stands out among other online bookmakers as a reliable company that strives to create a long-term association with each customer. Although the company is relatively young, it is already trusted by almost one million active fans. Hundreds of betting websites offer their services to millions of fans who like to bet on sports online. The client spends large amounts of money to acquire new customers, that's why it is more important than ever to prevent customer churn and turn new customers into loyal ones. The rate of customer churn directly affects the growth of the company. Write a case study for a solution that can build a predictive analytics solution to transforms the raw customer data into features for churn prediction models by analyzing, training and identify different stages of customer lifecycles.			

Module III	CSP AND GAME THEORY	12	5
Constraint Satisfaction Problems – Constraint Propagation – Backtracking Search for CSP – Local Search for CSP – Structure of Problem - Game theory – Optimal Decisions in Games Alpha-Beta Search – Monte-Carlo Tree Search – Stochastic Games – Partially Observable Games.			
Guided Self Study Topics			
▪ 8 – Queen problem			

- Job – Shop scheduling

Case Study

Gamers are very active on social media and various forums posting feedback about new game releases. Their actions result in thousands of pages of valuable content, which plays a significant role in product development. However, such amount of unstructured text data can't be manually processed in an effective way. That is why game developer's main concern was associated with the amount of work social research department had to do manually when copying all the comments from online channels and defining their sentiment and topics. These texts contain valuable information about different aspects of the game, such as developers, interface, pricing, engine, bugs, and etc. It was important for the Client to be able to monitor each of these aspects separately and export reports in a format convenient for social research department to work with.Write a case study to process the unstructured data and create an automated review collection and analysis.

Module IV	**LOGIC**	**12**	**5**

Propositional logic – Agents based on Propositional logic - First Order logic – Knowledge Engineering in FOL

Forward Chaining – Backward Chaining – Unification – Resolution.

Guided Self Study Topics

- Wumpus world

Case Study

As per the law, it is a crime for an American to sell weapons to hostile nations. Country A, an enemy of America, has some missiles, and all the missiles were sold to it by Robert, who is an American citizen."

Prove that "Robert is criminal."

Write a case study to solve the above problem, by converting all the above facts into first-order definite clauses, and then use a forward-chaining algorithm to reach the goal.

Module V	**PROJECT**	**12**	**6**

1. **Pathfinding Visualizer:** Create a visualization tool that demonstrates various pathfinding algorithms such as Dijkstra's algorithm, A* search, or weighted A* search on a grid-based map.
2. **Game Playing Agent:** Implement a simple game-playing agent (e.g., tic-tac-toe, Connect Four) using search algorithms like minimax with alpha-beta pruning.
3. **Logical Reasoning Game:** Create a logic-based game that challenges players to solve logical puzzles or deduce conclusions based on given premises, incorporating principles of deductive reasoning and logical inference.

Total Hours	**60**

Learning Resources:

Text Books:

1.	S. Russell and P. Norvig, "Artificial Intelligence: A Modern Approach", Prentice Hall, Fourth Edition, 2022.
Reference Books:	
1.	M. Tim Jones, "Artificial Intelligence: A Systems Approach (Computer Science)", Jones and Bartlett Publishers, Inc.; First Edition, 2008.
2.	Alan K. Mackworth, "Artificial Intelligence: Foundations of Computational Agents", Cambridge University Press, 2010.
3.	Deepak Khemani, "Artificial Intelligence", Tata McGraw Hill Education, 2013.

Course Code	Course Title	Sem	Category	Periods/Week				C
				L	T	P	S	
AGI1242	**Machine Learning Techniques**	**III**	**PC**	**2**	**0**	**4**	**2**	**4**
Pre-requisite	Python Programming	**Course Type**	TCPR	**QP TYPE**				QP1

Course Objectives:

Foundational concepts of machine learning and develop both supervised and unsupervised learning models. Learn to evaluate algorithms using appropriate performance metrics.

Course Outcomes:

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

CO Number	Course Outcomes	Max BTL
CO1	Apply the basics of Machine Learning and Python Packages.	**3**
CO2	Construct Supervised Learning models.	**4**
CO3	Demonstrate the different Unsupervised Learning Algorithms.	**4/5**
CO4	Evaluate and Compare Ensemble Techniques.	**4/5**
CO5	Analyze various Regression and Classification methods and its applications	**5/6**

Syllabus			Max BTL
Module I	**Introduction to Machine Learning**	**9+9**	**3**

Introduction to Machine Learning – Types of Machine Learning, Machine Learning Application, Pipeline, MLOps and AutoML

Introduction to python Packages - NumPy, Pandas, Matplotlib, Seaborn, Scikit learn, and TensorFlow.

Guided Self-Study Topics

- DevOps
- Data Engineering

Case Study Problem

This project focuses on predicting the selling prices of houses based on various features like area, number of bedrooms, location, etc. It is a regression problem that helps

understand how property features affect their market value		
Module II	**Supervised Learning** **9+9**	**4**
Supervised Learning - Training and Testing Data, Supervised Learning Algorithm – Classification, Regression. Application of Supervised Learning Overfitting and Underfitting, Regularization – Types of Regularization – Ridge, Coadaptation		
Guided Self-Study Topics		
● Lasso Regression ● Elastic Net Regression.		
Study Problem		
Stock price prediction models aim to forecast the future prices of stocks based on historical data and potentially other market indicators. This is a challenging area due to the volatility and unpredictability of financial markets.		
Module III	**Unsupervised Learning** **9+9**	**4/5**
Unsupervised Learning – Types of Unsupervised Algorithms, Application of Unsupervised Learning. Clustering – Types of Clustering, Hierarchical Clustering, Applications of Hierarchical Cluster, K-Means Clustering-Medoids Algorithm Outliers, PCA, DBSCAN, MCA, Singular Value Decomposition.		
Guided Self-Study Topics		
● ICA ● Feature Tree		
Case Study Problem		
The growing demand for small Unmanned Aerial Vehicles (UAVs) in civil and military applications necessitates addressing challenges in propulsion system optimization. Designing efficient propellers for small UAVs involves navigating trade-offs in size, power, and weight against range and endurance requirements. This project aims to understand and overcome aerodynamic complexities unique to small UAVs, enhancing their overall performance and adaptability.		
Module IV	**Ensemble Techniques** **9+9**	**4/5**
Ensemble Learning- Types of Ensemble Learning, Sequential Ensemble Technique, Parallel Ensemble Technique and Applications. Ensemble Methods – Types of Ensemble Methods – Bagging, Boosting Stacking – Boosting Algorithm, Stacking Algorithm.		
Guided Self-Study Topics		

- XGBoost
- LogitBoost

Case Study Problem

A significant public health concern is the rising cost of healthcare. Therefore, it's crucial to be able to predict future costs and gain a solid understanding of their causes. The insurance industry must also take this analysis seriously. This analysis may be used by healthcare insurance providers to make a variety of strategic and tactical decisions.

Module V	**Project Specimen**	**18**	**5/6**

- Spam Email Detection
- Movie Recommendation System
- Fake News Detection
- House Price Prediction
- Customer Segmentation
- Sentiment Analysis of Social Media posts
- Credit Card Fraud Detection
- Stock Price Prediction
- Plant Disease Detection

	Total Hours	**90**

Learning Resources:

Text Books:

1.	Ethem Alpaydin, “Introduction to Machine Learning”, MIT Press, Fourth Edition, 2020.
2.	Stephen Marsland, “Machine Learning: An Algorithmic Perspective, “Second Edition”, CRC Press, 2014.

Reference Books:

1.	Christopher M. Bishop, “Pattern Recognition and Machine Learning”, Springer, 2006.
2	Tom Mitchell, “Machine Learning”, McGraw Hill, 3rd Edition, 1997
3.	Mehryar Mohri, Afshin Rostamizadeh, Ameet Talwalkar, “Foundations of Machine Learning”, Second Edition, MIT Press, 2012, 2018.

Course Code	Course Title	Sem	Category	Periods/Week				C
				L	T	P	S	
CGB1211	**Design and Analysis of Algorithms Laboratory**	**3**	**PC**	0	0	2	0	**1**
Pre-requisite	C Programming and Data Structures	**Theory**	Practical	**QP TYPE**				ASPR

Course Objectives:

Critically analyze the efficiency of alternative algorithmic solutions for the same problem. Understand the brute force, divide and conquer, dynamic programming, greedy technique, backtracking and branch bound algorithmic techniques in various problem solving. Identify the P and NP class problems.

Course Outcome:

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

CO Number	Course Outcome
CO1	Analyse the efficiency of recursive and non-recursive algorithms.
CO2	Implement the various algorithm in brute force and divide and conquer approach.
CO3	Demonstrate the different algorithm using dynamic programming and greedy techniques.
CO4	Apply the backtracking and branch and bound technique to solve the real-world problems.
CO5	Develop the algorithm to solve the chromatic number decision problem.

Syllabus

List of Experiments / Exercises:

1	Implement recursive and non-recursive algorithms and study the order of growth from $\log_2 n$ to n!
2	Design and implement an efficient string-matching algorithm to rapidly compare the label text on a jar with the ingredient lists.
3	Design and implement the Quick Sort algorithm using the divide and conquer strategy. The algorithm recursively divides an array into smaller sub-arrays based on a chosen pivot element, and then sorts these sub-arrays independently. The pivotal aspect of Quick Sort lies in its partitioning step, where elements are rearranged such that elements smaller than the pivot are placed before it, and

	elements greater than the pivot are placed after it. The algorithm continues this process recursively until the entire array is sorted.
4	A person planning a backpacking trip can carry a maximum weight of W kilograms. We have a list of items with their weights and values Apply dynamic programming algorithm design technique in 0/1 knapsack problem and develop an algorithm to maximize the total value of items that can carry without exceeding the weight limit. Each item can only be selected once.
5	A logistics manager for a company responsible for delivering goods to various locations across a city. Your task is to optimize the delivery routes to minimize both the time taken for deliveries and the overall transportation costs. The city is represented as a graph, with intersections as nodes and roads as edges, and each road has a certain length and associated travel time. The goal is to use Dijkstra's algorithm to find the shortest path from the company's warehouse to each delivery location.
6	A software engineer working for a telecommunications company that specializes in transmitting large volumes of data over networks efficiently. The company is facing challenges with bandwidth limitations and wants to implement a compression technique to reduce data transmission times and costs. Develop a compression algorithm using Huffman coding to compress text messages sent between users while ensuring minimal loss of data and efficient decompression at the receiving end.
7	Develop an algorithm for the N-Queen problem utilizing the Backtracking algorithm design technique.
8	Design an algorithm for solving the assignment problem by the branch-and-bound algorithm. Experiment with your program to determine the average size of the cost matrices for which the problem is solved in a given amount of time.
9	A researcher working for a conservation organization tasked with planning a survey expedition to study a group of endangered species in a remote wilderness area. Solve the Travelling Salesman Problem (TSP) using the Backtracking algorithm to find the shortest route that visits each observation site exactly once before returning to the base camp. This optimal route will minimize travel time and disturbance to the wildlife while maximizing the effectiveness of the survey.
10	Optimize the resource allocation in a telecommunication network, where each node represents a base station. Adjacent nodes must use different frequency channels to avoid interference. Develop an algorithm to solve the Chromatic Number Decision Problem for the telecommunication network
PRACTICE EXERCISE	
1	Given n sorted files, find an optimal way (i.e., requiring the fewest comparisons or record moves) to pair wise merge them into one sorted file. Apply the Greedy approach,

2	A courier company tasked with optimizing delivery routes for a fleet of vehicles. The target is to ensure that each vehicle can visit all specified delivery locations exactly once, returning to the depot (starting point), while minimizing the total distance travelled. To achieve this, you plan to utilize the Backtracking method to find Hamiltonian circuits, which are paths that visit every vertex (delivery location) exactly once and return to the starting point.
3	Given n points in the plane, write the algorithm to find a pair with the smallest Euclidean distance between them. When brute force method is used, it is required to check all pairs of points p and q with $O(n^2)$ comparisons.
4	The retail company that wants to optimize its product bundling strategy to increase sales and customer satisfaction. Develop an algorithm using the Backtracking technique to find all possible combinations of products that sum up to a specific target value. By identifying these subsets, the company aims to create bundled offers that appeal to customers while maximizing revenue.
5	Develop the algorithms using Strassen's method of matrix multiplication is a typical divide and conquer algorithm. With Strassen's algorithm we can find the product of two 2 by 2 matrices with just seven multiplications.
	Total Hours **30**
Learning Resources:	
Text Books:	
1	Anany Levitin, Introduction to the Design and Analysis of Algorithms, Third Edition, Pearson Education, 2021.
2	Ellis Horowitz, Sartaj Sahni and Sanguthevar Rajasekaran, Computer Algorithms/ C++, Second Edition, Universities Press, 2019.
Reference Books:	
1	Thomas H.Cormen, Charles E.Leiserson, Ronald L. Rivest and Clifford Stein, Introduction to Algorithms, Third Edition, PHI Learning Private Limited, 2012.
2	S. Sridhar, Design and Analysis of Algorithms, Oxford university press, 2014.
3	Alfred V. Aho, John E. Hopcroft and Jeffrey D. Ullman, Data Structures and Algorithms, Pearson Education, Reprint 2006.

Course Code	Course Title	Sem	Category	Periods/ Week				C
				L	T	P	S	
AGB1211	**DESIGN THINKING**	**III**	**PC**	**0**	**0**	**4**	**0**	**2**
Pre-requisite	Engineering knowledge, Technical Communication skills	**Course Type**	Practical	**QP TYPE**				ASPR

Course Objectives:

Impart analytical thinking and design skills to empathize users, define problems, ideate solutions, prototype concepts, and test assumptions through practical activities.

Course Outcomes:

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

CO1	Create user personas and empathy maps to empathize with users for understanding their needs and able to frame the problem statement with well-defined scope and boundaries.
CO2	Demonstrate creative skills to visualize solutions and translate ideas into tangible concepts.
CO3	Explore a wide range of solutions through divergent and convergent thinking and to organize and synthesize insights gathered from exploration activities.
CO4	Experiment rapid prototyping techniques to quickly iterate and refine concepts based on user Feedback and to identify market opportunities and assess external factors influencing the commercialization potential of the solution.
CO5	Create a business model canvas chart to articulate key aspects of the business model and to prepare documentation for Patent / IPR filing.

Syllabus

List of Experiments / Exercises:

1	Perform a journey mapping to understand and assess the user needs by developing user personas and empathy maps.
2	Define a clear and actionable problem statement with required root cause analysis and problem framing techniques.
3	Visualize a solution using imagery to envision possibilities and bring them into real-time.
4	Perform a Brainstorming technique to generate new ideas and possibilities with divergent and convergent thinking.
5	Perform a mind-mapping to generate insights from exploration activities and using those to create design Criteria.

6	Implement a concept development to assemble innovative elements into a coherent alternative solution using design simulation and prototyping techniques.
7	Perform an assumption testing through gathering feedback from users and iterating them.
8	Identify the Market opportunities for commercialization through PEST (Political, Economic, Social and Technological) analysis
9	Prepare documentation (including detailed descriptions, drawings, prototypes, or samples of invention or Creation) to file for patent/ Intellectual Property Right.
10	Prepare a business model Canvas chart and pitching.
Total Hours	**30**
Content Beyond Experiment: To Implement Empathy-Driven Innovation: From Problem Discovery to Market-Ready Solution	
Learning Resources:	
Textbooks:	
1.	Nigel Cross, Design Thinking: Understanding How Designers Think and Work (Berg Publishers, 5th Edition, 2018).
2.	Michael Lewrick, Patrick Link, and Larry Leifer, The Design Thinking Playbook: Mindful Digital Transformation of Teams, Products, Services, Businesses and Ecosystems (Wiley, 1st Edition, 2019).
3.	Intellectual property right - Unleashing the knowledge economy, Prabuddha Ganguli, Tata McGraw Hill Publishing Company Ltd, 2017
Reference Books:	
1.	Tim Brown, Change by Design: How Design Thinking Transforms Organizations and Inspires Innovation (Harper Business, Revised Edition, 2009).
2.	Jeanne Liedtka, Andrew King, and Kevin Bennett, Solving Problems with Design Thinking (Columbia University Press Publishers, Revised Edition, 2013)
3.	Marc Stickdorn and Jakob Schneider, This Is Service Design Thinking: Practices, Tools, and Techniques for Inclusive Service Innovation (Wiley, 1st Edition, 2018).

Course Code	Course Title	Sem	Category	Periods/Week				C
				L	T	P	S	
GEA1202	Career Skill Development II	III	HS	1	0	0	1	1
Pre-requisite	NIL	Course Type	Theory	QP TYPE				QP1

Course Objectives:

Sharpen problem solving skills and to improve thinking capability of the students. To overcome the fear in group communication and to improve the social and Interpersonal skills of the students.

Course Outcomes:

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

CO Number	Course Outcomes	Max BTL
CO1	Solve real-life problems requiring Interpretation and comparison of complex numeric summaries which extend beyond simple measures of center.	4
CO2	Improve sentence formation taking into consideration effective ways of presenting ones ideas.	3
CO3	Develop self-awareness, awareness of others, improve confidence & preciseness in presenting	4

SYLLABUS			Max BTL
Module I	QUANTITATIVE APTITUDE AND REASONING	15	4
Number system (Unit Digit) – Problems on Partnership - Time and Distance - Problems on Train - Clock & Calendar - Direction sense test - Ranking Test			
Module II	VERBAL ABILITY	5	3
Error spotting, Verbal Analogy, Vocabulary, Synonyms & Antonyms - Developing Stories with Picture Homophones, Homographs, Homonyms			
Module III	SOFT SKILLS	10	4
SWOT Analysis - Communication skills (Debate,Tech Talk, Biography) - Reading skills and its Techniques (Newspaper Case Study, Short story, Blogs) - Emotional Intelligence.			
		Total Hours	30

Learning Resources	
Text Books	
1	Placement Training Companion (Career Skill Development Paper – II) 1E, Pearson Publication
Reference Books:	
1	Dr. R.S. Aggarwal, “Quantitative Aptitude”, S. Chand & Company Limited, 2022.
2	Dr. R.S. Aggarwal, “A Modern Approach to Verbal & Non - Verbal Reasoning”, S. Chand & Company Limited, 2022.
3	Nishit K. Sinha Quantitative Aptitude & Verbal Ability 6E, Pearson Publication.