PROGRAM STRUCTURE FOR THIRD YEAR AI and DS

Scheme for Autonomous Program (With Effect from 2023-20234)

Semester V

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		
		Theory	Pract.	Theory	Pract.	Total
ADC501	Cloud Computing	3	--	3	--	3
ADC502	Web Development	3	--	3		3
ADC503	Artificial Intelligence	3	--	3	--	3
ADC504	Data Warehousing & Mining	3	--	3	--	3
ADLO5 01X	Department Level Optional Course- 1	3	--	3	--	3
ADL501	Web Development L a b	--	2	--	1	1
ADL502	Artificial Intelligence Lab	--	2	--	1	1
ADL503	Data warehousing and Mining Lab		2	--	1	1
ADL504	Professional Communication and Ethics-II	--	2*+2	--	2	2
ADS501	Skill based Lab : Cloud Computing	--	4$	--	2	2
Total		**15**	**14**	**15**	**07**	**22**

Course Code	Course Name	Examination Scheme						
		Theory				Term Work	Pract	Total
		Internal Assessment		End Sem Exam	Exam. Duration (in Hrs)			
		Mid Term	CA					
ADC501	Cloud Computing	20	20	60	2	-	--	100
ADC502	Web Development	20	20	60	2	--	--	100
ADC503	Artificial Intelligence	20	20	60	2	--	--	100
ADC504	Data Warehousing & Mining	20	20	60	2	--	--	100
ADLO5 01X	Department Level Optional Course- 1	20	20	60	2	--	--	100
ADL 502	Web Development Lab					25	25	50
ADL502	Artificial Intelligence Lab	--	--	--	--	25	25	50
ADL503	Data Warehousing and Mining Lab	--	--	--	--	25	25	50
ADL504	Professional Communication and Ethics-II	--	--	--	--	50	--	50
ADS501	Skill based Lab : Cloud Computing Lab					50	--	50
Total		**100**	**100**	**300**	--	**175**	**75**	**750**

PROGRAM STRUCTURE FOR THIRD YEAR(AI and DS)

Scheme for Autonomous Program

Semester VI

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		
		Theory	Pract. Tut.	Theory	Pract.	Total
ADC601	Data Analytics and Visualization	3	--	3	--	3
ADC602	Cryptography and System Security	3	--	3		3
ADC603	Software Engineering and Project Management	3	--	3	--	3
ADC604	Machine Learning	3	--	3	--	3
ADLO601X	Department Level Optional Course -2	3	--	3	--	3
ADL601	Data Analytics and Visualization Lab	--	2	--	1	1
ADL602	Cryptography & System Security Lab	--	2	--	1	1
ADL603	Software Engineering and Project Management Lab	--	2	--	1	1
ADL604	Machine Learning Lab	--	2	--	1	1
ADL605	R Programming / Tableau	--	2*+ 2	--	2	2
ADS601	Skill based lab: AWS Essentials /Azure Data Engineer	--	4$	--	2	2
Total		**15**	**16**	**15**	**08**	**23**

Course Code	Course Name	Examination Scheme						
		Theory				Term Work	Pract.	Total
		Internal Assessment		End Sem Exam	Exam. Duration (in Hrs)			
		Mid Term	CA					
ADC601	Data Analytics and Visualization	20	20	60	2	--	--	100
ADC602	Cryptography and System Security	20	20	60	2	--	--	100
ADC603	Software Engineering and Project Management	20	20	60	2	--	--	100
ADC604	Machine Learning	20	20	60	2	--	--	100
ADLO601X	Department Level Optional Course -2	20	20	60	2	--	--	100
ADL601	Data Analytics and Visualization Lab	--	--	--	--	25	25	50
ADL602	Cryptography & System Security Lab	--	--	--	--	25	--	25
ADL603	Software Engineering and Project Management Lab	--	--	--	--	25	25	50
ADL604	Machine Learning Lab	--	--	--	--	25	25	50
ADL605	R Programming / Tableau lab	--	--	--	--	50	--	50

ADS601	Skill based lab: AWS Essentials / Azure Data Engineer	--	--	--	--	50	--	50
Total		**100**	**100**	**300**	--	**200**	**75**	**775**

* Theory class to be conducted for full class and $ indicates workload of Learner (Not Faculty)

Department Optional Courses	**Semester**	**Code & Subject**
Department Optional Course -1	V	CSDLO5011 : Statistics for Artificial Intelligence & Data Science CSDLO5012: Advanced Algorithms CSDLO5013: Computer Graphics
Department Optional Course -2	VI	CSDLO6011: High Performance Computing CSDLO6012: Distributed Computing CSDLO6013: Image processing and Computer Vision

Course Code	Course Name	Credit
ADC501	Cloud Computing	03

Pre-requisite: Operating System	
Course Objectives: To understand cloud computing techniques	
1	To comprehend Characteristics and Concept of cloud techniques.
2	To understand levels of virtualization
3	To correlate the connection of cloud service providers
4	To understand cloud implementation
5	To explore security and risk involved with cloud computing
Course Outcomes: After successful completion of the course, student will be able to:	
1	Differentiate between different cloud computing techniques.
2	Understand virtualization and its key concepts
3	Compare various cloud computing providers/software.
4	Handle open source cloud implementation and administration.
5	Understand risks involved in cloud computing.

Module		Detailed Content	Hours
1		**Introduction to Cloud Computing**	05
	1.1	Introduction– Component of CC, Comparing CC with Virtualization, Grids, Utility Computing, client-server model, P to P Computing, Impact of CC on Business, Key Drivers for Cloud Computing, Cloud computing Service delivery model. Cloud Types – Private, Public and Hybrid, when to avoid public cloud, Cloud AP.	
2		**Virtualization**	06
	2.1	Introduction & benefit of Virtualization, Implementation Levels of Virtualization, VMM Design Requirements and Providers, Virtualization at OS level, Middleware support for Virtualization, Virtualization structure/tools and mechanisms: Hypervisor and Xen Architecture, Binary Translation with full Virtualization, Para Virtualization with Compiler Support. Virtualization of CPU, Memory and I/O Devices, Hardware support for Virtualization in Intel x86 processor, CPU Virtualization, Memory Virtualization	
3		**Cloud computing Services and business value**	08
	3.1	XaaS, IaaS, PaaS- Leveraging PaaS for Productivity Languages for PaaS-DBaaS(Database as a services) – SaaS (Software as a service) – Comparison of various cloud computing providers/ Softwares.	
	3.2	Key Business Drivers for CC- Cloud computing and out sourcing – Types of Scalability – Security issues in Cloud Computing- time to Market Benefits-Distribution over Internet – Three levels of Business value from Cloud computing.	

4		**Cloud Deployment Techniques**	07
	4.1	Factors for Successful Cloud Deployment – Network Requirements – Potential Problem areas in a cloud Network and their Mitigation – Cloud Network Topologies – Automation and Self-service feature in a cloud –cloud performance. Mobile Cloud Computing Introduction, Definition, Architecture, Benefits, challenges in mobile and at cloud shield.	
5		**Security**	07
	5.1	Security for Virtualization Platform – Host security for SaaS, 4 PaaS and IaaS – Data Security – Data Security Concerns – Data Confidentiality and Encryption – Data Availability – Data Integrity – Cloud Storage Gateways – Cloud Firewall Security as a service What can security as service offer- Benefits for Security as a service Issues with Security as a Service- Identity Management as a Service	
6		**Architecture for Cloud Application:**	06
	6.1	Cloud Application requirements- Architecture for traditional Vs Cloud Applications Multi-ties Application Architecture SOA for Cloud applications – Resource oriented SOA – Method –oriented SOA and Event Driven SOA – Parallelization within Cloud Applications – Leveraging In memory Operations for Cloud Application.	

Textbooks:	
1	Cloud computing: concepts, Technology and architecture : The Pearson Service Technology Series from Thomas Erl) 1st Edition
2	Cloud computing for Dummies

References:	
1	Rajkumar Buya,' Cloud computing principles and Paradigms', Wiley.
2	Kai Hwang,' Distributed and cloud computing', MK Publications.
3	Cloud computing, black book, Dreamtech publication.
4	Using Google Apps engine O'reilly Publication

Internal Assessment:
Assessment consists of one Mid Term Test of 20 marks and Continuous Assessment of 20 marks. Mid Term test is to be conducted when approx. 50% syllabus is completed Duration of the midterm test shall be one hour.

Continuous Assessment:-
Continuous Assessment **is of 20 marks.** The rubrics for assessment will be considered on approval by the subject teachers. The rubrics can be any 2 or max 4 of the following:-

Sr.no	Rubrics	Marks
1.	*Certificate course for 4 weeks or more:- NPTEL/ Coursera/ Udemy/any MOOC	10 marks
2.	Content beyond syllabus presentation	10 marks
3.	Creating Proof of concept	10 marks
4.	Mini Project / Extra Experiments/ Virtual Lab / Competitive programming-based event / Group Discussion	10 marks
5.	Multiple Choice Questions (Quiz)	5 marks
6.	GATE Based Assignment /Tutorials etc	10 marks

For sr.no.1, the date of certification exam should be within the term and in case a student is unable to complete the certification , the grading has to be done accordingly.

End Semester Theory Examination:

1	Question paper will be of 60 marks
2	Question paper will have a total of five questions
3	All questions have equal weightage and carry 20 marks each
4	Any three questions out of five needs to be solved.

Course Code	Course Name	Credit
ADC502	Web Development	03

Pre-requisite:	
Course Objectives: The course aims:	
1	To orient students to Web Programming fundamental.
2	To expose students to JavaScript to develop interactive web page development
3	To orient students to Basics of REACT along with installation
4	To expose students to node.js applications using express framework
5	To orient students to Fundamentals of node.js
6	To expose students to Advanced concepts in REACT
Course Outcomes:	
1	Select protocols or technologies required for various web applications
2	Apply JavaScript to add functionality to web pages. .
3	Design front end application using basic React. .
4	Construct web based Node.js applications using Express
5	Design front end applications using functional components of React.
6	Design back-end applications using Node.js

Module		Detailed Content	Hours
1		**Web programming fundamentals**	
	1.1	Working of web browser, HTTP protocol, HTTPS, DNS, TLS, XML introduction, Json introduction, DOM, URL, URI, REST API	6
2		**Javascript**	8
	2.1	Introduction to JavaScript: JavaScript language constructs, Objects in JavaScript- Built in, Browser objects and DOM objects, event handling, form validation and cookies.Introduction to ES5,ES6, Difference between ES5 and E S6. Variables, Condition, Loops, Functions, Events, Arrow functions, Setting CSS Styles using JavaScript, DOM manipulation, Classes and Inheritance. Iterators andGenerators, Promise, Client-server communication, Fetch	
3		**React Fundamentals**	10
	3.1	Installation, Installing libraries, Folder and file structure, Components, Component lifecycle, State and Props, React Router and Single page applications, UI design, Forms, Events, Animations, Best practices.	
4		**Node.js**	5
	4.1	Environment setup, First app, Asynchronous programming, Callback concept,Event loops, REPL, Event emitter, Networking module, Buffers, Streams, Filesystem, Web module.	
5		Express	5
	5.1	Introduction, Express router, REST API, Generator, Authentication,sessions,	

		Integrating with React	
6		**Advance React**	5
	6.1	Functional components- Refs, Use effects, Hooks, Flow architecture, Model-ViewController framework, Flux, Bundling the application. Webpack.	

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

References:

1	–Web Development with Node and Express, Ethan Brown, O'Reilly
2	HTML5 Cookbook, By Christopher Schmitt, Kyle Simpson, O'Reilly Media
3	Core Python Applications Programming by Wesley J Chun Third edition Pearson Publication

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Useful Links	
1	https://www.coursera.org/learn/html-css-javascript-for-web-developers?action=enroll
2	ttps://onlinecourses.swayam2.ac.in/ugc19_lb05/preview
3	https://reactjs.org/tutorial/tutorial.html
4	https://nptel.ac.in/courses/106105183

Course Code	Course Name	Credit
ADC503	Artificial Intelligence	03

Pre-requisite: C Programming	
Course Objectives: The course aims:	
1	To gain perspective of AI and its foundations.
2	To study different agent architectures and properties of the environment
3	To understand the basic principles of AI towards problem solving, inference, perception, knowledge representation, and learning.
4	To investigate probabilistic reasoning under uncertain and incomplete information.
5	To explore the current scope, potential, limitations, and implications of intelligent systems
Course Outcomes: **After successful completion of the course students will be able to:**	
1	Identify the characteristics of the environment and differentiate between various agent architectures.
2	Apply the most suitable search strategy to design problem solving agents.
3	Represent a natural language description of statements in logic and apply the inference rules to design Knowledge Based agents.
4	Apply a probabilistic model for reasoning under uncertainty.
5	Comprehend various learning techniques.
6	Describe the various building blocks of an expert system for a given real word problem.

Module		Detailed Content	Hours
1		**Introduction to Artificial Intelligence**	3
	1.1	Artificial Intelligence (AI), AI Perspectives: Acting and Thinking humanly, Acting and Thinking rationally	
	1.2	History of AI, Applications of AI, The present state of AI, Ethics in AI	
2		**Intelligent Agents**	4
	2.1	Introduction of agents, Structure of Intelligent Agent, Characteristics of Intelligent Agents	
	2.2	Types of Agents: Simple Reflex, Model Based, Goal Based, Utility Based Agents.	
	2.2	Environment Types: Deterministic, Stochastic, Static, Dynamic, Observable, Semi-observable, Single Agent, Multi Agent	
3		**Solving Problems by Searching**	12
	3.1	Definition, State space representation, Problem as a state space search, Problem formulation, Well-defined problems	
	3.2	Solving Problems by Searching, Performance evaluation of search strategies,Time Complexity, Space Complexity, Completeness, Optimality	

	3.3	Uninformed Search: Depth First Search, Breadth First Search, Depth Limited Search, Iterative Deepening Search, Uniform Cost Search, Bidirectional Search	
	3.4	Informed Search: Heuristic Function, Admissible Heuristic, Informed Search Technique, Greedy Best First Search, A* Search, Local Search: Hill Climbing Search, Simulated Annealing Search.	
	3.5	Game Playing, Adversarial Search Techniques, Mini-max Search, Alpha-BetaPruning	
4		**Knowledge and Reasoning**	10
	4.1	Definition and importance of Knowledge, Issues in Knowledge Representation, Knowledge Representation Systems, Properties of Knowledge Representation Systems	
	4.2	Propositional Logic (PL),Predicate Logic: FOPL, Syntax, Semantics, Quantification, Inference rules inFOPL,	
	4.3	Forward Chaining, Backward Chaining and Resolution in FOPL	
	4.4	Ontological Engineering Categories and Objects, Events, Reasoning Systems for Categories.	
5		**Reasoning Under Uncertainty**	5
		Handling Uncertain Knowledge, Random Variables, Prior and Posterior Probability, Inference using Full Joint Distribution	
		Bayes' Rule and its use, Bayesian Belief Networks, Reasoning in Belief Networks	
6		**Planning and Learning**	5
	6.1	The planning problem, Partial order planning, total order planning.	
	6.2	Learning in AI, Learning Agent, Concepts of Supervised, Unsupervised, Semi -Supervised Learning, Reinforcement Learning, Ensemble Learning.	
		Total	39

Textbooks:	
1	Stuart J. Russell and Peter Norvig, 'Artificial Intelligence A Modern Approach —Second Edition' Pearson Education.
2	Elaine Rich and Kevin Knight —Artificial Intelligence‖ Third Edition, Tata McGraw-Hill Education Pvt. Ltd., 2008.
3	George F Luger –Artificial Intelligence Low Price Edition, Pearson Education., Fourth edition.
References:	
1	Ivan Bratko —PROLOG Programming for Artificial Intelligence, Pearson Education, Third Edition.
2	D. W. Patterson, Artificial Intelligence and Expert Systems, Prentice Hall.
3	Saroj Kaushik –Artificial Intelligence, Cengage Learning.
4	Davis E. Goldberg, –Genetic Algorithms: Search, Optimization and Machine Learning, Addison Wesley, N.Y., 1989.
5	Patrick Henry Winston, –Artificial Intelligence, Addison-Wesley, Third Edition.
6	N. P. Padhy, –Artificial Intelligence and Intelligent Systems, Oxford University Press.

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1	An Introduction to Artificial Intelligence - Course (nptel.ac.in)
2	NPTEL
3	https://www.classcentral.com/course/independent-elements-of-ai-12469
4	https://tinyurl.com/ai-for-everyone

Course Code	Course Name	Credit
ADC504	Data Warehousing and Mining	03

Pre-requisite: Database Management concepts	
Course Objectives: The course aims:	
1	To create awareness of how enterprise can organize and analyze large amounts of data by creating a Data Warehouse
2	To introduce the concept of data Mining as an important tool for enterprise data management and as a cutting edge technology for building competitive advantage.
3	To enable students to effectively identify sources of data and process it for data mining
4	To make students well versed in all data mining algorithms, methods of evaluation
5	To impart knowledge of tools used for data mining,and study web mining
Course Outcomes:	
1	Organize strategic data in an enterprise and build a data Warehouse.
2	Analyze data using OLAP operations so as to take strategic decisions and Demonstrate an understanding of the importance of data mining.
3	Organize and Prepare the data needed for data mining using pre preprocessing techniques
4	Implement the appropriate data mining methods like classification, clustering or Frequent Pattern mining on large data sets.
5	Define and apply metrics to measure the performance of various data mining algorithms
6	Understand Concepts related to Web mining

Module		Detailed Content	Hours
1		**Data Warehouse and OLAP**	
		Data Warehousing, Dimensional Modeling and OLAP The Need for Data Warehousing; Data Warehouse Defined; Benefits of Data Warehousing ; Features of a Data Warehouse; Data Warehouse Architecture; Data Warehouse and Data Marts; Data Warehousing Design Strategies. Dimensional Model Vs ER Model; The Star Schema, The Snowflake Schema; Fact Tables and Dimension Tables; Fact less Fact Table; Updates To Dimension Tables, Primary Keys, Surrogate Keys & Foreign Keys; Aggregate Tables; Fact Constellation Schema or Families of Star Need for Online Analytical Processing; OLTP vs OLAP; OLAP Operations in a cube: Roll-up, Drilldown, Slice, Dice, Pivot ; OLAP Models: MOLAP, ROLAP, HOLAP. Major steps in ETL Process	9
2		**Introduction to Data Mining ,Data Exploration and Data Preprocessing**	8

		Data Mining Task primitives,Architecture,KDD process,Issues in data Mining,Types of Attributes; Statistical Description of Data; Data Visualization; Measuring similarity and dissimilarity. Why Preprocessing? Data Cleaning; Data Integration; Data Reduction: Attribute subset selection, Histograms, Clustering and Sampling; Data Transformation & Data Discretization: Normalization, Binning, Histogram Analysis and Concept hierarchy generation.	
3		**Classification**	6
		Basic Concepts; Classification methods: 1. Decision Tree Induction: Attribute Selection Measures, Tree pruning. 2. Bayesian Classification: Naïve Bayes' Classifier Accuracy and Error measures,Precision, Recall.Rule based classifier	
4		**Clustering**	4
		Cluster Analysis: Basic Concepts; Partitioning Methods: K-Means, K Mediods; Hierarchical Methods: Agglomerative, Divisive, DBSCAN outlier analysis Types, Challenges; Outlier Detection Methods: Supervised, Semi Supervised, Unsupervised, Proximity based, Clustering Based	
5		**Frequent Pattern**	8
		Market Basket Analysis, Frequent Item sets, Closed Item sets, and Association Rules; Frequent Pattern Mining, Efficient and Scalable Frequent Itemset Mining Methods, The Apriori Algorithm for finding Frequent Item sets Using Candidate Generation, Generating Association Rules from Frequent Item sets, Improving the Efficiency of Apriori, A pattern growth approach for mining Frequent Item sets; Mining Frequent item sets using vertical data formats; **Introduction to Mining Multilevel Association** Rules and Multidimensional Association Rules; From Association Mining to Correlation Analysis, lift, ; Introduction to Constraint-Based Association Mining	
6		**Web Mining**	4
		Introduction to Web content Mining, Crawlers, Personalization, Web structure mining, Page rank,, Clever, Web Usage Mining	

Textbooks:	
1	Han, Kamber, 'Data Mining Concepts and Techniques', Morgan Kaufmann 3nd Edition
2	P. N. Tan, M. Steinbach, Vipin Kumar, –Introduction to Data Mining, Pearson Education.
3	Paulraj Ponniah, –Data Warehousing: Fundamentals for IT Professionals, Wiley India.
4	Raghu Ramakrishnan and Johannes Gehrke, –Database Management Systems 3rd Edition - McGraw Hill
5	Elmasri and Navathe, –Fundamentals of Database Systems, 6th Edition, PEARSON Education

References:	
1	Theraja Reema, –Data Warehousing, Oxford University Press, 2009
2	Ralph Kimball, Margy Ross, –The Data Warehouse Toolkit: The Definitive Guide To Dimensional Modeling, 3rd Edition. Wiley India.

3	Michael Berry and Gordon Linoff –Mastering Data Mining- Art & science of CRM, Wiley Student Edition
4	Michael Berry and Gordon Linoff –Data Mining Techniques, 2nd Edition Wiley Publications

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Useful Links	
1	https://www.coursera.org/learn/data-warehousing-business-intelligence
2	https://www.coursera.org/specializations/data-mining-foundations-practice
3	https://onlinecourses.nptel.ac.in/noc20_cs12/preview
4	https://nptel.ac.in/courses/106105174

Course Code	Course Name	Credit
ADLO5011	Statistics for Artificial Intelligence Data Science	03

Prerequisite: C Programming	
Course Objectives: The course aims:	
1	To Perform exploratory analysis on the datasets
2	To Understand the various distribution and sampling
3	To Perform Hypothesis Testing on datasets
4	To Explore different techniques for Summarizing Data
5	To Perform the Analysis of Variance
6	To Explore Linear Least Squares
Course Outcomes: Learner will be able to	
1	Illustrate Exploratory Data Analysis
2	Describe Data and Sampling Distributions
3	Solve Statistical Experiments and Significance Testing
4	Demonstrate Summarizing Data
5	Interpret the Analysis of Variance
6	Use Linear Least Squares

Prerequisite: Discrete Structures and Graph Theory

Module		Detailed Content	Hours
1		**Exploratory Data Analysis**	5
	1.1	Elements of Structured Data ,Further Reading ,Rectangular Data ,Data Frames and Indexes ,Nonrectangular Data Structures , Estimates of Location ,Mean ,Median and Robust Estimates , Estimates of Variability, Standard Deviation and Related Estimates, Estimates Based on Percentiles , Exploring the Data Distribution ,Percentiles and Boxplots ,Frequency Tables and Histograms ,Density Plots and Estimates.	
	1.2	Exploring Binary and Categorical Data,Mode, Expected Value, Probability, Correlation, Scatterplots ,Exploring Two or More Variables ,Hexagonal Binning andContours (Plotting Numeric Versus Numerical Data) ,Two Categorical Variables, Categorical and Numeric Data ,Visualizing Multiple Variables.	
2		**Data and Sampling Distributions**	6
	2.1	Random Sampling and Sample Bias ,Bias ,Random Selection ,Size Versus Quality, Sample Mean Versus Population Mean ,Selection Bias ,Regression to the Mean, Sampling Distribution of a Statistic ,Central Limit Theorem ,Standard Error ,TheBootstrap ,Resampling Versus Bootstrapping .	
	2.2	Confidence Intervals, Normal Distribution, Standard Normal and QQ-Plots, Long-Tailed Distributions ,Student‘s t-Distribution ,Binomial Distribution ,Chi-SquareDistribution ,F-Distribution, Poisson Distributions.	
3		**Statistical Experiments and Significance Testing**	8
	3.1	A/B Testing ,Hypothesis Tests ,The Null Hypothesis ,Alternative Hypothesis ,One-WayVersus Two-Way Hypothesis Tests ,Resampling ,Permutation Test, Statistical Significance and p-Values ,p-Value ,Alpha ,Type 1 and Type 2 Error	

	3.2	Data Science and p-Values, t-Tests, Multiple Testing, Degrees of Freedom ANOVA F-Statistic, Two-Way ANOVA.	
4		**Summarizing Data**	6
	4.1	Methods Based on the Cumulative Distribution Function, The Empirical Cumulative Distribution Function, The Survival Function, Quantile-Quantile Plots, Histograms, Density Curves, and Stem-and-Leaf Plots, Measures of Location.	
	4.2	The Arithmetic Mean ,The Median , The Trimmed Mean , M Estimates , Comparison of Location Estimates, Estimating Variability of Location Estimates by the Bootstrap, Measures of Dispersion , Boxplots , Exploring Relationships with Scatterplots .	
5		**The Analysis of Variance**	6
	5.1	The One-Way Layout, Normal Theory; the F Test, The Problem of Multiple Comparisons, A Nonparametric Method—The Kruskal-Wallis Test, The Two-WayLayout , Additive Parametrization , Normal Theory for the Two-Way Layout Randomized Block Designs , A Nonparametric Method—Friedman's Test .	
6		**Linear Least Squares**	8
	6.1	Simple Linear Regression, Statistical Properties of the Estimated Slope and Intercept , Assessing the Fit , Correlation and Regression , The Matrix Approach to Linear Least Squares , Statistical Properties of Least Squares Estimates , Vector-Valued Random Variables , Mean and Covariance of Least Squares Estimates , Estimation of $\sigma 2$, Residuals and Standardized Residuals , Inference about β , Multiple Linear Regression—An Example	

Textbooks:	
1	Bruce, Peter, and Andrew Bruce. Practical statistics for data scientists: 50 essential concepts. Reilly Media,2017.
2	Mathematical Statistics and Data Analysis John A. Rice University of California, Berkeley,Thomson HigherEducation
References:	
1	Dodge, Yadolah, ed. Statistical data analysis and inference. Elsevier, 2014.
2	Ismay, Chester, and Albert Y. Kim. Statistical Inference via Data Science: A Modern Dive into R and theTidyverse. CRC Press, 2019.
3	Milton. J. S. and Arnold. J.C., 'Introduction to Probability and Statistics', Tata McGraw Hill, 4th Edition,2007.
4	Johnson. R.A. and Gupta. C.B., 'Miller and Freund's Probability and Statistics for Engineers', PearsonEducation, Asia, 7th Edition, 2007.
5	A. Chandrasekaran, G. Kavitha, ―Probability, Statistics, Random Processes and Queuing Theory, DhanamPublications, 2014.

Internal Assessment:

Assessment consists of one Mid Term Test of 20 marks and Continuous Assessment of 20 marks. Mid Term test is to be conducted when approx. 50% syllabus is completed Duration of the midterm test shall be one hour.

Continuous Assessment:-

Continuous Assessment **is of 20 marks.** The rubrics for assessment will be considered on approval by the subject teachers. The rubrics can be any 2 or max 4 of the following:-

Sr.no	Rubrics	Marks
1.	*Certificate course for 4 weeks or more:- NPTEL/ Coursera/ Udemy/any MOOC	10 marks
2.	Content beyond syllabus presentation	10 marks
3.	Creating Proof of concept	10 marks
4.	Mini Project / Extra Experiments/ Virtual Lab / Competitive programming-based event / Group Discussion	10 marks
5.	Multiple Choice Questions (Quiz)	5 marks
6.	GATE Based Assignment /Tutorials etc	10 marks

*For sr.no.1, the date of certification exam should be within the term and in case a student is unable to complete the certification , the grading has to be done accordingly.

End Semester Theory Examination:

1	Question paper will be of 60 marks
2	Question paper will have a total of five questions
3	All questions have equal weightage and carry 20 marks each
4	Any three questions out of five needs to be solved.

Useful Links	
1	https://www.edx.org/course/introduction-probability-science-mitx-6-041x-2
2	https://www.coursera.org/learn/statistical-inference
3	https://www.datacamp.com/community/open-courses/statistical-inference-and-data-analysis

Course Code	Course Name	Credit
ADL05012	**Advanced Algorithms**	**03**

Pre-requisite:	
Course Objectives: The course aims:	
1	To provide mathematical approaches for problem solving using advanced concepts of Algorithms
2	To understand and solve problems using various algorithmic approaches like Randomized algorithms, approximation algorithms, Local search and Amortized algorithms.
3	To discuss and apply the Combinatorial Analysis techniques to solve various mathematical and statistical problems
Course Outcomes:	
1	Analyze the classification of problems into various NP classes and their Computational Intractability
2	Describe, apply and analyze the complexity of Approximation Algorithms.
3	Describe, apply and analyze the complexity of Randomized Algorithms.
4	Describe, apply and analyze the complexity of Local Search Algorithms.
5	Design and Apply the concepts of String and Amortized Analysis
6	To Understand Combinatorial Analysis techniques

Module		**Detailed Content**	**Hours**
1		**NP and Computational Intractability**	
	1.1	Polynomial-Time Reductions, NP Completeness: Overview, Class P– Class NP – NP Hardness, NP Completeness, Cook Levine Theorem, Characteristics of NP Complete Problems, The Satisfiability Problem, NP-Complete Problems, Sequencing Problems Partitioning Problems, Graph Coloring, Numerical Problems, Co-NP and the Asymmetry of NP, A Partial Taxonomy of Hard Problems. Reduction of standard NP Complete Problems: SAT, 3SAT, Clique, Vertex Cover, Set Cover, Hamiltonian Cycle.	8
2		**Approximation Algorithms**	9

	2.1	Approximation algorithms for known NP hard problems, Inapproximability, Approximation algorithms with small additive error: Edge Coloring, Bin Packing, Randomized rounding and linear programming, Problems having polynomial approximation schemes, Optimization problems with constant-factor approximations, Hard-to-approximate problems, Analysis of Approximation Algorithms.	
3		**Randomized Algorithms**	9
	3.1	Introduction to randomized algorithm, Finding the Global Minimum Cut, Random Variables and Their Expectations, A Randomized Approximation Algorithm for MAX 3-SAT, Randomized Divide and Conquer: Median-Finding and Quicksort, Hashing: A Randomized Implementation of Dictionaries, Finding the Closest Pair of Points: A Randomized Approach, Randomized Caching, Chernoff Bounds, Load Balancing, Packet Routing, Las Vegas Algorithm, Monte Carlo Algorithm.	
4		**Local Search**	5
	4.1	The Landscape of an Optimization Problem, The Metropolis Algorithm and Simulated Annealing, An Application of Local Search to Hopfield Neural Networks, Maximum-Cut Approximation via Local Search, Choosing a Neighbour Relation, Classification via Local Search, Best-Response Dynamics and Nash Equilibria.	
5		**String and Amortized Analysis**	4
	5.1	String Sort, Tries, Substring Search, Regular Expressions, Data Compression, String Matching Algorithms: Introduction to String matching, The Knuth-Morris-Pratt algorithm, Aho- Korasik algorithm, Z-algorithm, Amortized Analysis: Aggregate analysis, The accounting method, The potential method Dynamic tables.	
6		Combinatorial Analysis	4
	6.1	Introduction, Next subset of n-Set problems, Random Subset of n-Setproblems, Sequencing, Ranking and selection algorithms for general combinatorial families.	

Textbooks:

1	Jon Kleinberg, Eva Tardos, –Algorithm Design, Cornell University, Pearson Publications
2	Robert Sedgewick, Kevin Wayne, –Algorithms, Princeton, fourth edition, AddisonWessely.
3	Thomas H. Cormen , Charles E., Ronald l., Clifford Stein, –Introduction to Algorithms,Third Edition, The MIT Press Cambridge.

4	Albert Nijenhuis, Herbert Wilf, –Combinatorial Algorithms for computers and calculators,Second edition, Academic Press
5	George Heineman, Gary Pollice, Stanley Selkow, –Algorithms in a Nutshell, Oreilly Press.
References:	
1	Anany Levitin, Introduction to The design and analysis of algorithms, 3rd Edition, Pearson publication.
2	Peter J. Cameron, –Combinatorics: Topics, Techniques, Algorithms, Cambridge University Press

Internal Assessment:
Assessment consists of one Mid Term Test of 20 marks and Continuous Assessment of 20 marks. Mid Term test is to be conducted when approx. 50% syllabus is completed Duration of the midterm test shall be one hour.

Continuous Assessment:-
Continuous Assessment **is of 20 marks.** The rubrics for assessment will be considered on approval by the subject teachers. The rubrics can be any 2 or max 4 of the following:-

Sr.no	Rubrics	Marks
1.	*Certificate course for 4 weeks or more:- NPTEL/ Coursera/ Udemy/any MOOC	10 marks
2.	Content beyond syllabus presentation	10 marks
3.	Creating Proof of concept	10 marks
4.	Mini Project / Extra Experiments/ Virtual Lab / Competitive programming-based event / Group Discussion	10 marks
5.	Multiple Choice Questions (Quiz)	5 marks
6.	GATE Based Assignment /Tutorials etc	10 marks

*For sr.no.1, the date of certification exam should be within the term and in case a student is unable to complete the certification , the grading has to be done accordingly.

End Semester Theory Examination:

1	Question paper will be of 60 marks
2	Question paper will have a total of five questions
3	All questions have equal weightage and carry 20 marks each
4	Any three questions out of five needs to be solved.

Useful Links	
1	https://www.binghamton.edu/watson/continuing-education/data-science/advanced-algorithms.html
2	https://nptel.ac.in/courses/106104019
3	https://www.coursera.org/learn/advanced-algorithms-and-complexity

Course Code	Course Name	Credit
ADLO5013	Computer Graphics	03

Prerequisite: Knowledge of C Programming and Basic Mathematics**.**	
Course Objectives	
1	To equip students with the fundamental knowledge and basic technical competence in thefield of Computer Graphics.
2	To emphasize on implementation aspect of Computer Graphics Algorithms.
3	To prepare the student for advance areas and professional avenues in the field of Computer Graphics
Course Outcomes: At the end of the course, the students should be able to	
1	Describe the basic concepts of Computer Graphics.
2	Demonstrate various algorithms for basic graphics primitives.
3	Apply 2-D geometric transformations on graphical objects.
4	Use various Clipping algorithms on graphical objects
5	Explore 3-D geometric transformations, curve representation techniques and projectionsmethods.
6	Explain visible surface detection techniques and Animation.

Module		Detailed Content	Hours
1		**Introduction and Overview of Graphics System:**	**02**
	1.1	Definition and Representative uses of computer graphics, Overview of coordinate system, Definition of scan conversion, rasterization and rendering.	
	1.2	Raster scan & random scan displays, Architecture of raster graphics system with display processor, Architecture of random scan systems.	
2		**Output Primitives:**	**10**
	2.1	Scan conversions of point, line, circle and ellipse: DDA algorithm and Bresenham algorithm for line drawing, midpoint algorithm for circle, midpoint algorithm for ellipse drawing (Mathematical derivation for above algorithms is expected)	
	2.2	Aliasing, Antialiasing techniques like Pre and post filtering, super sampling, and pixel phasing).	
	2.3	Filled Area Primitive: Scan line Polygon Fill algorithm, inside outside tests, Boundary Fill and Flood fill algorithm.	
3		**Two Dimensional Geometric Transformations**	**6**
	3.1	Basic transformations: Translation, Scaling, Rotation	
	3.2	Matrix representation and Homogeneous Coordinates	
	3.3	Composite transformation	
	3.4	Other transformations: Reflection and Shear	
4		**Two-Dimensional Viewing and Clipping**	**7**
	4.1	Viewing transformation pipeline and Window to Viewport coordinate transformation	

	4.2	Clipping operations: Point clipping, Line clipping algorithms: Cohen-Sutherland, Liang: Barsky, Polygon Clipping Algorithms: Sutherland-Hodgeman, Weiler-Atherton.	
5		**Three Dimensional Geometric Transformations, Curves andFractal Generation**	**8**
	5.1	3D Transformations: Translation, Rotation, Scaling and Reflection	
	5.2	Composite transformations: Rotation about an arbitrary axis	
	5.3	Projections – Parallel, Perspective. (Matrix Representation)	
	5.4	Bezier Curve, B-Spline Curve, Fractal-Geometry: Fractal Dimension, Koch Curve.	
6		Visible Surface Detection and Animation	6
	6.1	Visible Surface Detection: Classification of Visible Surface Detection algorithm, Back Surface detection method, Depth Buffer method, Area Subdivision method	
	6.2	Animation: Introduction to Animation, Traditional Animation Techniques, Principles of Animation, Key framing: Character and Facial Animation, Deformation, Motion capture.	

Textbooks:	
1	Hearn & Baker, 'Computer Graphics C version', 2nd Edition, Pearson Publication
2	James D. Foley, Andries van Dam, Steven K Feiner, John F. Hughes, 'Computer Graphics Principles and Practice in C', 2nd Edition, Pearson Publication
3	Samit Bhattacharya, 'Computer Graphics', Oxford Publication
References:	
1	D. Rogers, 'Procedural Elements for Computer Graphics', Tata McGraw-Hill Publications.
2	Zhigang Xiang, Roy Plastock, 'Computer Graphics', Schaum's Outlines McGraw-HillEducation
3	Rajesh K. Maurya, 'Computer Graphics', Wiley India Publication.
4	F. S. Hill, 'Computer Graphics using OpenGL', Third edition, Pearson Publications.

Internal Assessment:
Assessment consists of one Mid Term Test of 20 marks and Continuous Assessment of 20 marks. Mid Term test is to be conducted when approx. 50% syllabus is completed Duration of the midterm test shall be one hour.

Continuous Assessment:-
Continuous Assessment **is of 20 marks.** The rubrics for assessment will be considered on approval by the subject teachers. The rubrics can be any 2 or max 4 of the following:-

Sr.no	Rubrics	Marks
1.	*Certificate course for 4 weeks or more:- NPTEL/ Coursera/ Udemy/any MOOC	10 marks
2.	Content beyond syllabus presentation	10 marks
3.	Creating Proof of concept	10 marks
4.	Mini Project / Extra Experiments/ Virtual Lab / Competitive programming-based event / Group Discussion	10 marks
5.	Multiple Choice Questions (Quiz)	5 marks
6.	GATE Based Assignment /Tutorials etc	10 marks

*For sr.no.1, the date of certification exam should be within the term and in case a student is unable to complete the certification , the grading has to be done accordingly.

End Semester Theory Examination:

1	Question paper will be of 60 marks
2	Question paper will have a total of five questions
3	All questions have equal weightage and carry 20 marks each
4	Any three questions out of five needs to be solved.

Useful Links	
1	https://www.classcentral.com/course/interactivegraphics-2067
2	https://swayam.gov.in/nd2_ntr20_ed15/preview
3	https://nptel.ac.in/courses/106/106/106106090/
4	https://www.edx.org/course/computer-graphics-2

Lab Code	Lab Name	Credit
ADL501	**Web Development Lab**	**1**

Prerequisite: Operating System, Basics of Java and Python Programming.	
Lab Objectives:	
1	To orient students to HTML for making webpages
2	To expose students to CSS for formatting web pages
3	To expose students to developing responsive layout
4	To expose students to JavaScript to make web pages interactive
5	To orient students to React for developing front end applications
6	To orient students to Node.js for developing backend applications
Lab Outcomes:	
1	Identify and apply the appropriate HTML tags to develop a webpage
2	Identify and apply the appropriate CSS tags to format data on webpage
3	Construct responsive websites using Bootstrap
4	Use JavaScript to develop interactive web pages.
5	Construct front end applications using React and back end using Node.js/express

Suggested Experiments: Students are required to complete at least 10 experiments.	
Star (*) marked experiments are compulsory.	
Sr. No.	**Name of the Experiment**
1	HTML:Elements, Attributes, Head, Body, Hyperlink, Formatting, Images, Tables, List, Frames, Forms, Multimedia
2	CSS3.Syntax, Inclusion, Color, Background, Fonts, Tables, lists,CSS3 selectors, Pseudo classes, Pseudo elements .
3	Bootstrap:BootstrapGrid system, Forms, Button, Navbar, Breadcrumb, Jumbotron
4	Javascript:Variables, Operators, Conditions, Loops,
5	Java Script : FunctionsValidations, Arrays, String, Date
6	Java Script :Events, Classes and Objects, Error handling,
7	React:Installation and Configuration. JSX, Components, Props, State, Forms, Events, Routers, Refs, Keys.
8	Advance React: Concepts and Practical.

Useful Links:	
1	www.leetcode.com
2	www.hackerrank.com
3	www.cs.usfca.edu/~galles/visualization/Algorithms.html
4	www.codechef.com

Term Work:	
1	Term work should consist of 8(min) to 12(max) experiments.
2	The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work.
3	Total 25 Marks based on evaluation of Experiments.
Evaluation exam	
	Practical Exam based on lab syllabus of ADL501

Lab Code	Lab Name	Credit
ADL502	Artificial Intelligence Lab	1

Prerequisite: C Programming Language.	
Lab Objectives:	
1	To design suitable Agent Architecture for a given real world AI problem
2	To implement knowledge representation and reasoning in AI language
3	To design a Problem-Solving Agent
4	To incorporate reasoning under uncertainty for an AI agent
Lab Outcomes: **At the end of the course, students will be able to —-**	
1	Identify suitable Agent Architecture for a given real world AI problem
2	Implement simple programs using Prolog.
3	Implement various search techniques for a Problem-Solving Agent.
4	Represent natural language description as statements in Logic and apply inference rules to it.
5	Construct a Bayesian Belief Network for a given problem and draw probabilistic inferences from it

Suggested Experiments: Students are required to complete at least 10 experiments.

Sr. No	Name of the Experiment
1.	Write simple programs using PROLOG as an AI programming Language
2.	Implement any one of the Uninformed search techniques
3.	Implement any one of the Informed search techniques E.g. A-Star algorithm for 8 puzzle problem
4.	Implement adversarial search using min-max algorithm.
5.	Implement any one of the Local Search techniques. E.g. Hill Climbing, Simulated Annealing, Genetic algorithm
6.	Define an ontology in first-order logic for tic-tac-toe/ building Pizza ontology
7.	Create a Bayesian Network for the given Problem Statement and draw inferences from it. (You can use any Belief and Decision Networks Tool for modeling Bayesian Networks)
8.	Implement a Planning Agent
9.	Design a prototype of an AI based Game
10.	Case study of any existing successful AI system

Useful Links:	
1	An Introduction to Artificial Intelligence - Course (nptel.ac.in)
2	https://tinyurl.com/ai-for-everyone
3	https://ai.google/education/
4	https://openai.com/research/
5	https://protege.stanford.edu/publications/ontology_development/ontology101-noy-mcguinness.html

Term Work:	
1	Term work should consist of 8(min) to 12(max) experiments.
2	The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work.
3	Total 25 Marks based on evaluation of Experiments.
Evaluation Exam	
	Practical Exam based on lab syllabus of ADL502

Lab Code	Lab Name	Credit
ADL503	Data warehousing and Mining Lab	1

Prerequisite: Java and Python Programming.	
Lab Objectives:	
1	To create awareness of how enterprise can organize and analyze large amounts of data by creating a Data Warehouse
2	To introduce the concept of data Mining as an important tool for enterprise data management and as a cutting edge technology for building competitive advantage
3	To enable students to effectively identify sources of data and process it for data mining
4	To make students well versed in all data mining algorithms, methods, and tools..
Lab Outcomes:	
1	Build a data warehouse
2	Analyze data using OLAP operations so as to take strategic decisions.
3	Demonstrate an understanding of the importance of data mining
4	Organize and Prepare the data needed for data mining using pre preprocessing techniques
5	Perform exploratory analysis of the data to be used for mining.
6	Implement the appropriate data mining methods like classification, clustering or Frequent Pattern mining on large data sets.

Suggested Experiments: Students are required to complete all experiments from the list given below.

Sr. No.	Name of the Experiment
1	Data Warehouse Construction a) Real life Problem to be defined for Warehouse Design b) Construction of star schema and snow flake schema c) ETL Operations.
2	Construction of Cubes , OLAP Operations, OLAP Queries
3	Tutorials a) Solving exercises in Data Exploration b) Solving exercises in Data preprocessing
4	Using open source tools Implement Classifiers
5	Using open source tools Implement Association Mining Algorithms
6	Using open source tools Implement Clustering Algorithms
7	Implementation of any one classifier using languages like JAVA/ python
8	Implementation of any one clustering algorithm using languages like JAVA/ python
9	Implementation of any one association mining algorithm using languages like JAVA/ python .

Useful Links:	
1	www.leetcode.com
2	www.hackerrank.com
3	www.cs.usfca.edu/~galles/visualization/Algorithms.html
4	www.codechef.com

Term Work:	
1	Term work should consist of 8(min) to 12(max) experiments.
2	The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work.
3	Total 25 Marks based on evaluation of Experiments.
Evaluation Exam	
	Practical Exam based on lab syllabus of ADL503

Course Code	Course Name	Credit
ADL504	Professional Communication and Ethics-II	02

Prerequisite: Professional Communication and Ethics-I	
Course Objectives:	
1	To discern and develop an effective style of writing important technical/business documents.
2	To investigate possible resources and plan a successful job campaign.
3	To understand the dynamics of professional communication in the form of group discussions, meetings, etc. required for career enhancement.
4	To develop creative and impactful presentation skills.
5	To analyze personal traits, interests, values, aptitudes and skills.
6	To understand the importance of integrity and develop a personal code ofethics.
Course Outcomes:	
1	Plan and prepare effective business/ technical documents which will inturn provide solid foundation for their future managerial roles.
2	Strategize their personal and professional skills to build a professionalimage and meet the demands of the industry.
3	Emerge successful in group discussions, meetings and result-orientedagreeable solutions in group communication situations.
4	Deliver persuasive and professional presentations.
5	Develop creative thinking and interpersonal skills required for effective professional communication.
6	Apply codes of ethical conduct, personal integrity and norms of organizational behaviour.

Module		Topics	Hours
1		**Advanced technical writing : project/problem based learning (pbl)**	

	1.1	**Purpose and Classification of Reports: Classification on the basis of:** • Subject Matter (Technology, Accounting, Finance, Marketing,etc.) • Time Interval (Periodic, One-time, Special) • Function (Informational, Analytical, etc.) • Physical Factors (Memorandum, Letter, Short & Long	**6**
	1.2	**Parts of a Long Formal Report:** • Prefatory Parts (Front Matter) • Report Proper (Main Body) • Appended Parts (Back Matter)	
	1.3	**Language and Style of Reports** • Tense, Person & Voice of Reports • Numbering Style of Chapters, Sections, Figures, Tables and • Equations • Referencing Styles in APA & MLA Format • Proofreading through Plagiarism Checkers	
	1.4	**Definition, Purpose & Types of Proposals** • Solicited (in conformance with RFP) & Unsolicited Proposals • Types (Short and Long proposals)	
	1.5	**Parts of a Proposal** • Elements • Scope and Limitations • Conclusion	
2		**EMPLOYMENT SKILLS**	**6**
	2.1	**Cover Letter & Resume** • Parts and Content of a Cover Letter • Difference between Bio-data, Resume & CV • Essential Parts of a Resume • Types of Resume (Chronological, Functional & Combination)	
	2.2	**Statement of Purpose** • Importance of SOP • Tips for Writing an Effective SOP	
	2.3	**Group Discussions** • Purpose of a GD • Parameters of Evaluating a GD • Types of GDs (Normal, Case-based & Role Plays) • GD Etiquettes	
	2.4	**Personal Interviews** • Planning and Preparation • Types of Questions • Types of Interviews (Structured, Stress, Behavioural, Problem • Solving & Case-based) • Modes of Interviews: Face-to-face (One-to one and Panel) • Telephonic, Virtual	

3		**BUSINESS MEETINGS**	**2**
	3.1	**Conducting Business Meetings** □ Types of Meetings □ Roles and Responsibilities of Chairperson, Secretary andMembers □ Meeting Etiquette	
	3.2	**Documentation** • Notice • Agenda • Minutes	
4		**TECHNICAL/ BUSINESS PRESENTATIONS**	**2**
	4.1	**Effective Presentation Strategies** □ Defining Purpose □ Analyzing Audience, Location and Event □ Gathering, Selecting &Arranging Material □ Structuring a Presentation □ Making Effective Slides □ Types of Presentations Aids □ Closing a Presentation □ Platform skills	
	4.2	**Group Presentations** □ Sharing Responsibility in a Team □ Building the contents and visuals together □ Transition Phases	
5		**INTERPERSONAL SKILLS**	**8**
	5.1	**Interpersonal Skills** □ Emotional Intelligence □ Leadership & Motivation □ Conflict Management & Negotiation □ Time Management □ Assertiveness □ Decision Making	
6		**CORPORATE ETHICS**	**2**
		6.1 Intellectual Property Rights • Copyrights • Trademarks • Patents • Industrial Designs	
		Case Studies • Cases related to Business/ Corporate Ethics	
		Total	**26**

Textbooks:	
1	Fred Luthans, 'Organisational Behavior' , McGraw Hill, edition
2	Robbins Stephen judge timothy 'Organisational Behavior' Pearson
3	R.C Sharma and Krishna Mohan, 'Business Correspondence and Report Writing'
4	Foundation course in Human values and Professional Ethics L R R Gaur, R. Asthana, G.P.Bagaria
Reference Books:	
1	Lesiker and Petit, 'Report Writing for Business' , McGraw Hill, edition
2	Wallace and Masters, 'Personal Development for Life and Work' , Thomson Learning,12th edition
3	B N Ghosh, 'Managing Soft Skills for Personality Development', Tata McGraw Hill.Lehman,

Internal Assessment:

Internal assessment will be for 50 Marks as given below

Sr No	Headings		Marks
A	Assignments		10 Marks
B	Continuous Assessment		20 Marks
C	a)Report	10 Marks	10 Marks
	b)Presentation	10 Marks	
D	Group Discussion		10 Marks
	Total		50 Marks

A) Assignments: List of assignments are as given below. The assignments have to be discussed in the group and approach approved by faculty. Each student in the group willhave to write the assignments individually (10 Marks)

Sr No	List of Assignments
1.	Proposal
2.	Resume and Cover Letter /SOP
3.	Notice ,Agenda and Minutes of Meeting
4	Case Study /Role Play on Interpersonal Skills
5	Case study on Ethics

B) Continuous Assessment:-

Continuous Assessment **is of 20 marks.** The rubrics for assessment will be considered on approval by the subject teachers. The rubrics can be any 2 or max 4 of the following:-

Sr.no	Rubrics	Marks
1.	*Certificate course for 4 weeks or more:- NPTEL/ Coursera/ Udemy/any MOOC	10 marks
2.	Content beyond syllabus presentation	10 marks
3.	Creating Proof of concept	10 marks
4.	Mini Project / Extra Experiments/ Virtual Lab / Competitive programming-based event / Group Discussion	10 marks

5.	Multiple Choice Questions (Quiz)	5 marks
6.	GATE Based Assignment /Tutorials etc	10 marks

C) Report on presentation: A detail typed report has to be prepared of minimum 25 pagesand maximum 30 pages in the given format.

D) A final Group Discussion Round will be conducted and every student must participate inthe group discussion

Tutorials will be conducted batch wise*

Lab Code	Lab Name	Credit
ADS501	Skill Based Lab course: Cloud Computing	2

Prerequisite: Computer Networks	
Lab Objectives:	
1	To make students familiar with key concepts of virtualization.
2	To make students familiar with various deployment models of cloud such as private, public, hybrid and community so that they start using and adopting appropriate types of cloud for their application.
3	To make students familiar with various service models such as IaaS, SaaS, PaaS, Security as a Service (SECaaS) and Database as a Service.
4	To make students familiar with security and privacy issues in cloud computing and how to address them.
Lab Outcomes:	
1	Implement different types of virtualization techniques.
2	Analyze various cloud computing service models and implement them to solve the given problems.
3	Design and develop real world web applications and deploy them on commercial cloud(s).
4	Explain major security issues in the cloud and mechanisms to address them.
5	Explore various commercially available cloud services and recommend the appropriate one for the given application.
6	Implement the concept of containerization

Lab:

1	**Title:** To study and Implement Infrastructure as a Service using AWS/Microsoft Azure. **Objective:** To demonstrate the steps to create and run virtual machines inside a Public cloud platform. This experiment should emphasize on creating and running Linux/Windows Virtual machines inside Amazon EC2 or Microsoft Azure Compute and accessing them using RDP or VNC tools.	4
2	**Title:** To study and Implement Platform as a Service using AWS Elastic Beanstalk/ Microsoft Azure App Service. **Objective:** To demonstrate the steps to deploy Web applications or Web services written in different languages on AWS Elastic Beanstalk/ Microsoft Azure App Service.	4

3	To study and Implement Storage as a Service using Own Cloud/ AWS S3, Glaciers/ Azure Storage.	2
4	To study and Implement Database as a Service on SQL/NOSQL databases like AWS RDS, AZURE SQL/ MongoDB Lab/ Firebase.	2
5	**Title:** To study and Implement Security as a Service on AWS/Azure **Objective:** To understand the Security practices available in public cloud platforms and to demonstrate various Threat detection, Data protection and Infrastructure protection services in AWS and Azure.	3
6	**Title:** To study and implement Identity and Access Management (IAM) practices on AWS/Azure cloud. **Objective:** To understand the working of Identity and Access Management IAM in cloud computing and to demonstrate the case study based on Identity and Access Management (IAM) on AWS/Azure cloud platform.	2
7	**Title:** To study and Implement Containerization using Docker **Objective:** To know the basic differences between Virtual machine and Container. It involves demonstration of creating, finding, building, installing, and running Linux/Windows application containers inside a local machine or cloud platform.	4
8	**Title:** To study and implement container orchestration using Kubernetes **Objective:** To understand the steps to deploy Kubernetes Cluster on local systems, deploy applications on Kubernetes, creating a Service in Kubernetes, develop Kubernetes configuration files in YAML and creating a deployment in Kubernetes using YAML,	2
9	**Mini-project:** Design a Web Application hosted on a public cloud platform [It should cover the concept of IaaS, PaaS, DBaaS, Storage as a Service, Security as a Service etc.]	4

Suggested Experiments: Students are required to complete the above experiments.	
Sr. No.	**Assignment**
1	Assignment based on selection of suitable cloud platform solution based on requirement analysis considering given problem statement
2	Assignment on recent trends in cloud computing and related technologies
3	Assignment on comparative study of different computing technologies [Parallel, Distributed, Cluster, Grid, Quantum)
4	Comparative study of different hosted and bare metal Hypervisors with suitable parameters along with their use in public/private cloud platform
5	Assignment on explore and compare the similar type of services provided by AWS and Azure [Any ten services]

Useful Links:	
1	https://docs.aws.amazon.com/
2	https://docs.microsoft.com/en-us/azure
3	https://kubernetes.io/docs/home/
4	https://docs.docker.com/get-started/

Term Work:	
1	Term work should consist of 8(min) to 12(max) experiments.
2	The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work.
3	Total 50 Marks (Experiments: 30 Marks , Mini Project: 10, Assingnment:10)

Course Code	Course Name	Credit
ADC601	Data Analytics and Visualization	03

Prerequisite: Basic statistics and Maths, Python programming	
Course Objectives: The course aims:	
1	To Introduce the concept of Data Analytics Lifecycle.
2	To Develop Mathematical concepts required for advance regression.
3	To Understand data modeling in time series and its process.
4	To create awareness about Text analytics and its applications.
5	To provide overview of Data analytics and visualization with R.
6	To provide overview of Data analytics and visualization with Python.
Course Outcomes: After successful completion of the course students will be able to:	
1	Comprehend basics of data analytics and visualization.
2	Apply various regression models on given data set and perform prediction.
3	Demonstrate advance understanding of Time series concepts and analysis of data using various time series models.
4	Analyze Text data and gain insights.
5	Experiment with different analytics techniques and visualization using R.
6	Experiment with different analytics techniques and visualization using Python.

Module		Detailed Content	Hours
1		**Introduction to Data analytics and life cycle**	5
	1.1	Data Analytics Lifecycle overview:Key Roles for a Successful Analytics, Background and Overview of Data Analytics Lifecycle Project **Phase 1**: Discovery: Learning the Business Domain, Resources Framing the Problem, Identifying Key Stakeholders. Interviewing the Analytics Sponsor, Developing Initial Hypotheses Identifying Potential Data Sources **Phase 2**: Data Preparation: Preparing the Analytic Sandbox, Performing ETLT, Learning About the Data, Data Conditioning, Survey and visualize, Common Tools for the Data Preparation Phase **Phase 3**: Model Planning: Data Exploration and Variable Selection, Model Selection ,Common Tools for the Model Planning Phase **Phase 4**: Model Building: Common Tools for the Model Building Phase **Phase 5:** Communicate Results **Phase 6:** Operationalize	
2		**Regression Models**	6

	2.1	Introduction to SLR and MLR model, polynomial regression models; interaction models; qualitative predictor variables. Model selection procedures Leverage; influence measures; diagnostics. Weighted least squares; ridge regression; loess regression; bootstrapping.	
	2.2	Logistic Regression: Logistic Response function and logit, Logistic Regression and GLM, Generalized Linear model, Predicted values from Logistic Regression, Interpreting the coefficients and odds ratios, Linear and Logistic Regression: similarities and Differences, Assessing the models.	
3		**Time Series**	7
		Definition of time series, Times series forecasting. Time series components, Decomposition – additive and multiplicative. Exponential smoothing, Holt winters method. Time Series Analysis - Box-Jenkins Methodology, ARIMA Model Autocorrelation Function (ACF, PACF) Autoregressive Models ,Moving Average Models ,ARMA and ARIMA Models , Building and Evaluating an ARIMA Model.	
4		**Introduction to Data Visualization**	8
	4.1	Acquiring and Visualizing Data, Simultaneous acquisition and visualization, Applications of Data Visualization, Keys factors of Data Visualization , Exploring the Visual Data Spectrum: charting Primitives (Data Points, Line Charts, Bar Charts, Pie Charts, Area Charts), Exploring advanced Visualizations (Candlestick Charts, Bubble Charts, Surface Charts, Map Charts) ; Narrative visualization and digital story Telling ,infographics and interactive dashboards	
5		**Introduction to D3.js:**	7
	5.1	Getting setup with D3, Making selections, changing selection's attribute, Loading and filtering External data : Building a graphic that uses all of the population distribution data, Data formats you can use with D3, Creating a server to upload your data, D3's function for loading data, Dealing with Asynchronous requests, Loading and formatting Large Data Sets	
6		**Data analytics and Visualization with Python**	6
	6.1	Essential Data Libraries for data analytics: Pandas, NumPy, SciPy. Plotting and visualization with python: Introduction to Matplotlib, Basic Plotting with Matplotlib, Create Histogram, Bar Chart, Pie Chart, Box Plot, violin plot using Matplotlib, Matrix charts and heat maps.	
	6.2	Introduction to seaborne Library, Multiple Plots, Regression plot, replot. Discover and visualize the data to gain insights, Feature scaling and Transformation pipelines	
		Total	39

Textbooks:	
1	Data Science and Big Data Analytics: Discovering, Analyzing, Visualizing and Presenting Data,EMC Education services Wiley Publication
2	Data Analytics using Python: Bharati Motwani, Wiley Publications.

3	Forecasting : methods and applications- Spyros G Makridakis, Steven C wheelwright, Rob J Hyndman, 3rd edition Wiley publications
4	Practical Text Mining and statistical Analysis for non-structured text data applications,1st edition,Grey Miner,Thomas Hill.
5	Ritchie S. King, Visual story telling with D3' Pearson
References:	
1	Data Mining, Concepts and Techniques: 3rd edition, Jiawei Han, Micheline Kamber and Jian Pei
2	Python for Data Analysis: 3rd Edition, Wes McKinney ,Publisher(s): O'Reilly Media, Inc.
3	Ben Fry, 'Visualizing data: Exploring and explaining data with the processing environment', O'Reilly, 2008.

Internal Assessment:
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Continuous Assessment:-
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4.	Mini Project / Extra Experiments/ Virtual Lab / Competitive programming-based event / Group Discussion	10 marks
5.	Multiple Choice Questions (Quiz)	5 marks
6.	GATE Based Assignment /Tutorials etc	10 marks

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End Semester Theory Examination:	
1	Question paper will be of 60 marks
2	Question paper will have a total of five questions
3	All questions have equal weightage and carry 20 marks each
4	Any three questions out of five needs to be solved.

Useful Links	
1	http://varianceexplained.org/RData/
2	https://www.kaggle.com/code/iamleonie/time-series-interpreting-acf-and-pacf
3	https://www.geeksforgeeks.org/data-visualization-using-matplotlib/

Course Code	Course Name	Credit
ADC602	Cryptography and System Security	03

Pre-requisite: Basic concepts of OSI Layer	
Course Objectives: The course aims:	
1	The concepts of classical encryption techniques and concepts of finite fields and number theory.
2	To explore the working principles and utilities of various cryptographic algorithms including secret key cryptography, hashes and message digests, and public key algorithms
3	To explore the design issues and working principles of various authentication protocols, PKI standards.
4	To explore various secure communication standards including Kerberos, IPsec, and SSL/TLS and email.
5	The ability to use existing cryptographic utilities to build programs for secure communication.
6	The concepts of cryptographic utilities and authentication mechanisms to design secure Applications
Course Outcomes:	
1	Identify information security goals, classical encryption techniques and acquire fundamental knowledge on the concepts of finite fields and number theory.
2	Understand, compare and apply different encryption and decryption techniques to solve problems related to confidentiality and authentication
3	Apply the knowledge of cryptographic checksums and evaluate the performance of different message digest algorithms for verifying the integrity of varying message sizes
4	Apply different digital signature algorithms to achieve authentication and create secure applications .
5	Apply network security basics, analyze different attacks on networks and evaluate the performance of firewalls and security protocols like SSL, IPSec, and PGP
6	Apply the knowledge of cryptographic utilities and authentication mechanisms to design secure applications

Module		Detailed Content	Hours
1		**Introduction & Number Theory**	
	1.1	Services, Mechanisms and attacks-the OSI security architecture-Network security model-Classical Encryption techniques (Symmetric cipher model, mono-alphabetic and poly-alphabetic substitution techniques: Vignere cipher, playfair cipher, Hill cipher, transposition techniques: keyed and keyless transposition ciphers, steganography).	7
2		**Block Ciphers & Public Key Cryptography**	7
	2.1	Data Encryption Standard-Block cipher principles-block cipher modes of operationAdvanced Encryption Standard (AES)-Triple DES-Blowfish-RC5 algorithm. Public key cryptography: Principles of public key cryptosystems-The RSA algorithm, The knapsack algorithm, El-Gamal Algorithm. Key management – Diffie Hellman Key exchange	

3		**Cryptographic Hashes, Message Digests and Digital Certificates**	7
	3.1	Authentication requirement – Authentication function,Typesof Authentication, MAC – Hash function – Security of hash function and MAC –MD5 – SHA – HMAC – CMAC, Digital Certificate: X.509, PKI	
4		**Digital signature schemes and authentication Protocols**	6
	4.1	Digital signature and authentication protocols : Needham Schroeder Authentication protocol, Digital Signature Schemes – RSA .	
5		**System Security**	6
		Operating System Security: Memory and Address Protection, File Protection Mechanism, User Authentication. Linux and Windows: Vulnerabilities, File System Security Database Security: Database Security Requirements, Reliability and Integrity, Sensitive Data, Inference Attacks, Multilevel Database Security	
6		**Web security**	**6**
	6.1	Web Security Considerations, User Authentication and Session Management, Cookies, SSL, HTTPS, SSH, Web Browser Attacks, WebBugs, Clickjacking, CrossSite Request Forgery, Session Hijacking and Management, Phishing Technique, DNS Attack, Secure Electronic Transaction, Email Attacks, Firewalls, Penetration Testing	

Textbooks:	
1	Computer Security Principles and Practice, William Stallings, Sixth Edition, Pearson Education
2	Security in Computing, Charles P. Pfleeger, Fifth Edition, Pearson Education
3	Network Security and Cryptography, Bernard Menezes, Cengage Learning
4	Network Security Bible, Eric Cole, Second Edition, Wiley
5	Mark Stamp‘s Information Security Principles and Practice, Wiley

References:	
1	Web Application Hackers Handbook by Wiley.
2	Computer Security, Dieter Gollman, Third Edition, Wiley
3	CCNA Security Study Guide, Tim Boyle, Wiley
4	Introduction to Computer Security, Matt Bishop, Pearson. 5.
5	Cloud Security and Privacy, Tim Mather, Subra Kumaraswamy, Shahed Latif , O‘Riely
6	Cryptography and Network Security, Atul Kahate, Tata Mc Graw Hill

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Continuous Assessment:-
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1.	*Certificate course for 4 weeks or more:- NPTEL/ Coursera/ Udemy/any MOOC	10 marks
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3.	Creating Proof of concept	10 marks
4.	Mini Project / Extra Experiments/ Virtual Lab / Competitive programming-based event / Group Discussion	10 marks
5.	Multiple Choice Questions (Quiz)	5 marks
6.	GATE Based Assignment /Tutorials etc	10 marks

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End Semester Theory Examination:	
1	Question paper will be of 60 marks
2	Question paper will have a total of five questions
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Useful Links	
1	https://nptel.ac.in/courses/106105031
2	https://onlinecourses.nptel.ac.in/noc22_cs03/preview
3	https://www.coursera.org/learn/basic-cryptography-and-crypto-api

Course Code	Course Name	Credit
ADC603	Software Engineering and Project Management	03

Pre-requisite: None	
Course Objectives: The course aims:	
1	To provide the knowledge of software engineering discipline.
2	To understand Requirements and analyze it
3	To do planning and apply scheduling
4	To apply analysis, and develop software solutions
5	To demonstrate and evaluate real time projects with respect to software engineering principles and Apply testing and assure quality in software solution.
6	To understand need of project management and project management life cycle.
Course Outcomes:	
1	Understand and use basic knowledge in software engineering.
2	Identify requirements, analyze and prepare models.
3	Plan, schedule and track the progress of the projects.
4	Design & develop the software solutions for the growth of society
5	Apply testing and assure quality in software solutions
6	Generate project schedule and can construct, design and develop network diagram for different type of Projects. They can also organize different activities of project

Module		Detailed Content	Hours
1		**Introduction to Software Engineering**	
		Nature of Software, Software Engineering, Software Process, Capability Maturity Model (CMM) Generic Process Model, Prescriptive Process Models: The Waterfall Model, V-model, Incremental Process Models, Evolutionary Process Models, Concurrent Models, Agile process, Agility Principles, Extreme Programming (XP), Scrum, Kanban model	08
2		**Requirements Analysis and Cost Estimation**	06
	2.1	Software Requirements: Functional & non-functional – user-system requirement engineering process – feasibility studies – elicitation – validation & management – software prototyping – S/W documentation – Analysis and modelling Requirement Elicitation, Software requirement specification (SRS) 3Ps (people, product and process) Process and Project metrics Software Project Estimation: LOC, FP, Empirical Estimation Models - COCOMO II Model	
3		**Design Engineering**	07

	3.1	Design Process & quality, Design Concepts, The design Model, Pattern-based Software Design. 4.2 Architectural Design :Design Decisions, Views, Patterns, Application Architectures, Modeling Component level Design: component, Designing class based components, conducting component-level design, User Interface Design: The golden rules, Interface Design steps & Analysis, Design Evaluation	
4		**Software Risk, Configuration Management**	05
	4.1	Risk Identification, Risk Assessment, Risk Projection, RMMM Software Configuration management, SCM repositories, SCM process Software Quality Assurance Task and Plan, Metrics, Software Reliability, Formal Technical Review (FTR), Walkthrough.	
5		**Software Testing and Maintenance**	05
	5.1	Testing: Software Quality, Testing: Strategic Approach, Strategic Issues-Testing: Strategies for Conventional Software, Object oriented software, Web AppsValidating Testing- System Testing- Art of Debugging. Maintenance : Software Maintenance-Software Supportability-Reengineering- Business Process Reengineering- Software Reengineering-Reverse Engineering- Restructuring- Forward Engineering.	
6		**IT Project Management and Project Scheduling**	08
	6.1	Introduction, 4 P‘s, W5HH Principle, Need for Project Management, Project Life cycle and ITPM, Project Feasibility, RFP, PMBOK Knowledge areas, Business Case, Project Planning, Project Charter and Project Scope.	
	6.2	Project Scheduling:Defining a Task Set for the Software Project, Timeline chartsWBS, Developing the Project Schedule, Network Diagrams (AON, AOA), CPM and PERT, Gantt Chart , Tracking the Schedule, Earned Value Analysis	

Textbooks:	
1	Roger S. Pressman, Software Engineering: A practitioner's approach, McGraw Hill
2	Rajib Mall, Fundamentals of Software Engineering, Prentice Hall India
3	John M. Nicholas, Project Management for Business and Technology, 3rd edition, Pearson Education.
References:	
1	–Software Engineering : A Precise Approach Pankaj Jalote , Wiley India
2	Ian Sommerville — Software Engineering 9th edition Pearson Education SBN-13: 978-0- 13-703515-1, ISBN-10: 0-13-703515-2
3	PankajJalote, An integrated approach to Software Engineering, Springer/Narosa.

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Useful Links	
1	https://onlinecourses.swayam2.ac.in/cec21_cs21/preview
2	https://nptel.ac.in/courses/106101061
3	http://www.nptelvideos.com/video.php?id=911&c=9 4

Course Code	Course Name	Credit
ADC604	Machine Learning	03

Pre-requisite: Data Structures, Basic Probability and Statistics, Algorithms	
Course Objectives: The course aims:	
1	To introduce Machine learning concepts
2	To develop mathematical concepts required for Machine learning algorithms
3	To understand various Regression techniques
4	To understand Clustering techniques
5	To develop Neural Network based learning models
Course Outcomes: **After successful completion of the course students will be able to:**	
1	Comprehend basics of Machine Learning
2	Build Mathematical foundation for machine learning
3	Understand various Machine learning models
4	Select suitable Machine learning models for a given problem
5	Build Neural Network based models
6	Apply Dimensionality Reduction techniques

Module		Detailed Content	Hours
1		**Introduction to Machine Learning**	6
	1.1	Introduction to Machine Learning, Issues in Machine Learning, Application of Machine Learning, Steps of developing a Machine Learning Application.	
		Supervised and Unsupervised Learning: Concepts of Classification, Clustering and prediction, Training, Testing and validation dataset, cross validation, overfitting and underfitting of model	
		Performance Measures: Measuring Quality of model- Confusion Matrix, Accuracy, Recall, Precision, Specificity, F1 Score, RMSE	
2		**Mathematical Foundation for ML**	5
	2.1	System of Linear equations, Norms, Inner products, Length of Vector, Distance between vectors, Orthogonal vectors	
	2.2	Symmetric Positive Definite Matrices, Determinant, Trace, Eigenvalues and vectors, Orthogonal Projections, Diagonalization, SVD and its applications	
3		**Linear Models**	7
	3.1	The least-squares method, Multivariate Linear Regression, Regularized Regression, Using Least-Squares Regression for classification	
	3.2	Support Vector Machines	
4		**Clustering**	4
	4.1	Hebbian Learning rule	

	4.2	Expectation -Maximization algorithm for clustering	
5		**Classification models**	10
	5.1	Introduction, Fundamental concept, Evolution of Neural Networks, Biological Neuron, Artificial Neural Networks, NN architecture, McCulloch-Pitts Model. Designing a simple network, Non-separable patterns, Perceptron model with Bias. Activation functions, Binary, Bipolar, continuous, Ramp. Limitations of Perceptron.	
	5.2	Perceptron Learning Rule. Delta Learning Rule (LMS-Widrow Hoff), Multi-layer perceptron network. Adjusting weights of hidden layers. Error back propagation algorithm.	
	5.3	Logistic regression	
6		**Dimensionality Reduction**	07
	6.1	Curse of Dimensionality.	
	6.2	Feature Selection and Feature Extraction	
	6.3	Dimensionality Reduction Techniques, Principal Component Analysis.	

Textbooks:	
1	Nathalie Japkowicz & Mohak Shah, –Evaluating Learning Algorithms: A Classification Perspective, Cambridge.
2	Marc Peter Deisenroth, Aldo Faisal, Cheng Soon Ong, –Mathematics for machine learning,
3	Samir Roy and Chakraborty, –Introduction to soft computing, Pearson Edition.
4	Ethem Alpaydın, –Introduction to Machine Learning, MIT Press McGraw-Hill Higher Education
5	Peter Flach, –Machine Learning, Cambridge University Press
References:	
1	Tom M. Mitchell, –Machine Learning, McGraw Hill
2	Kevin P. Murphy, –Machine Learning — A Probabilistic Perspective, MIT Press
3	Stephen Marsland, –Machine Learning an Algorithmic Perspective, CRC Press
4	Shai Shalev-Shwartz, Shai Ben-David, –Understanding Machine Learning, Cambridge University Press
5	Peter Harrington, –Machine Learning in Action, DreamTech Press

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Continuous Assessment:-
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5.	Multiple Choice Questions (Quiz)	5 marks
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1	Question paper will be of 60 marks
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Useful links:	
1	NPTEL
2	AI and ML Certification - Enroll in PGP AI ML Courses with Purdue (simplilearn.com)
3	https://www.learndatasci.com/out/coursera-machine-learning/
4	https://www.learndatasci.com/out/google-machine-learning-crash-course/

CourseCode	Course Name	Credit
ADLO6011	High Performance Computing	03

Pre-requisite: Computer Organization, C Programming, Data structures and Algorithm Analysis.

Course Objectives: The course aims:

1	Learn the concepts of high-performance computing.
2	Gain knowledge of platforms for high performance computing.
3	Design and implement algorithms for parallel programming applications.
4	Analyze the performance metrics of High Performance Computing.
5	Understand the parallel programming paradigm, algorithms and applications.
6	Demonstrate the understanding of different High Performance Computing tools

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

1	Understand the fundamentals of parallel Computing.
2	Describe different parallel processing platforms involved in achieving High PerformanceComputing.
3	Demonstrate the principles of Parallel Algorithms and their execution.
4	Evaluate the performance of HPC systems.
5	Apply HPC programming paradigm to parallel applications
6	Discuss different current HPC Platforms.

Module		Detailed Content	Hours
1		**Introduction to Parallel Computing:**	**05**
	1.1	Motivating Parallelism, Scope of Parallel Computing, Levels of parallelism (instruction,transaction, task, thread, memory, function), Models (SIMD, MIMD, SIMT, SPMD, Dataflow Models, Demand- drivenComputation).	

2		Parallel Programming Platforms	**04**
	2.1	Implicit Parallelism: Dichotomy of Parallel Computing Platforms, Physical Organization of Parallel Platforms, Communication Costs in Parallel Machines.	
3		Parallel Algorithm And Concurrency	**09**
	3.1	Preliminaries, Decomposition Techniques, Characteristics of Tasks and Interactions, Mapping Techniques for Load Balancing. Basic Communication Operation.	
4		Performance Measures for HPC	**05**
	4.1	**Performance Measures :** Speedup, execution time, efficiency,cost, scalability, Effect of granularity on performance, Scalability of Parallel Systems, Amdahl‘s Law, Gustavson‘s Law.	
5		Programming Paradigms for HPC	**09**
	5.1	Principles of Message Passing Programming, The BuildingBlocks: Send and Receive Operations, MPI: the Message Passing Interface, Topology and Embedding. One-Dimensional Matrix-Vector Multiplication, Graph Algorithms, Sample Sort, Two-Dimensional Matrix Vector Multiplication	
6		GPU Architecture and Programming	**05**
	6.1	OpenCL Device Architectures, Introduction to OpenCL Programming.	

Textbooks:	
1	AnanthGrama, Anshul Gupta, George Karypis, Vipin Kumar , –Introduction to Parallel Computing, Pearson Education, Second Edition, 2007.
2	Kai Hwang, Naresh Jotwani, –Advanced Computer Architecture: Parallelism, Scalability, Programmability, McGraw Hill, Second Edition, 2010
3	Edward Kandrot and Jason Sanders, –CUDA by Example – An Introduction to General Purpose GPU Programming, Addison-Wesley Professional ©, 2010.
4	Georg Hager, Gerhard Wellein, –Introduction to High Performance Computing for Scientists and Engineers', Chapman & Hall / CRC Computational Science series, 2011.
5	Benedict Gaster, Lee Howes, David Kaeli, Perhaad Mistry, Dana Schaa ,–Heterogeneous Computing with OpenCL , 2nd Edition, Elsevier, 2012.
References:	
1	Michael J. Quinn, –Parallel Programming in C with MPI and OpenMP, McGraw-Hill International Editions, Computer Science Series, 2008.
2	Kai Hwang, Zhiwei Xu, –Scalable Parallel Computing: Technology, Architecture, Programming, McGraw Hill, 1998.
3	Stephen Marsland, –Machine Learning an Algorithmic Perspective, CRC Press
4	Laurence T. Yang, MinyiGuo, –High- Performance Computing: Paradigm and Infrastructure Wiley, 2006.
5	Fayez Gebali, –Algorithms and Parallel Computing, John Wiley & Sons, Inc., 2011.

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End Semester Theory Examination:	
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4	Any three questions out of five needs to be solved.

Useful links:	
1	https://onlinecourses.nptel.ac.in/noc21_cs46/preview
2	https://onlinecourses.nptel.ac.in/noc22_cs21/preview

Course Code	Course Name	Credit
ADLO6012	Distributed Computing	03

Pre-requisite: C Programming	
Course Objectives: The course aims:	
1	To provide students with contemporary knowledge in distributed systems
2	To equip students with skills to analyze and design distributed applications.
3	To provide master skills to measure the performance of distributed synchronization algorithms
4	To equip students with skills to availability of resources
5	To provide master skills to distributed file system
Course Outcomes:	
1	Demonstrate knowledge of the basic elements and concepts related to distributed system technologies.
2	Illustrate the middleware technologies that support distributed applications such as RPC, RMI and Object based middleware.
3	Analyze the various techniques used for clock synchronization and mutual exclusion
4	Demonstrate the concepts of Resource and Process management and synchronization algorithms
5	Demonstrate the concepts of Consistency and Replication Management
6	Apply the knowledge of Distributed File System to analyze various file systems like NFS, AFS and the experience in building large-scale distributed applications

Module		Detailed Content	Hours
1		**Introduction to Distributed Systems**	
	1.1	Characterization of Distributed Systems: Issues, Goals, and Types of distributed systems, Distributed System Models, Hardware concepts, Software Concept.	06
	1.2	Middleware: Models of Middleware, Services offered by middleware, Client Server model.	
2		**Communication**	06
	2.1	Layered Protocols, Interprocess communication (IPC): MPI, Remote Procedure Call (RPC), Remote Object Invocation, Remote Method Invocation (RMI**)**	
	2.2	Message Oriented Communication, Stream Oriented Communication, Group Communication	
3		**Synchronization**	09
	3.1	Clock Synchronization, Physical Clock, Logical Clocks, Election Algorithms, Mutual Exclusion, Distributed Mutual Exclusion-Classification of Mutual Exclusion Algorithm, Requirements of Mutual Exclusion Algorithms, Performance measure.	

	3.2	Non Token based Algorithms: Lamport Algorithm, Ricart–Agrawala‘s Algorithm, Maekawa‘s Algorithm	
	3.3	Token Based Algorithms: Suzuki-Kasami‘s Broadcast Algorithms, Singhal‘s Heuristic Algorithm, Raymond‘s Tree.based Algorithm, Comparative Performance Analysis.	
4		**Resource and Process Management**	06
	4.1	Desirable Features of global Scheduling algorithm, Task assignment approach, Load balancing approach, load sharing approach	
	4.2	Introduction to process management, process migration, Threads, Virtualization, Clients, Servers, Code Migration .	
5		**Consistency, Replication and Fault Tolerance**	06
	5.1	Introduction to replication and consistency, Data-Centric and Client-Centric Consistency Models, Replica Management	
	5.2	Fault Tolerance: Introduction, Process resilience, Reliable client-server and group communication, Recovery	
6		**Distributed File Systems and Name Services**	06
	6.1	Introduction and features of DFS, File models, File Accessing models, File-Caching ,Schemes, File Replication, Case Study: Distributed File Systems (DSF), Network File System (NFS), Andrew File System (AFS), HDFS	

Textbooks:	
1	Andrew S. Tanenbaum and Maarten Van Steen, –Distributed Systems: Principles and Paradigms, 2nd edition, Pearson Education.
2	George Coulouris, Jean Dollimore, Tim Kindberg, , ‘Distributed Systems: Concepts and Design’, 4th Edition, Pearson Education, 2005.
References:	
1	A. S. Tanenbaum and M. V. Steen, ‘Distributed Systems: Principles and Paradigms’, Second Edition, Prentice Hall, 2006.
2	M. L. Liu, –Distributed Computing Principles and Applications, Pearson Addison Wesley, 2004.
3	Learn to Master Distributed Computing by ScriptDemics, StarEdu Solutions

Internal Assessment:
Assessment consists of one Mid Term Test of 20 marks and Continuous Assessment of 20 marks. Mid Term test is to be conducted when approx. 50% syllabus is completed Duration of the midterm test shall be one hour.

Continuous Assessment:-
Continuous Assessment **is of 20 marks.** The rubrics for assessment will be considered on approval by the subject teachers. The rubrics can be any 2 or max 4 of the following:-

Sr.no	Rubrics	Marks
1.	*Certificate course for 4 weeks or more:- NPTEL/ Coursera/ Udemy/any MOOC	10 marks
2.	Content beyond syllabus presentation	10 marks
3.	Creating Proof of concept	10 marks
4.	Mini Project / Extra Experiments/ Virtual Lab / Competitive programming-based event / Group Discussion	10 marks
5.	Multiple Choice Questions (Quiz)	5 marks
6.	GATE Based Assignment /Tutorials etc	10 marks

For sr.no.1, the date of certification exam should be within the term and in case a student is unable to complete the certification , the grading has to be done accordingly.

End Semester Theory Examination:	
1	Question paper will be of 60 marks
2	Question paper will have a total of five questions
3	All questions have equal weightage and carry 20 marks each
4	Any three questions out of five needs to be solved.

Useful Links	
1	https://onlinecourses.nptel.ac.in/noc21_cs87/
2	https://nptel.ac.in/courses/106106168

Course Code:	Course Title	Credit
ADLO6013	Image Processing and computer vision	3

Prerequisite: Engineering Mathematics, Algorithms	
Course Objectives:	
1	To introduce students to the basic concepts of image processing, file formats.
2	To acquire an in-depth understanding of image enhancement technqiues.
3	To gain knowledge of image segmentation and compression techniques.
4	To acquire fundamentals of image transform techniques.
Course Outcomes	
1	To gain fundamental knowledge of Image processing.
2	To apply image enhancement techniques.
3	To apply image segmentation and compression techniques.
4	To gain an in-depth understanding of image transforms.
5	To gain fundamental understanding of video processing.

Module		Content	Hrs
1		**Digital Image Fundamentals**	**04**
	1.1	Introduction to Digital Image, Digital Image Processing System, Sampling and Quantization,	
	1.2	Representation of Digital Image, Connectivity, Image File Formats : BMP, TIFF and JPEG.	
2		**Image Enhancement in Spatial Domain**	**08**
	2.1	**Image Enhancement** (point processing): Image Negative, Thresholding, Gray-level slicing with and without background, power law and log transform, Contrast Stretching, Histogram equalization and Histogram Specification	
	2.2	**Image Enhancement in Spatial Domain** (Neighbourhood processing): Low Pass and High Pass filtering for image enhancement, Basics of Spatial Filtering, Generating Spatial Filter Masks–Smoothing and Sharpening Spatial Filtering	
	2.3	**Image Transforms:** 1-D DFT, 2-D Discrete Fourier Transform and Its Inverse, Some Properties of 2D DFT, Walsh -Hadamard, Discrete Cosine Transform, Haar Transform, Slant Transform	
3		**Image Compression**	**06**
	3.1	Introduction, Redundancy, Fidelity Criteria	
	3.2	Lossless Compression Techniques : Run length Coding, ArithmeticCoding, Huffman Coding	

	3.3	Lossy Compression Techniques: Improved Gray Scale Quantization,Vector Quantization	
4	4.1	**Morphology:** Erosion and Dilation, Opening and Closing, The Hit or-Miss Transformation. Restoration: Noise models – Mean Filters – Order Statistics – Adaptive filters –wiener filter.	**08**
	4.2	**Corner and Interest Point detection:** The Harris Interest Point Operator: Corner Signals and shifts for various geometric configuration, Performance with crossing point and Junctions, Different forms of Harris Operator, Local Invariant Feature Detectors and Descriptors: Harris scale and Affine-Invariant Detectors and Descriptors, The SIFT operators, The SURF operators.	
5	5.1	**Point, Line, and Edge Detection:** Detection of Isolated Points, Line detection, edge models, basic and advance edge detection, Edge linking and boundary detection, Canny's edge detection algorithm **Thresholding:** Foundation, Role of illumination, Basic Global thresholding, Otsu's method Region Based segmentation: Region Growing, Region Splitting and merging, Relationships between pixels, Hough transform	**08**
	5.2	**Region Identification:** Chain code, simple geometric border representation, Fourier Transform of boundaries, Boundary description using segment sequences	
6	6.1	**Motion:** Optical Flow, Interpretation of Optical Fields, Using focus of expansion to avoid collision, Time to adjacency analysis, Basic difficulties with optical flow models, Stero from Motion	**05**
		Total	**39**

Textbooks:	
1	Rafael C. Gonzalez and Richard E. Woods, _Digital Image Processing', Pearson Education Asia, Third Edition, 2009
2	S. Jayaraman, E. Esakkirajan and T. Veerkumar, –Digital Image Processing TataMcGraw Hill Education Private Ltd, 2009
3	Anil K. Jain, —Fundamentals and Digital Image Processing, Prentice Hall of India Private Ltd, Third Edition
4	S. Sridhar, –Digital Image Processing, Oxford University Press, Second Edition, 2012.
5.	Alan C. Bovik, –The Essential Guide To Video Processing Academic Press,
6	Yao Wang, Jorn Ostermann, Ya-Qin Zang, –Video Processing and Communications, Prentice Hall, Signal Processing series.
	References Books
1.	S. Salivahanan, A. Vallavaraj, C. Gnanapriya, 'Digital Signal Processing', Tata McGraw Hill Publication 4th Edition, 2019.
2.	E. R. Davies, 'Computer and Machine Vision: Theory, Algorithms', Academic Press, 4th Edition, 2012.
3	David A. Forsyth, Jean Ponce, –Computer Vision: A Modern Approach, Pearson Education, Limited, 2011

4	Malay K. Pakhira, –Digital Image Processing and Pattern Recognition, Prentice Hall of India Private Ltd, Third Edition

Internal Assessment:
Assessment consists of one Mid Term Test of 20 marks and Continuous Assessment of 20 marks. Mid Term test is to be conducted when approx. 50% syllabus is completed Duration of the midterm test shall be one hour.

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For sr.no.1, the date of certification exam should be within the term and in case a student is unable to complete the certification , the grading has to be done accordingly.

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Useful Links

1	https://swayam.gov.in
2	https://nptel.ac.in/courses
3	https://www.coursera.org

Lab Code	Lab Name	Credit
ADL601	Data Analytics and Visualization Lab	1

Prerequisite: Basic Python	
Lab Objectives:	
1	To effectively use libraries for data analytics.
2	To understand the use of regression Techniques in data analytics applications.
3	To use time series models for prediction.
4	To introduce the concept of text analytics and its applications.
5	To apply suitable visualization techniques using R and Python.
Lab Outcomes: **At the end of the course, students will be able to —-**	
1	Explore various data analytics Libraries in R and Python.
2	Implement various Regression techniques for prediction.
3	Build various time series models on a given data set.
4	Design Text Analytics Application on a given data set.
5	Implement visualization techniques to given data sets using R .
6	Implement visualization techniques to given data sets using Python.

Suggested Experiments: Students are required to complete at least 08 experiments Preferably using **R Programming Language/Python**

Sr. No.	Name of the Experiment
1	Getting introduced to data analytics libraries in Python and R.
2	Simple Linear Regression in Python.
3	Multiple Linear Regression in Python
4	Time Series Analysis in Python
5	Implementation of ARIMA model in python
6	Implementation of Time series Decomposition and ACF and PACF
7,8	Set Up a D3.js Environment, Select Elements in D3, Modify Elements in D3,Data Loading in D3,Create a World Map with d3.js, Event Handling with D3.js
9,10	Two visualization experiments in python using different Libraries.

Useful Links:	
1	https://www.geeksforgeeks.org/data-visualization-with-python
2	https://www.coursera.org/specializations/data-science-python
3	https://www.geeksforgeeks.org/data-visualization-in-r/
5	https://towardsdatascience.com/introduction-to-arima-for-time-series-forecasting-

References:	
1	Data Analytics using R, Bharati Motwani, Wiley Publications
2	Python for Data Analysis: 3rd Edition, WesMcKinney, Publisher(s): O'Reilly Media, Inc.

3	Better Data Visualizations A Guide for Scholars, Researchers, and Wonks, Jonathan Schwabish, Columbia University Press

Term Work:	
1	Term work should consist of 8(min) to 12(max) experiments.
2	The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work.
3	Total 25 Marks based on evaluation of Experiments
Evaluation Exam	
	Practical Exam based on lab syllabus of ADL601

Lab Code	Lab Name	Credit
ADL602	Cryptographic and system security Lab	1

Prerequisite: Operating System, Basics of Java and Python Programming.	
Lab Objectives:	
1	To be able to apply the knowledge of symmetric cryptography to implement simple ciphers
2	To be able to analyze and implement public key algorithms like RSA and El Gamal
3	To analyze and evaluate performance of hashing algorithms
4	To explore the different network reconnaissance tools to gather information about networks .
Lab Outcomes:	
1	Apply the knowledge of symmetric cryptography to implement simple ciphers
2	Analyze and implement public key algorithms like RSA and El Gamal
3	Analyze and evaluate performance of hashing algorithms
4	Explore the different network reconnaissance tools to gather information about networks
5	Use tools like sniffers, port scanners and other related tools for analyzing packets in a network.
6	Apply and set up firewalls and intrusion detection systems using open source technologies and to explore email security.

Suggested Experiments: Students are required to complete at least 10 experiments.	
Star (*) marked experiments are compulsory.	
Sr. No.	**Name of the Experiment**
1*	Design and Implementation of a product cipher using Substitution and Transposition ciphers.
2*	Implementation and analysis of RSA cryptosystem and Digital signature scheme using RSA/El Gamal.
3*	Implementation of Diffie Hellman Key exchange algorithm
4	For varying message sizes, test integrity of message using MD-5, SHA-1, and analyse the performance of the two protocols. Use crypt APIs.
5*	Exploring wireless security tools like Kismet, NetStumbler etc.
6*	Study the use of network reconnaissance tools like WHOIS, dig,traceroute, nslookup to gather information about networks and domain registrars.
7	Study of packet sniffer tools wireshark, :- 1. Observer performance in promiscuous as well as non-promiscuous mode. 2. Show the packets can be traced based on different filters.
8*	Download and install nmap. Use it with different options to scan open ports, perform OS fingerprinting, do a ping scan, tcp port scan, udp port scan, etc. .
9*	Detect ARP spoofing using nmap and/or open source tool ARPWATCH and wireshark
10	Use the NESSUS/ISO Kaali Linux tool to scan the network for vulnerabilities

11	Set up IPSEC under LINUX. b) Set up Snort and study the logs. c) Explore the GPG tool of linux to implement email security.

Useful Links:	
1	www.leetcode.com
2	www.hackerrank.com
3	www.cs.usfca.edu/
4	www.codechef.com

Term Work:	
1	Term work should consist of 8(min) to 12(max) experiments.
2	The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work.
3	Total 25 Marks based on evaluation of Experiments

Lab Code	Lab Name	Credit
ADL603	Software Engineering and Project Management Lab	1

Prerequisite: Knowledge of Linux Operating system, installation and configuration of services and command line basics, Basics of Computer Networks and Software Development Life cycle.	
Lab Objectives:	
1	To understand DevOps practices which aims to simplify Software Development Life Cycle.
2	To be aware of different Version Control tools like GIT, CVS or Mercurial
3	To Integrate and deploy tools like Jenkins and Maven, which is used to build, test and deploy applications in DevOps environment
4	To understand the importance of Jenkins to Build and deploy Software Applications on server environment
5	To use Docker to Build, ship and manage applications using containerization
6	To understand the concept of Infrastructure as a code and install and configure Ansible tool
Lab Outcomes:	
1	To understand the fundamentals of DevOps engineering and be fully proficient with DevOps terminologies, concepts, benefits, and deployment options to meet your business requirements
2	To obtain complete knowledge of the –version control system to effectively track changes augmented with Git and GitHub
3	Understand the importance of Selenium and Jenkins to test Software Applications
4	To understand the importance of Jenkins to Build and deploy Software Applications on server environment
5	To understand concept of containerization and Analyze the Containerization of OS images and deployment of applications over Dockerk.
6	To Synthesize software configuration and provisioning using Ansible.

Suggested Experiments: Students are required to complete at least 10 experiments from the list given below.	
Star (*) marked experiments are compulsory.	
Sr. No.	**Name of the Experiment**
1	To understand DevOps: Principles, Practices, and DevOps Engineer Role and Responsibilities
2	To understand Version Control System / Source Code Management, install git and create a GitHub account
3	To Perform various GIT operations on local and Remote repositories using GIT Cheat-Sheet
4	To understand Continuous Integration, install and configure Jenkins with

	Maven/Ant/Gradle to setup a build Job
5	To Build the pipeline of jobs using Maven / Gradle / Ant in Jenkins, create a pipeline script to Test and deploy an application over the tomcat server.
6	To understand Jenkins Master-Slave Architecture and scale your Jenkins standalone implementation by implementing slave nodes.
7	To Setup and Run Selenium Tests in Jenkins Using Maven.
8	To understand Docker Architecture and Container Life Cycle, install Docker and execute docker commands to manage images and interact with containers
9	To learn Docker file instructions, build an image for a sample web application using Docker file.
10	To install and Configure Pull based Software Configuration Management and provisioning tools using Puppet
11	To learn Software Configuration Management and provisioning using Puppet Blocks(Manifest, Modules, Classes, Function)
12	To provision a LAMP/MEAN Stack using Puppet Manifest.

Useful Links:	
1	https://nptel.ac.in/courses/128106012
2	https://www.edureka.co/devops-certification-training
3	https://www.coursera.org/professional-certificates/devops-and-software-engineering

Term Work:	
1	Term work should consist of 8(min) to 12(max) experiments.
2	The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work.
3	Total 25 Marks based on evaluation of Experiments
Evaluation Exam	
	Practical Exam based on lab syllabus of ADL603

Lab Code	Lab Name	Credit
ADL604	Machine Learning Lab	1

Prerequisite: C Programming Language.	
Lab Objectives:	
1	To introduce platforms such as Anaconda, COLAB suitable to Machine learning
2	To implement various Regression techniques
3	To develop Neural Network based learning models
4	To implement Clustering techniques
Lab Outcomes: **After successful completion of the course students will be able to:**	
1	Implement various Machine learning models
2	Apply suitable Machine learning models for a given problem
3	Implement Neural Network based models
4	Apply Dimensionality Reduction techniques

Suggested Experiments: Students are required to complete at least 10 experiments.	
Sr. No.	**Name of the Experiment**
1	Introduction to platforms such as Anaconda, COLAB
2	Study of Machine Learning Libraries and tools (Python library, tensorflow, keras,...)
	Implementation of following algorithms for a given example data set-
3	Linear Regression.
4	Logistic Regression.
5	Support Vector Machines
6	Hebbian Learning
7	Expectation -Maximization algorithm
8	McCulloch Pitts Model.
9	Single Layer Perceptron Learning algorithm
10	Error Backpropagation Perceptron Training Algorithm
11	Principal Component Analysis
12	Applications of above algorithms as a case study (E.g. Hand Writing Recognition using MNIST data set, classification using IRIS data set, etc)

Useful Links:	
1	https://www.learndatasci.com/out/edx-columbia-machine-learning/
2	https://www.learndatasci.com/out/oreilly-hands-machine-learning-scikit-learn-keras-and-tensorflow-2nd-edition/
3	https://www.learndatasci.com/out/google-machine-learning-crash-course/

4	https://www.learndatasci.com/out/edx-columbia-machine-learning/

Term Work:	
1	Term work should consist of 8(min) to 12(max) experiments.
2	The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work.
3	Total 25 Marks based on evaluation of Experiments
Evaluation Exam	
	Practical Exam based on lab syllabus of ADL604

Course Code	Course Name	Credits
ADL601	Skill based Lab: R Programming / Tableau	02

Prerequisite:	
Lab Objectives:	
1	To understand and identify the problem
2	To apply basic engineering fundamentals and attempt to find solutions to the problems.
3	Identify, analyze, formulate and handle programming projects with a comprehensive and systematic approach
Lab Outcomes: **At the end of the course, students will be able to —-**	
1	Identify Methodology for solving above problem and apply engineering knowledge and skills to solve it
2	Analyze and evaluate the impact of solution/product/research/innovation /entrepreneurship towards societal/environmental/sustainable development
3	Identify Methodology for solving above problem and apply engineering knowledge and skills to solve it

R Programming	
1	Introduction: Installing R on personal machines. installing R and RStudio. • The basic functionality of R will be demonstrated, Variable types in R. Numeric variables, strings and factors. • Accessing the help system. Retrieving R packages. • Basic data types and operations: numbers, characters and composites. • Data entry and exporting data
2	Data structures: vectors, matrices, lists and data frames.
3	R as a programming language:Grouping, loops and conditional execution, Functions Exploratory data analysis Range, summary, mean, variance, median, standard deviation, histogram, box plot, scatterplot
4	Graphics in R • Graphics and tables • Working with larger datasets • Building tables with aggregate • Introduction to ggplot2 graphics
5	Regression and correlation • Simple regression and correlation Multiple regression • Tabular data and analysis of Categorical Data
6	R for Data Science (Mini Project) Implementing a mini project using any data mining or big data analytics algorithm in R • Extracting data from a large Dataset • Exploratory analysis • Using Mining algorithm • Visualizations and interpretation of Results

Tableau	
1	**Tableau Basic** :Connecting to Excel Files Connecting to Text Files , Connect to Microsoft SQL Server , Connecting to Microsoft Analysis Services ,Creating and Removing Hierarchies , Bins , Joining Tables , Data Blending
2	**Learn Tableau Basic Reports** : Parameters , Grouping Example 1 , Grouping Example 2 ,Edit Groups , Set , Combined Sets • Creating a First Report , Data Labels • Create Folders , Sorting Data , Add Totals, Sub Totals and Grand Totals to Report
3	**Learn Tableau Charts** : Area Chart ,Bar Chart , Box Plot , Bubble Chart , Bump Chart , Bullet Graph , Circle Views , Dual Combination Chart , Dual Lines Chart , Funnel Chart , Traditional Funnel Charts , Gantt Chart , Grouped Bar or Side by Side Bars Chart , Heat map , Highlight Table , Histogram , Cumulative Histogram • Line Chart
4	**Learn Tableau Calculations & Filters** : Calculated Fields ,Basic Approach to Calculate Rank , Advanced Approach to Calculate Rank , Calculating Running Total, Filters Introduction , Quick Filters , Filters on Dimensions , Conditional Filters ,Top and Bottom Filters , Filters on Measures , Context Filters , Slicing Filters , Data Source Filters , Extract Filters
5	**Learn Tableau Dashboards** : Create a Dashboard , Format Dashboard Layout , Create a Device preview of dashboard. Create Filters on Dashboard , Dashboard Objects , Create a Story

Term Work:	
1	Term work should consist of 5 Experiment.
2	The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work.
3	Total 50 Marks (Experiments: 50 Marks)

Course Code	Course Name	Credits
ADS602	Skill based Lab: AWS Essentials / Azure for data engineering	02

Prerequisite:	
Lab Objectives:	
1	To understand and identify the problem
2	To apply basic engineering fundamentals and attempt to find solutions to the problems.
3	Identify, analyze, formulate and handle programming projects with a comprehensive and systematic approach
Lab Outcomes: **At the end of the course, students will be able to —-**	
1	Identify Methodology for solving above problem and apply engineering knowledge and skills t solve it
2	Analyze and evaluate the impact of solution/product/research/innovation /entrepreneurship towards societal/environmental/sustainable development
3	Identify Methodology for solving above problem and apply engineering knowledge and skills to solve it

AWS Essentials	
1	Introduction to Amazon Web Services
2	Compute in the Cloud
3	Global Infrastructure and Reliability
4	Networking storage and database
5	Monitoring and Analytics

Data Engineering on Microsoft Azure	
1	Introduction to data engineering on Azure
2	Introduction to Azure Data Lake Storage Gen2
3	Introduction to Azure Synapse Analytics
4	Use Azure Synapse serverless SQL pool to query files in a data lake
5	Use Azure Synapse serverless SQL pools to transform data in a data lake

Term Work:	
1	Term work should consist of 5 Experiment.
2	The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work.
3	Total 50 Marks (Experiments: 50 Marks)