Annexure-A

Himachal Pradesh University

NAAC Accredited "A" Grade University

Gyan Path, Summerhill,

Shimla -171005

Plan, Scheme, and Syllabus

to start a programme

Master of Science (M.Sc.)

in

Data Science and Artificial Intelligence

(Effective from the session 2021-22)

Department of Data Science and Artificial Intelligence

Under the Faculty of Physical Sciences

Himachal Pradesh University

Shimla - 5

List of Contents

1. Introduction

Data Science and Artificial Intelligence are amongst the hottest fields of the 21st century that will impact all segments of daily life by 2025. The recent development in Data Science and Artificial Intelligence (AI) is bringing significant social and economic benefits to the world. As our daily lives are seamlessly integrating more and more data-driven applications, the role of data analytics and artificial intelligence becomes increasingly important in transforming organizations, industries and society in general. Using AI and Data Science techniques, digital machines can analyse and learn from big datasets and discover more efficient ways to do complex tasks; thereby, making intelligent decisions with much higher accuracy and speed than human beings. Thus, the need of the hour is to integrate the power of Data Science and Artificial Intelligence to every business to boost the global economy by transforming business models across all sectors like science, engineering, banking, sales, finance, marketing, construction, manufacturing, healthcare, travel, hospitality, leisure, environmental monitoring, logistics etc. Hence, the field of Data Science and AI has a potential to employ a large quantum of human resources and serve countries all over the globe.

As per World Economic Forum, Data Scientists and Analysts will become the number one emerging role in the world and thus will find job opportunities which are expected to rise appreciably in the years to come. So, academic institutions must take timely initiatives to offer academic programmes to equip aspirants with requisite job oriented skills and training and thereby contribute to meet the global industrial demand of workforce and diversity in AI and Data Science. Further, in higher education institutions, there is an urgent need for increased collaboration between industry and academia, through creation of channels of communication between faculty and industry, to promote exchange of ideas and expertise. Various avenues of collaboration need to be explored, including workshops, incentives for guest lectures by professionals and institutional arrangements for regular design of courses/curricula in collaboration with the Private Sector Units (PSU).

Master's programme in Data Science and Artificial Intelligence proposed in this report, and to be started by Himachal Pradesh University under the Faculty of Physical Sciences, shall be one of such academic platforms, which caters to impart most advanced knowledge, methods and processes to exploit data science and artificial intelligence-based solutions to real-world

problems. After the completion of this course, the students may have career opportunities with exceptional prospective fields of healthcare, business, e-Commerce, social networking companies, climatology, biotechnology, genetics and other important areas.

2. Vision and Mission

Vision

The vision of the Department of Data Science and Artificial Intelligence is to impart quality education, inculcate professionalism and enhance the problem solving skills of the students in the domain of Data Science and Artificial Intelligence with a focus to make them industry ready, involve in possible areas of research, to pursue and have continual professional growth. In particular, the department shall emphasise on recent advances in the fields of Data Analytics, Big Data tools and technologies, various investigative Data Science and Artificial Intelligence-based approaches etc. to make students industry-ready for Artificial Intelligence and Data Science job roles.

Further, the department shall design its curricula to encourage establishment of close relationships with companies, research, and government agencies where students will have the opportunity to visit such organisations for a specific period of time and work on interesting and practical data science and artificial intelligence based problems. Department shall be committed to liaison with the companies/organisations, which are interested in recruiting skilled graduates in data science and artificial intelligence.

Mission

The mission of the department shall be:

- to equip students with statistical, mathematical reasoning, machine learning, knowledge discovery, problem solving, and visualization skills.
- to create an academic environment conducive for higher learning through faculty training, self-learning, sound academic practices, and research endeavours.
- to make the students industry ready and to enhance their employability through training and internships.
- to establish department and industry collaboration through interaction including participation in professional society activities, guest lecturers, and industrial visits.

3. Programme Details:

(a). Programme : M.Sc. in Data Science and Artificial Intelligence

(b). Duration : Two (02) Years Programme divided into four (04) Semesters

(c). Eligibility : Any Engineering Graduate
Or
Any other graduate with Mathematics/Computer/IT/ Applications/Statistics as Major Subjects in all three years.

With 50% aggregate marks in qualifying exam (45% for SC/ST/PWD)

(d) Fee Structure : Subsidized Seats: 30,000 (Thirty Thousand Only) and Non-Subsidized Seats: 50,000 (Fifty Thousand Only) Annually.

(e) Student Intake : 40 (20 subsidised + 20 non-subsidised seats) + Over and above seats as per HPU norms. (Reservation: As per HPU norms)

(f) Mode of Admission : On the basis of Merit of Entrance Test

The admission to this course will be made on the basis of merit of the Entrance Examination (written test) conducted by H.P. University.

Written test	**100 Marks**
Duration of test	**1:30 Hours**

The written test shall include the following three sections:

Sr. No.	Contents	Marks
1	Computer Ability	50
2	Mathematics of Graduation level	30
3	General logical ability & aptitude	20
Total		100

The minimum qualifying marks in the Entrance Examination (written test) for subsidized as well as non-subsidized seats will be 35% .

4. Examinations:

As the degree is spanned over two years and distributed into four semesters, the learning outcomes shall be assessed after every semester. The assessment of the students shall consist of the following components:

Sr. No.	Assessment Component
1	Semester End External Examinations (Theory)
2	Internal Assessment (Theory)
3	Semester End External Examinations (Practical)
4	Internal Assessment (Practical)
5	Project Work Evaluation

Note: The concerned subject teacher shall submit the marks of Internal Assessment (Theory), Internal Assessment (Practical), and Semester End Examinations (Practical) to the Chairman/Head of the Department (as per the schedule mentioned in Academic Calendar) in triplicate - first copy for Examination Branch of HPU, second copy as an Office copy of the Department, and the third copy may be retained by the subject teacher.

In the fourth semester, the Chairman/Head of the Department will assign a guide/supervisor to each candidate for his/her project work. The candidate shall be required to maintain his/her project diary (logbook) of work in the organization/department. Each student will be required to give at least two seminars on his/her project work . Each student is required to submit three copies of his/her project reports in the department after completion of the project work which will be evaluated by an external examiner.

Further, the project work (final semester) will be jointly evaluated by an internal guide and external examiner. Internal assessment will be given on the basis of class tests (best of 2 in a semester), seminars, surprise quizzes, class participation and regularity of the student in the class, be evaluated by the department and the award list shall be sent to the examination branch by the Chairman/HOD.

5. Minimum Criteria to Award the Degree

Rules regarding the minimum criteria to award a Degree of Master of Science in Data Science and Artificial Intelligence shall remain the same as applicable in other Master of Science programmes run by HPU.

6. Faculty/Administrative Staff Requirement

To maintain the academic standard and for smooth functioning of the department, the minimum faculty and administrative staff requirement shall be as follows:

(a). Teaching Staff:

Professor	:	1
Associate Professor	:	2
Assistant Professor	:	4

(b). Non-Teaching Staff:

Section Officer	:	1
Sr. Superintendent	:	1
Superintendent	:	1
Clerk	:	1
Junior Office Assistant (IT)	:	1
Peon	:	1
Fraash	:	1

(c). Technical/Laboratory/Library Staff:

Programmer	:	1
Lab Technician	:	1
Lab Assistant	:	1
Lab Attendant	:	2
Library Assistant	:	1

7. Infrastructure Requirements

To provide adequate facilities for academic, research, and training & placement activities, following infrastructure is required:

Sr. No.	Room/Space Type	Capacity	NOs.
1	Lecture Theatres	40 each	2
2	Laboratories	40 each	1
3	Research Laboratory	10 each	1
4	Seminar/Conference Hall	100 each	1
5	Office Space	6 Workstations	1
6	Chairman/Head of the Department's Room with attached washroom	1+10 seats	1
7	Faculty Rooms	1+4 seats	8
8	Departmental Library	30 seats + 20 book shelves	1
9	UPS/Inverter Room	As per requirement	1
10	Toilets/Washrooms (Staff)	2 each	2 (1-Male+1-Female)
11	Toilets/Washrooms (Students)	4 each	2 (1-Male+1-Female)

8. Financial Liability (Tentative)

Initial Investment (one time)		
Sr. No.	**Component**	**Tentative Cost (in Rs.)**
1	Infrastructure	5,00,00,000
2	Furniture	1,00,00,000
3	Laboratory Equipment	1,00,00,000
4	Books/Journals	50,00,000
5	Networking	20,00,000

Total		**7,70,00,000**
Annual Expenditures (Recurring)		
1	Salary	2,00,00,000
2	Maintenance/Up-gradation	30,00,000
Total		2,30,00,000

9. Future Plan Proposed

The Department of Data Science and Artificial Intelligence has plenty of scope for expansion both horizontally and vertically. The courses that can be introduced in the future are:

(a) Ph.D. Programme

(b) M.Tech. Programme

(c) One-Year PG Diploma Programmes

(d) Six-Months Certification Courses

Master of Science in Data Science & Artificial Intelligence

Scheme and Syllabus

Credit Based System

Effective from

Academic Session 2021-2022

PROGRAMME OUTCOMES (POs)	
PO1	Knowledge: Capable of demonstrating comprehensive disciplinary knowledge gained during course of study.
PO2	Research Aptitude: Capability to ask relevant/appropriate questions for identifying, formulating and analyzing the research problems and to draw conclusions from the analysis.
PO3	Communication: Ability to communicate effectively on general and scientific topics with the scientific community and with society at large.
PO4	Problem Solving: Capability of applying knowledge to solve scientific and other problems.
PO5	Individual and Team Work: Capable to learn and work effectively as an individual, and as a member or leader in diverse teams, in multidisciplinary settings.
PO6	Investigation of Problems: Ability of critical thinking, analytical reasoning, and research-based knowledge including design of experiments, analysis, and interpretation of data to provide conclusions.
PO7	Modern Tool Usage: Ability to use and learn techniques, skills and modern tools for scientific practices.
PO8	Science and Society: Ability to apply reasoning to assess the different issues related to society and the consequent responsibilities relevant to the professional scientific practices.
PO9	Life-Long Learning: Aptitude to apply knowledge and skills that are necessary for participating in learning activities throughout life.
PO10	Ethics: Capability to identify and apply ethical issues related to one's work, avoid unethical behaviour such as fabrication of data, committing plagiarism and unbiased truthful actions in all aspects of work.
PO11	Project Management: Ability to demonstrate knowledge and understanding of the scientific principles and apply these to manage projects.

PROGRAMME SPECIFIC OUTCOMES (PSOs)	
PSO1	Develop competency to administer knowledge and awareness in the computing discipline along with learning aptitude for lifelong endurance in the professional realm.
PSO2	Develop proficiency to adapt to Data Science & Artificial Intelligence technologies and models for computing practice.
PSO3	Acquire expertise to adopt skills realized during research, experimentation and trending technology cognizance to solve business and real life problems.
PSO4	Promote professional competence to aspire careers in Commercial/Government Sectors, Academics/ Consultancy/ Research and Development for technological innovations, and collateral fields related to Computer Science, Information Technology, and Data Science & Artificial Intelligence.
PSO5	Foster analytical skills for programming and adept Data Science & Artificial Intelligence based designing of systems in the domains concordant to Algorithm Design, Web and Application Designing, Data Science & Analytics, Artificial Intelligence & Machine Learning, and Graphics & Visualization.

Abbreviations Used:

L	LECTURES
T	TUTORIALS
P	PRACTICALS
C	CREDITS
H	HOURS
EE	EXTERNAL EXAMINATIONS
IA	INTERNAL ASSESSMENT

Semester-I

Sr. No	Course Code	Course Title	Contact Hrs/week				C	Semester End Marks	
			L	T	P	H		EE	IA
1.	DSAI-101	Mathematics for Data Science	3	1	0	4	**4**	75	25
2.	DSAI-102	Computational Thinking	3	1	0	4	**4**	75	25
3.	DSAI-103	Data Science with Python	3	1	0	4	**4**	75	25
4.	DSAI-104	Data Structure and Algorithms	3	1	0	4	**4**	75	25
5.	DSAI-105	Database Management System	3	1	0	4	**4**	75	25
6.	DSAI-151	Data Structure and Algorithms using C - Lab	0	0	6	6	**3**	50	25
7.	DSAI-152	Database Management System - Lab	0	0	6	6	**3**	50	25
TOTAL						**32**	**26**	**475**	**175**
								Total = 650	

Semester-II

Sr. No	Course Code	Course Title	Contact Hrs/week				C	Semester End Marks	
			L	T	P	H		EE	IA
1.	DSAI-201	Statistics for Data Science	3	1	0	4	**4**	75	25
2.	DSAI-202	Artificial Intelligence	3	1	0	4	**4**	75	25
3.	DSAI-203	Data Mining	3	1	0	4	**4**	75	25
4.	DSAI-204	Machine Learning	3	1	0	4	**4**	75	25
5.	DSAI-205	Linux Operating System	3	1	0	4	**4**	75	25
6.	DSAI-251	Linux Operating System - Lab	0	0	6	6	**3**	50	25
7.	DSAI-252	Data Analytics using R - Lab	0	0	6	6	**3**	50	25
TOTAL						**32**	**26**	**475**	**175**
								Total = 650	

Semester-III

Sr. No	Course Code	Course Title	Contact Hrs/week				C	Semester End Marks	
			L	T	P	H		EE	IA
1.	DSAI-301	Big Data Analytics	3	1	0	4	**4**	75	25
2.	DSAI-302	Deep Learning	3	1	0	4	**4**	75	25
3.	DSAI-303	Data Visualization	3	1	0	4	**4**	75	25
4.	DSAI-304	Evolutionary Algorithms	3	1	0	4	**4**	75	25
5.	DSAI-EL	Elective	3	1	0	4	**4**	75	25
6.	DSAI-351	Deep Learning - Lab	0	0	6	6	**3**	50	25
7.	DSAI-352	Data Visualization - Lab	0	0	6	6	**3**	50	25
TOTAL						**32**	**26**	**475**	**175**
								Total = 650	

List of Elective Courses

	Name of the Course	Course Code
1.	Cyber Security	DSAI-EL-1
2.	Virtual Reality and Augmented Reality	DSAI-EL-2

Semester-IV

Sr. No	Course Code	Course Title	Evaluation Components	C	Semester End Marks	
					EE	IA
1.	DSAI-401	**Project Work**	Seminar (2)	**2**		50
			Project Report (3+1 Copies)	**4**	100	-
			Viva-Voce	**10**	250	-
			Log Book & Interim Report	**2**		50
TOTAL				**18**	**350**	**100**
					Total =450	

Total Credits : 26+26+26+18 = **96**
Total Maximum Marks : 650+650+650+450 = **2400**

Detailed Syllabus

Semester-I

Name of the Course	**MATHEMATICS FOR DATA SCIENCE**		
Course Code	**DSAI-101**	Credits-3	L-3, T-1, P-0
Lectures to be Delivered	52 (1 Hr Each) (L=39, T=13 for each semester)		
Semester End Examination	**Max Marks: 75**	**Min Pass Marks: 40%**	**Max. Time: 3 hrs**
Internal Assessment (based on sessional test (2) 50%, Tutorials/Assignments 30%, Quiz/Seminar 10%, Attendance 10%)			**Max Marks: 25**

Course Outcomes (COs)	At the end of this course, the student will be able to:
CO1	learn the basic linear algebra techniques useful for data science;
CO2	understand the tools that are used to diagnose the problems and solve them with new methods;
CO3	analyze the statistical algorithms for problem solving;
CO4	apply the elementary counting techniques.

INSTRUCTIONS

For Paper Setters: The question paper will consist of five sections A, B, C, D & E. Section E will be compulsory, it will consist of a single question with 10-20 subparts of short answer type, which will cover the entire syllabus and will carry 20% of the total marks of the semester end examination for the course. Section A, B, C & D will have two questions from the respective sections of the syllabus and each question will carry 20% of the total marks of the semester end examination for the course.

For candidates: Candidates are required to attempt five questions in all selecting one question from each of the sections A, B, C & D of the question paper and all the subparts of the questions in Section E. Use of non-programmable calculators is allowed.

SECTION-A

Introduction: Linear algebra and machine learning, Representing data as flat tables versus matrices and graphs; Different ways probabilities/randomness/noise interacts with data; Probability and matrices/graphs in data science versus other areas; Qualification of the inference step.

SECTION-B

Introduction to Matrices and Vectors: Vectors, Basic properties of R^n; Norms and Balls; Vectors additions and scalar multiplications. Vectors spaces and subspaces; Matrices, Operations on matrices, including matrix multiplications; Functions, linear functions, and linear transformations; Matrices as transformations. Dot products, angels, and perpendicularity; Linear combinations, span, and linear independence; bases, orthonormal bases, and projections. Applications in the theory of probability and data science.

SECTION-C

Spectral Theorems: Eigenvectors and Eigenvalues: Quadratic forms and matrices Symmetric bi-linear functions; Connection with conic sections; Definiteness, indent fitness, and quadratic forms as a sum/ differences of squares; Eigenvalue Decompositions (EVD) Singular Value Decompositions (SVD) Properties of the SVD Orthogonal Subspaces; Uses of the spectral decomposition Applications in Data Science.

SECTION-D

System of Linear Equations: Solving System of Linear equation: Geometry of linear equations; Gaussian eliminations; Row exchanges; Networks and incidence matrices; The four fundamental subspaces Basis Transformations; Orthogonal bases; Gram- Schmidt Orthogonalization; Numerical Issues. Applications in Data Science.

Text Books:

1. Nick Fieller (2015). Basics of Matrix Algebra for Statistics with R, Chapman and Hall/CRC.
2. Shayle R. Searle and Andre Khuri (2017). Matrix Algebra Useful for Statistics, John Wiley & Sons, Inc.

Reference Books:

1. Shayle R. Searle and Andre Khuri (2017). Matrix Algebra Useful for Statistics, John Wiley & Sons, Inc.
2. Michael W. Mahoney (2018). Linear Algebra for Data, University of California Berkeley.
3. Deisenroth M.P., Faisal A.A. and Ong C.S. (2019). Mathematics for Machines Learning, Cambridge University Press.
4. Jason Brownlee (2018). Linear Algebra for Machine Learning, https://www.mobt3ath.com/uplode/book-33342.pdf

Name of the Course	COMPUTATIONAL THINKING		
Course Code	**DSAI-102**	Credits-3	L-3, T-1, P-0
Lectures to be Delivered	52 (1 Hr Each) (L=39, T=13 for each semester)		
Semester End Examination	**Max Marks: 75**	**Min Pass Marks: 40%**	**Max. Time: 3 hrs**
Internal Assessment (based on sessional test (2) 50%, Tutorials/Assignments 30%, Quiz/Seminar 10%, Attendance 10%)			**Max Marks: 25**

Course Outcomes (COs)	At the end of this course, the student will be able to:
CO1	understand the basic concepts of computational thinking, including sequential logic, abstractions, conceptualization and problem-solving;
CO2	apply the fundamental ideas about the emerging trends in the field of computing;
CO3	analyze the various web technologies and the networking protocols to be used in computing communication;
CO4	acquire the basic programming skills to implement solutions using suitable data types and constructs;
CO5	develop computer solutions to problems of low-to-moderate complexity and implement them using a high-level programming language.

INSTRUCTIONS

For Paper Setters: The question paper will consist of five sections A, B, C, D & E. Section E will be compulsory, it will consist of a single question with 10-20 subparts of short answer type, which will cover the entire syllabus and will carry 20% of the total marks of the semester end examination for the course. Section A, B, C & D will have two questions from the respective sections of the syllabus and each question will carry 20% of the total marks of the semester end examination for the course.

For candidates: Candidates are required to attempt five questions in all selecting one question from each of the sections A, B, C & D of the question paper and all the subparts of the questions in Section E. Use of non-programmable calculators is allowed.

SECTION-A

Introduction: The Computer, Turing Machine, A brief history of computers, Software, Programming, Flowcharts, Algorithms, Pseudo code, Digital computer.

C Program Structure, Data types, Variables and Constants, Printing Out and Inputting Variables, Type-Casting, Expression, Order of Precedence.

SECTION-B

Networks: Introduction, The Internet, Local and Wide Area Networks, Wireless Networking, A Brief Introduction of Network Models and Protocols.

Web: Introduction, A brief history of Web, Web Server, Web Browser, URLs, Basics of Static and Dynamic Web Pages, Web Search Engine and Web Services.

SECTION-C

Logic Development: Operators: Arithmetic, Relational, Logical, Bitwise, Assignment; Decision Making: if, if-else, nested if-else. Iteration: While Loop, For Loop, Do While Loop. Single and Multi-dimensional Arrays, String, Basic String Handling Functions. Functions, Passing Parameters, Recursion, Storage classes. Standard C Preprocessor Directives. Standard Formatted & unformatted I/O Functions;

SECTION-D

Defining New Data Types, Structures, Unions, Enumerated Types, Bitwise Operators, Bit Fields.
Pointers: Pointers arithmetic, constant void pointers. Dynamic Memory Allocation, Pointers to Pointers, Pointer to array, Array of pointers, Command Line input, Pointers to a Function.

Text Books:

1. Wang, Paul S., From Computing to Computational Thinking. United Kingdom, CRC Press, 2017.
2. Riley, David D., and Hunt, Kenny A., Computational Thinking for the Modern Problem Solver. United States, Taylor & Francis, 2014.
3. Kanetkar, Yashavant P., Let Us C. India, BPB Publications, 2018.

Reference Books:

1. Forouzan, Behrouz, and Fegan, Sophia Chung. Data Communications Networking McGraw-HilL.
2. Rivest, Ronald L., Introduction to Algorithms. United Kingdom, McGraw-Hill, 2009.
3. Data Structures and Algorithms. India, Pearson Education.

Name of the Course	DATA SCIENCE WITH PYTHON		
Course Code	**DSAI-103**	Credits-3	L-3, T-1, P-0
Lectures to be Delivered	52 (1 Hr Each) (L=39, T=13 for each semester)		
Semester End Examination	**Max Marks: 75**	**Min Pass Marks: 40%**	**Max. Time: 3 hrs**
Internal Assessment (based on sessional test (2) 50%, Tutorials/Assignments 30%, Quiz/Seminar 10%, Attendance 10%)			**Max Marks: 25**

Course Outcomes (COs)	At the end of this course, the student will be able to:
CO1	understand the basic data types used in Python;
CO2	apply Python libraries to represent different forms of data;
CO3	analyze the different aspects of NumPy arrays and pandas data frames;
CO4	evaluation of different Python libraries for their implementation in problem solving.

INSTRUCTIONS

For Paper Setters: The question paper will consist of five sections A, B, C, D & E. Section E will be compulsory, it will consist of a single question with 10-20 subparts of short answer type, which will cover the entire syllabus and will carry 20% of the total marks of the semester end examination for the course. Section A, B, C & D will have two questions from the respective sections of the syllabus and each question will carry 20% of the total marks of the semester end examination for the course.

For candidates: Candidates are required to attempt five questions in all selecting one question from each of the sections A, B, C & D of the question paper and all the subparts of the questions in Section E. Use of non-programmable calculators is allowed.

SECTION-A

Introduction to Data Science - Importance of Python, Essential Python libraries - Python Introduction- Features, Identifiers, Reserved words, Indentation, Comments, Built-in Data types and their Methods: Strings, List, Tuples, Dictionary, Set - Type Conversion- Operators. Decision Making- Looping- Loop Control statement- Math and Random number functions. User defined functions - function arguments & its types.

SECTION-B

User defined Modules and Packages in Python- Files: File manipulations, File and Directory related methods - Python Exception Handling. OOPs Concepts -Class and Objects, Constructors – Data hiding- Data Abstraction- Inheritance.

NumPy Basics: Arrays and Vectorized Computation- The NumPy ndarray - Creating ndarrays - Data Types for ndarrays - Arithmetic with NumPy Arrays- Basic Indexing and Slicing - Boolean Indexing-Transposing Arrays and Swapping Axes. Universal Functions: Fast Element-Wise Array Functions- Mathematical and Statistical Methods-Sorting Unique and Other Set Logic.

SECTION-C

Introduction to Pandas Data Structures: Series, Data Frame, Essential Functionality: Dropping Entries Indexing, Selection, and Filtering- Function Application and Mapping- Sorting and Ranking. Summarizing and Computing Descriptive Statistics- Unique Values, Value Counts, and Membership. Reading and Writing Data in Text Format.

SECTION-D

Data Cleaning and Preparation: Handling Missing Data - Data Transformation: Removing Duplicates, Transforming Data Using a Function or Mapping, Replacing Values, Detecting and Filtering Outliers- String Manipulation: Vectorized String Functions in pandas. Plotting with pandas: Line Plots, Bar Plots, Histograms and Density Plots, Scatter or Point Plots.

Text Books:

1. Y. Daniel Liang, Introduction to Programming using Python, Pearson, 2012.
2. Wes McKinney, Python for Data Analysis: Data Wrangling with Pandas, NumPy, and I Python, O'Reilly, 2nd Edition, 2018.
3. Jake Vander Plas, Python Data Science Handbook: Essential Tools for Working with Data, O'Reilly, 2017.

Reference Books:

1. Wesley J. Chun, Core Python Programming, Prentice Hall, 2006.
2. Mark Lutz, Learning Python, O'Reilly, 4th Edition, 2009.

Name of the Course	DATA STRUCTURE AND ALGORITHMS		
Course Code	**DSAI-104**	Credits-3	L-3, T-1, P-0
Lectures to be Delivered	52 (1 Hr Each) (L=39, T=13 for each semester)		
Semester End Examination	**Max Marks: 75**	**Min Pass Marks: 40%**	**Max. Time: 3 hrs**
Internal Assessment (based on sessional test (2) 50%, Tutorials/Assignments 30%, Quiz/Seminar 10%, Attendance 10%)			**Max Marks: 25**

Course Outcomes (COs)	At the end of this course, the student will be able to:
CO1	understand the basic and advanced data structures & algorithmic techniques;
CO2	identify the type of problem to solve them using appropriate techniques;
CO3	analyse worst-case running times of algorithms using asymptotic analysis;
CO4	design optimum algorithms using various data structures.

INSTRUCTIONS

For Paper Setters: The question paper will consist of five sections A, B, C, D & E. Section E will be compulsory, it will consist of a single question with 10-20 subparts of short answer type, which will cover the entire syllabus and will carry 20% of the total marks of the semester end examination for the course. Section A, B, C & D will have two questions from the respective sections of the syllabus and each question will carry 20% of the total marks of the semester end examination for the course.

For candidates: Candidates are required to attempt five questions in all selecting one question from each of the sections A, B, C & D of the question paper and all the subparts of the questions in Section E. Use of non-programmable calculators is allowed.

SECTION-A

Introduction to Data Structures: Primitive and Composite data types, Self-referential structures, Classification of Data Structures, Arrays.

Stacks & Queues: Representation of Stacks, Stack Operations, Applications, Queues, Operations on Queues, Circular Queues, Dequeue, Priority Queues, Applications.

SECTION-B

Introduction to Algorithms: Role of algorithms in computing, Complexity of algorithms, analysing algorithms, designing algorithms, asymptotic notations.

Searching & Sorting: Linear Search, Binary Search, Selection Sort, Insertion Sort, Bubble Sort, Merge Sort. Implementation of these searching and sorting through algorithms.

SECTION-C

Linked Lists: Introduction, Types, and Operations (Insertion, Deletion, Traversal, Searching), Applications, Dynamic Memory Management, and Implementation of Linked Representations.
Trees: Binary Tree Traversals, Threaded Binary Trees, Binary Search Trees and Operations, AVL Trees, Heap, M-way Search Trees, B-Trees, B+ Trees, Applications.

SECTION-D

Divide and Conquer: Solving recurrence equations: back substitution method, recursion tree method, master's theorem. Analysis of heap sort and quicksort; Counting sort, Radix sort, Bucket sort, Lower bounds for sorting.
Design Techniques: Greedy Algorithms, General Method, Knapsack problem, Job sequencing with deadlines, Minimum Spanning Trees, Kruskal's Algorithm, Prim's Algorithm, Dijkstra's Single Source Shortest Path Algorithm.

Text Books:

1. G.A.V Pai, Data Structures and Algorithms, McGraw-Hill.
2. Cormen, Leiserson, Rivest, Introduction to Algorithms, PHI India.

Reference Books:

1. Neapolitan R., Foundations of Algorithms, Jones and Bartlett Learning.
2. Seymour Lipschutz, Data Structures, McGraw-Hill, Schaum's Outlines, New Delhi.
3. Alfred V. Aho, John E. Hopcroft, Jeffrey D. Ullman, Data Structures and Algorithms, Pearson Education.

Name of the Course	DATABASE MANAGEMENT SYSTEM		
Course Code	**DSAI-105**	Credits-3	L-3, T-1, P-0
Lectures to be Delivered	52 (1 Hr Each) (L=39, T=13 for each semester)		
Semester End Examination	**Max Marks: 75**	**Min Pass Marks: 40%**	**Max. Time: 3 hrs**
Internal Assessment (based on sessional test (2) 50%, Tutorials/Assignments 30%, Quiz/Seminar 10%, Attendance 10%)			**Max Marks: 25**

Course Outcomes (COs)	At the end of this course, the student will be able to:
CO1	learn different kinds of emerging databases in real life scenarios;
CO2	understand the fundamental aspects of database along with EER model;
CO3	analyze normalization and concurrency control techniques;
CO4	design SQL & PL/SQL database management system in an organization.

INSTRUCTIONS

For Paper Setters: The question paper will consist of five sections A, B, C, D & E. Section E will be compulsory, it will consist of a single question with 10-20 subparts of short answer type, which will cover the entire syllabus and will carry 20% of the total marks of the semester end examination for the course. Section A, B, C & D will have two questions from the respective sections of the syllabus and each question will carry 20% of the total marks of the semester end examination for the course.

For candidates: Candidates are required to attempt five questions in all selecting one question from each of the sections A, B, C & D of the question paper and all the subparts of the questions in Section E. Use of non-programmable calculators is allowed.

SECTION-A

Database System Concepts and Architecture: Three - Schema Architecture and Data Independence, Entity Relationship Model: Entity Types, Entity Sets, Attributes & keys, Relationships Types & Instances, ER Diagrams, Naming conventions and Design Issues. Relational Model Constraints, Enhanced Entity Relationship Model: Subclasses, Super classes, Inheritance, Specialization and Generalization, Constraints and characteristics of specialization and Generalization.

SECTION-B

SQL: Data Definition and Data Types, DDL, DML, and DCL, Views & Queries in SQL, Specifying Constraints & Indexes in SQL. PL/SQL: Architecture of PL/SQL, Basic Elements of PL/SQL, PL/SQL Transactions, Cursors and Triggers.

SECTION-C

Relational Database Design: Functional Dependencies, Decomposition, Normal Forms Based on Primary Keys-(1NF, 2NF, 3NF, BCNF), Multi-valued Dependencies, 4 NF, Join dependencies, 5 NF, Domain Key Normal Form.

SECTION-D

Transaction Processing: Introduction to Transaction Processing, Transaction and System Concepts, Desirable Properties of Transactions, Concurrency Control Techniques: Two-Phase Locking Techniques, Timestamp Ordering, Serializability. Database Backup and Recovery: Recovery facilities, Recovery Techniques.

Text Books:

1. Elmasri & Navathe, Fundamentals of Database systems, Pearson Education.
2. Ivan Bayross, SQL, PL/SQL- The Program Language of ORACLE, BPB Publication.
3. Alexis Leon & Mathews Leon: Database Management System, Leon Vikas Publication.

Reference Books:

1. Korth & Silberschatz, Database System Concept, McGraw Hill International Edition.
2. Raghu Ramakrishnan& Johannes Gehrke, Database Management Systems, Mcgraw Hill.
3. Peter Rob, Carlos Colonel, Database system Design, Implementation, and Measurement, Cengage Learning.
4. Abbey, Abramson & Corey. Oracle 8i-A Beginner's Guide, Tata McGraw Hill.

Name of the Course	DATA STRUCTURE AND ALGORITHMS USING C-LAB		
Course Code	**DSAI-151**	Credits-3	L-0, T-0, P-6
Lectures to be delivered	**32 hours of Lab sessions**		
Semester End Examination	**Max. Time : 3 hrs**	Max. Marks : 50	Min. Pass Marks:20
Internal Assessment (based on Lab work 30%, Lab record 30%, Viva 30%, Attendance 10%)		Max. Marks: 25	Min. Pass Marks:10

Course Outcomes (COs)	At the end of this course, the student will be able to:
CO1	understand the practical implementation of basic and advanced data structures & algorithmic techniques;
CO2	identify the type of problem to solve them using appropriate techniques through various types of data structures;
CO3	analyse worst-case running times of algorithms using asymptotic analysis;
CO4	design and implement optimum algorithms using various data structures.

List of Experiments:

1. WAP to find whether the entered number is Armstrong or not.
2. WAP to find whether the entered number is prime or not.
3. WAP to find the factorial value of any number.
4. Swap the value of two variables using call by value & by reference.
5. WAP to find the maximum number in an array.
6. WAP to find out in a[25] how many are positive, how many are negative, how many are even and how many are odd.
7. WAP using pointers to find the smallest number in an array of 25 integers.
8. Implement the Selection Sort, Bubble Sort and Insertion Sort.
9. Implement the Linear Search and Binary Search
10. WAP to reverse a string.
11. Implement the following:
    a. Inserting a node into the Linked List (First Node, Last Node, and nth Node)
    b. Deleting a node from the Linked List (First Node, Last Node, and nth Node)
12. Implement the following using arrays and Linked List:
    a. Stack and its operations b. Queue and its operations
13. Implement the following:
    a. Creating a binary search tree and traversing it using in order, preorder and post order.

Name of the Course	DATABASE MANAGEMENT SYSTEM-LAB		
Course Code	**DSAI-152**	Credits-3	L-0, T-0, P-6
Lectures to be delivered	**32 hours of Lab sessions**		
Semester End Examination	**Max. Time : 3 hrs**	Max. Marks : 50	Min. Pass Marks:20
Internal Assessment (based on Lab work 30%, Lab record 30%, Viva 30%, Attendance 10%)		Max. Marks: 25	Min. Pass Marks:10

Course Outcomes (COs)	At the end of this course, the student will be able to:
CO1	learn different kinds of commands for storage and retrieval of data;
CO2	understand the fundamental aspects of database along with EER model;
CO3	analyze different access rights for database management systems;
CO4	design SQL & PL/SQL database management system in an organization.

List of Experiments:

1. Create the table for:
   (a) COMPANY database
   (b) STUDENT database and Insert five records for each attribute.
2. Illustrate the use of SELECT statement
3. Conditional retrieval - WHERE clause
4. Query sorted - ORDER BY clause
5. Perform following:
   (a) UNION, INTERSECTION and MINUS operations on tables.
   (b) UPDATE, ALTER, DELETE, DROP operations on tables
6. Grouping the result of query - GROUP BY clause and HAVING clause
7. Query multiple tables using JOIN operation.
8. Query multiple tables using NATURAL and OUTER JOIN operation.
9. Create the following:
   (a) Synonym sequences and Index
   (b) Create alter and update views.
10. Create PL/SQL program using cursors, control structure, exception handling
11. Create following:
   (a) Simple Triggers
   (b) Package using procedures and functions.
12. Create User in Database and grant and revoke the privileges and use of commit, savepoint, rollback command.

Semester-II

Name of the Course	STATISTICAL LEARNING		
Course Code	**DSAI-201**	Credits-3	L-3, T-1, P-0
Lectures to be Delivered	52 (1 Hr Each) (L=39, T=13 for each semester)		
Semester End Examination	**Max Marks: 75**	**Min Pass Marks: 40%**	**Max. Time: 3 hrs**
Internal Assessment (based on sessional test (2) 50%, Tutorials/Assignments 30%, Quiz/Seminar 10%, Attendance 10%)			**Max Marks: 25**

Course Outcomes (COs)	At the end of this course, the student will be able to:
CO1	learn basis of probability & probability distributions;
CO2	apply various sample collection, estimation, and testing procedures on information gathered from different sections of population;
CO3	analyze estimation and hypothesis testing procedures to make conclusions about populations based on information from samples;
CO4	build and perform correlation and regression models.

INSTRUCTIONS

For Paper Setters: The question paper will consist of five sections A, B, C, D & E. Section E will be compulsory, it will consist of a single question with 10-20 subparts of short answer type, which will cover the entire syllabus and will carry 20% of the total marks of the semester end examination for the course. Section A, B, C & D will have two questions from the respective sections of the syllabus and each question will carry 20% of the total marks of the semester end examination for the course.

For candidates: Candidates are required to attempt five questions in all selecting one question from each of the sections A, B, C & D of the question paper and all the subparts of the questions in Section E. Use of non-programmable calculators is allowed.

SECTION-A

Introduction: Probability, Random Variables & Probability Distributions: Discrete and continuous random variables - distribution function and its properties - probability mass function and probability density function - discrete and continuous probability distributions - Binomial, Geometric, Poisson, Uniform, Exponential and Normal distributions.

SECTION-B

Types of data: primary and secondary data - classification and representation of data - formation of frequency distribution - various measures of central tendency, dispersion - and their merits and demerits - concept of skewness and kurtosis. Sampling, analysis of sample data - Empirical Distributions, Sampling from a Population Estimation, confidence intervals, point estimation-Maximum Likelihood.

SECTION-C

Test of Hypothesis: Z, t, Chi-Square & F-test. ANOVA & Designs of Experiments--Single, Two factor ANOVA, Factorials ANOVA models.

SECTION-D

Correlation and Curve Fitting: Correlation coefficient and regression - rank correlation - curve fitting by least square methods, fitting a straight line, parabola, power curve and exponential curves. (no derivation, numerical problems only) Correlation & Regression Models-- linear regression methods, Ridge regression, LASSO, univariate and Multivariate Linear Regression, probabilistic interpretation, Regularization, Logistic regression, locally weighted regression.

Text Books:

1. Gareth James, Daniela Witten, Trevor Hastie, Robert Tibshirani, An Introduction to Statistical Learning with Applications in R, Springer 2013.
2. T. Veerarajan, Probability, Statistics and Random Processes, Tata McGraw Hill, 2nd edition.

Reference Books:

1. Nils Nilsson, Artificial Intelligence, A New Synthesis, PHI, 2000.
2. Douglas C. Montgomery and George C. Runger, Applied Statistics and Probability for Engineers, Third Edition, John Wiley & Sons Inc., 2003.
3. Ronald E. Walpole, Raymond H Myres, Sharon. L. Myres and Kying Ye, Probability and Statistics for Engineers and Scientists, Seventh Edition, Pearson Education, 2002.
4. Richard Arnold Johnson, Irwin Miller, John E. Freund , Miller & Freund's Probability and Statistics for Engineers, Prentice Hall, 2011.
5. Dr. P. Kandaswamy, Dr. K. Thilagavathy and Dr. K. Gunavathy, Probability and Queuing Theory, Revised edition, S. Chand Publishing, 2013.
6. Goon, A.M., M. K. Gupta and B. Das Gupta Fundamentals of Statistics- Vol. I, World Press Ltd, Kolkata, 2002.
7. Gupta, S.C. and V. K. Kapoor, Fundamentals of Mathematical Statistics, Sultan Chand & Sons, New Delhi, 2002.
8. Hogg, R.V. and A. Craig, Introduction to Mathematical Statistics, McMillan Publishing.

Name of the Course	FOUNDATION OF ARTIFICIAL INTELLIGENCE		
Course Code	**DSAI-202**	Credits-3	L-3, T-1, P-0
Lectures to be Delivered	52 (1 Hr Each) (L=39, T=13 for each semester)		
Semester End Examination	**Max Marks: 75**	**Min Pass Marks: 40%**	**Max. Time: 3 Hrs**
Internal Assessment (based on sessional test (2) 50%, Tutorials/Assignments 30%, Quiz/Seminar 10%, Attendance 10%)			**Max Marks: 25**

Course Outcomes (COs)	At the end of this course, the student will be able to:
CO1	understand basic principles of Artificial Intelligence;
CO2	apply various AI based algorithms to solve real life problems;
CO3	analyze the usage of different techniques for their exquisite utilization;
CO4	implementation of AI techniques in the aspects of computing.

INSTRUCTIONS

For Paper Setters: The question paper will consist of five sections A, B, C, D & E. Section E will be compulsory, it will consist of a single question with 10-20 subparts of short answer type, which will cover the entire syllabus and will carry 20% of the total marks of the semester end examination for the course. Section A, B, C & D will have two questions from the respective sections of the syllabus and each question will carry 20% of the total marks of the semester end examination for the course.
For candidates: Candidates are required to attempt five questions in all selecting one question from each of the sections A, B, C & D of the question paper and all the subparts of the questions in Section E. Use of non-programmable calculators is allowed.

SECTION-A

Introduction: Artificial Intelligence (AI) - Introduction, The history of AI, The state of the Art; Intelligent Agents-Agents and Environments, Good Behavior: The Concept of Rationality, The Nature of Environments, The Structure of Agents.

SECTION-B

Solving Problems by Searching- Problem Solving Agents, Searching for Solutions- Infrastructure for search algorithms, Measuring problem-solving performance; Uninformed Search Strategies-Breadth-first search, Uniform-cost search, Depth-first search, Depth-limited search, Iterative deepening depth-first search, Bidirectional search, Comparing uninformed search strategies;

SECTION-C

Informed (Heuristic) Search Strategies- Greedy best-first search, A* search: Minimizing the total estimated solution cost, memory-bounded heuristic search, Learning to search better; Heuristic Functions- The effect of heuristic accuracy on performance, Generating admissible heuristics from relaxed problems, Generating admissible heuristics from subproblems: Pattern database, Learning heuristics from experience.

SECTION-D

Beyond Classical Search: Local Search Algorithms and Optimization Problems- Hill-Climbing Search, Simulated Annealing, Local Beam Search, Genetic Algorithms; Local Search in Continuous Spaces, Search with Nondeterministic Actions- The erratic vacuum world, AND-OR search trees, Try, try again; Search with Partial Observations-Searching with no observation, Searching with observations, Solving partially observable problems, An agent for partially observable environments.

Text Books:

1. Russell, Norvig, Artificial Intelligence: A Modern Approach, Third edition, Prentice Hall, 2010.
2. Khemani, Deepak. A First Course in Artificial Intelligence. India, McGraw Hill Education (India), 2013.

Reference Book:

1. Hastie, Tibshirani, Friedman. The elements of statistical learning, Second edition, Springer, 2009.

Name of the Course	DATA MINING		
Course Code	**DSAI-203**	Credits-3	L-3, T-1, P-0
Lectures to be Delivered	52 (1 Hr Each) (L=39, T=13 for each semester)		
Semester End Examination	**Max Marks: 75**	**Min Pass Marks: 40%**	**Max. Time: 3 hrs**
Internal Assessment (based on sessional test (2) 50%, Tutorials/Assignments 30%, Quiz/Seminar 10%, Attendance 10%)			**Max Marks: 25**

Course Outcomes (COs)	At the end of this course, the student will be able to:
CO1	understand the data storage, mining, and retrieval techniques;
CO2	apply data processing mechanisms to achieve efficient performance of the system;
CO3	evaluation of various patterns to define correlation and associations amongst the data items;
CO4	design data-mining solutions for different applications.

INSTRUCTIONS

For Paper Setters: The question paper will consist of five sections A, B, C, D & E. Section E will be compulsory, it will consist of a single question with 10-20 subparts of short answer type, which will cover the entire syllabus and will carry 20% of the total marks of the semester end examination for the course. Section A, B, C & D will have two questions from the respective sections of the syllabus and each question will carry 20% of the total marks of the semester end examination for the course.

For candidates: Candidates are required to attempt five questions in all selecting one question from each of the sections A, B, C & D of the question paper and all the subparts of the questions in Section E. Use of non-programmable calculators is allowed.

SECTION-A

Introduction: Data Mining - definition, usages, classification of data, classification of data patterns, Technologies to be used, area of applications, Major issues in Data Mining.

SECTION-B

Data Preprocessing: Data Preprocessing: An Overview, Data Cleaning, Data Integration, Data Reduction, Data Transformation and Data Discretionary.

SECTION-C

Data Warehousing and Online Analytical Processing: Data Warehouse: Basic Concepts, Data Warehouse Modeling: Data Cube and OLAP, Data Warehouse Design and Usage, Data Warehouse Implementation.

SECTION-D

Mining Frequent Patterns, Associations, and Correlations: Basic Concepts and Methods: Basic

Concepts, Frequent Itemset Mining Methods, interesting patterns- Pattern Evaluation Methods.
Advanced Pattern Mining: Pattern Mining: A Road Map, Pattern Mining in Multilevel, Multidimensional Space.

Text Books:

1. Jiawei Han, Micheline kamber, Jian Pei, Data Mining: Concepts and Techniques, Morgan Kaufmann Publishers, Elsevier Science, 2012. 3rd Edition.
2. Jiawei Han, Micheline kamber, Data Mining: Concepts and Techniques, Morgan Kaufmann Publishers, Elsevier Science, 2006. 2nd Edition.

Reference Books:

1. Web Data Mining by Liu Bing, Springer-Verlag.
2. Mining the World Wide Web by Chang George, Springer-Verlag.
3. Data Warehousing, Data mining and OLAP by Alex Berson and Stephen Smith, McGraw Hill.

Name of the Course	MACHINE LEARNING		
Course Code	**DSAI-204**	Credits-3	L-3, T-1, P-0
Lectures to be Delivered	52 (1 Hr Each) (L=39, T=13 for each semester)		
Semester End Examination	**Max Marks: 75**	**Min Pass Marks: 40%**	**Max. Time: 3 hrs**
Internal Assessment (based on sessional test (2) 50%, Tutorials/Assignments 30%, Quiz/Seminar 10%, Attendance 10%)			**Max Marks: 25**

Course Outcomes (COs)	At the end of this course, the student will be able to:
CO1	learn different methods of machine learning;
CO2	understand different machine learning models;
CO3	analyze the techniques for classification of data;
CO4	implementation of algorithms to predict results of experiments.

INSTRUCTIONS

For Paper Setters: The question paper will consist of five sections A, B, C, D & E. Section E will be compulsory, it will consist of a single question with 10-20 subparts of short answer type, which will cover the entire syllabus and will carry 20% of the total marks of the semester end examination for the course. Section A, B, C & D will have two questions from the respective sections of the syllabus and each question will carry 20% of the total marks of the semester end examination for the course.

For candidates: Candidates are required to attempt five questions in all selecting one question from each of the sections A, B, C & D of the question paper and all the subparts of the questions in Section E. Use of non-programmable calculators is allowed.

SECTION-A

Introduction: Machine Learning- Introduction, Supervised Learning- Classification, Regression, Unsupervised Learning- Discovering Clusters, Discovering latent factors, Discovering graph Structure, Matrix Completion, Basic Concepts in Machine Learning – Parametric vs Non-parametric models, A simple non-parametric classifier: K – nearest Neighbours, the curse of dimensionality, Parametric models for classification and regression, Linear regression, Logistic regression, Overfitting, Model selection, No free lunch theorem.

Machine Learning Applications – Learning Associations, Classification, Regression, Unsupervised Learning, Reinforcement Learning.

Generative models for discrete data: The Dirichlet-multinomial model – Likelihood, Prior, Posterior, Posterior predictive; Naive Bayes Classifiers - Model fitting, Using the model for prediction, the log-sum-exp trick, Feature selection using mutual information, Classifying documents using bag of words.

SECTION-B

Clustering: Introduction, Mixture Densities, *k*-Means Clustering, Expectation-Maximization Algorithm, Mixtures of Latent Variable Models, Supervised Learning after Clustering, Spectral Clustering, Hierarchical Clustering, Choosing the Number of Clusters.

SECTION-C

Decision Trees: Introduction, Univariate Trees – Classification Trees, Regression Trees, Pruning, Rule Extraction from Trees, Learning Rules from Data, Multivariate Trees.

SECTION-D

Design and Analysis of Machine Learning Experiments: Introduction, Factors, Response, and Strategy of Experimentation, Randomization, Replication, and Blocking, Guidelines for Machine Learning Experiments, Cross-Validation and Resampling Methods – *k*-Fold Cross-Validation, 5*2 Cross-Validation, Bootstrapping, Measuring Classifier Performance, Interval Estimation, Hypothesis Testing, Assessing a Classification Algorithm's Performance - Binomial Test, Approximate Normal Test, *t* Test, Comparison over Multiple Datasets – Comparing Two algorithms, Multiple Algorithms.

Text Books:

1. Alpaydin, Ethem. Introduction to Machine Learning. United Kingdom, MIT Press, 2014.
2. Murphy, Kevin P. Machine Learning: A Probabilistic Perspective. United States, MIT Press, 2012.

Reference Book:

1. James, Gareth, et al. An Introduction to Statistical Learning: With Applications in R. Germany, Springer New York, 2013.

Name of the Course	LINUX OPERATING SYSTEM		
Course Code	**DSAI-205**	Credits-3	L-3, T-1, P-0
Lectures to be Delivered	52 (1 Hr Each) (L=39, T=13 for each semester)		
Semester End Examination	**Max Marks: 75**	**Min Pass Marks: 40%**	**Max. Time: 3 hrs**
Internal Assessment (based on sessional test (2) 50%, Tutorials/Assignments 30%, Quiz/Seminar 10%, Attendance 10%)			**Max Marks: 25**

Course Outcomes (COs)	At the end of this course, the student will be able to:
CO1	learn the concepts and commands of Linux;
CO2	understand the file management and process manipulation in Linux;
CO3	apply system administration and communication mechanisms in Linux;
CO4	implementation of C environment under linux;
CO5	design shell programs in Linux.

INSTRUCTIONS

For Paper Setters: The question paper will consist of five sections A, B, C, D & E. Section E will be compulsory, it will consist of a single question with 10-20 subparts of short answer type, which will cover the entire syllabus and will carry 20% of the total marks of the semester end examination for the course. Section A, B, C & D will have two questions from the respective sections of the syllabus and each question will carry 20% of the total marks of the semester end examination for the course.

For candidates: Candidates are required to attempt five questions in all selecting one question from each of the sections A, B, C & D of the question paper and all the subparts of the questions in Section E. Use of non-programmable calculators is allowed.

SECTION-A

Introduction: History of Linux - Linux Components/Architecture - Features of Linux – Linux Environment and Linux Structure - Posix and Single Linux specification - The login prompt - Linux commands – Basic commands - echo, printf, ls, who, date,passwd, cal - Combining commands - Internal and external commands – type, man , more and other commands - the user terminal, displaying its characteristics and setting characteristics - The root login - super user: su command - /etc/passwd and /etc/shadow files - Commands to add, modify and delete users.

SECTION-B

File System: File basics - File types and Categories – File Organization – Directories - home directory and the HOME variable - Reaching required files- the PATH variable - Relative and absolute pathnames.

Directory commands – pwd, cd, mkdir, rmdir commands. The dot (.) and double dots (..) notations to represent parent directories - File related commands – cat, mv, rm, cp, wc - File inodes and the inode structure. File links – hard and soft links – Head and tail commands - Cut and paste commands - The sort command - Special files /dev/null and /dev/tty - File attributes and permissions - The umask and default file permissions - ls command - Changing file permissions: the relative and absolute permissions changing methods. Recursively changing file permissions. Directory permissions

SECTION-C

Process Management: The Structure of Processes: Process States and Transitions - Layout of system memory - Context of a process. Process Control: Process Creation – Signals – Process Termination – Invoking other programs – PID & PPID – Shell on a Shell.

Vi Editor: Introduction to Text Processing, Command & edit Mode, Invoking vi, deleting & inserting Line, Deleting & Replacing Character, Searching for Strings, Yanking, Running Shell Command Macros, Set Window, Set Auto Indent, Set No. Communicating with Other Users: who, mail, wall, send, mesg.

SECTION-D

Shell programming: Introduction – Need for Scripts – Creating and Calling the Script – The Shebang – Different ways of running a script - Using variables in Script – Reading Input – Integer Variables – Arithmetic Expressions – Read-only variables – Exporting variables – Arrays - Control Statements: If, Then, Else, While and Until, Classic For, Break and Continue, Case – Handling Script Parameters: Shift, Getopts – Shell Functions – Handling Conditional expression patterns and Regular expressions in scripts.

Text Books:

1. Sumitabha Das., UNIX Concepts and Applications. 4th Edition. Tata McGraw Hill, July 2017.
2. Behrouz A. Forouzan, Richard F. Gilberg : UNIX and Shell Programming- Cengage Learning – India Edition. 2009

Reference Books:

1. M.G. Venkatesh Murthy: UNIX & Shell Programming, Pearson Education.
2. Richard Blum, Christine Bresnahan: Linux Command Line and Shell Scripting Bible, 2nd Edition, Wiley, 2014.
3. Beginning Linux Programming, 4th Edition, N. Matthew, R. Stones, Wrox, Wiley India Edition.
4. Unix for programmers and users, 3rd Edition, Graham Glass, King Ables, Pearson.
5. System Programming with C and Unix, A. Hoover, Pearson.
6. Unix System Programming, Communication, Concurrency and Threads, K. A. Robbins and S. Robbins, Pearson Education.

Name of the Course	LINUX OPERATING SYSTEM-LAB		
Course Code	**DSAI-251**	Credits-3	L-0, T-0, P-6
Lectures to be delivered	**32 hours of Lab sessions**		
Semester End Examination	**Max. Time : 3 hrs**	Max. Marks : 50	Min. Pass Marks:20
Internal Assessment (based on Lab work 30%, Lab record 30%, Viva 30%, Attendance 10%)		Max. Marks: 25	Min. Pass Marks:10

Course Outcomes (COs)	At the end of this course, the student will be able to:
CO1	learn the concepts and commands of Linux;
CO2	understand the file management and process manipulation in Linux through vi editor;
CO3	apply system administration and communication mechanisms in Linux through the terminal;
CO4	implementation of C environment under linux;
CO5	design shell programs in Linux.

List of Experiments:

1. Execute 25 basic commands of LINUX.
2. Basics of functionality and modes of VI Editor.
3. WAP that accepts user name and reports if user is logged in.
4. WAP which displays the following menu and executes the option selected by user:
   (I) ls (ii) Pwd 3. ls –l 4. ps –fe
5. WAP to print 10 9 8 7 6 5 4 3 2 1 .
6. WAP that replaces all "*.txt" file names with "*.txt.old" in the current.
7. Use the cat command to create a file containing data of students. Use tabs to separate the fields, Use the cat command to display the file, Use the sort command to sort the file, and Use the cut and paste commands to swap fields of file. Print the file.
8. Use the appropriate command to determine your login shell and verify it by using /etc/passwd file.
9. Use the 'who' command and redirect the result to a file called myfile1. Use the more command to see the contents of myfile1.
10. Develop an interactive grep script that asks for a word and a file name and then tells how many lines contain that word.
11. WAP that echoes itself to stdout, but backwards.
12. WAP that takes a filename as input and checks if it is executable, if not make it executable.
13. WAP to take string as command line argument and reverse it.
14. Create a data file called employee in the format given below:

a. EmpCode Character

b. EmpName Character
c. Grade Character
d. Years of experience Numeric
e. Basic Pay Numeric
$vi employee

A001	ARJUN	E1	01	12000.00
A006	Anand	E1	01	12450.00
A010	Rajesh	E2	03	14500.00
A002	Mohan	E2	02	13000.00
A005	John	E2	01	14500.00
A009	Denial Smith	E2	04	17500.00
A004	Williams	E1	01	12000.00

15. Perform the following functions on the file:
a. Sort the file on EmpCode.
b.Sort the file on
(i) Decreasing order of basic pay
(ii) Increasing order of years of experience.
c. Display the number of employees whose details are included in the file.
d. Display all records with 'smith' a part of the employee name.
e. Display all records with EmpName starting with 'B'.
f. Display the records on Employees whose grade is E2 and have work experience of 2 to 5 years.
g.Store in 'file 1' the names of all employees whose basic pay is between 10000 and 15000.
h.Display records of all employees who are not in grade E2.
16. Write a shell script that accepts a filename, starting and ending line numbers as arguments and displays all the lines between the given line numbers.
17. Write a shell script that deletes all lines containing a specified word in one or more files supplied as arguments to it.
18. Write a shell script that displays a list of all the files in the current directory to which the user has read, write and execute permissions.
19. Write a shell script that receives any number of file names as arguments, checks if every argument supplied is a file or a directory and reports accordingly. Whenever the argument is a file, the number of lines on it is also reported.
20. Write a shell script that accepts a list of file names as its arguments, counts and reports the occurrence of each word that is present in the first argument file on other argument files.

Name of the Course	**DATA ANALYTICS USING R -LAB**		
Course Code	**DSAI-252**	Credits-3	L-0, T-0, P-6
Lectures to be delivered	**32 hours of Lab sessions**		
Semester End Examination	**Max. Time : 3 hrs**	Max. Marks : 50	Min. Pass Marks:20
Internal Assessment (based on Lab work 30%, Lab record 30%, Viva 30%, Attendance 10%)		Max. Marks: 25	Min. Pass Marks:10

Course Outcomes (COs)	At the end of this course, the student will be able to:
CO1	learn the basic functions of R Programming;
CO2	apply the file management techniques;
CO3	analyze the different models to be implemented;
CO4	evaluation of datasets using various testing techniques;

List of Experiments:

1. Take a random data set, which can be found as *x.csv* and Implement the following functions using R:
   a) Use *read.csv()* function
   b) Use *fix()* function.
   c) Use the *summary()* function to produce a numerical summary of the variable in the data set.
   d) Use the *pairs()* function to produce a scatterplot matrix of the first ten columns or variable of the data.
   e) Use the *plot()* function to produce side-by-side boxplots using any two variables from the data set.
   f) Use the *hist()* function to produce some histograms with differing numbers of bins for a few of the quantitative variables. You may find the command *par(mfrow=c(2,2))* useful: it will divide the print window into four regions so that four plots can be made simultaneously. Modifying the arguments to this function will divide the screen in other ways.
   g) Continue exploring the data, and provide a brief summary of what you discover.

2. Take a random data set, which can be found as *x.csv,* make sure that the missing values have been removed from the data and Implement the following functions using R:
   a) Which of the predictors are quantitative, and which are qualitative?
   b) What is the range of each quantitative predictor? You can answer this using the *range()* function.
   c) What is the mean and standard deviation of each quantitative predictor?
   d) Using the full data set, investigate the predictors graphically, using scatterplots or other tools of your choice. Create some plots highlighting the relationships among the predictors. Comment on your findings.

3. This question involves the use of simple linear regression on a random data set and Implement the following functions using R:
   a) Use the *lm()* function to perform a simple linear regression with *r* as the response and *p* as the predictor. Use the *summary()* function to print the results. Comment on the output. For example:
      i. Is there a relationship between the predictor and the response?
      ii. How strong is the relationship between the predictor and the response?
      iii. Is the relationship between the predictor and the response positive or negative?
   b) Plot the response and the predictor. Use the *abline()* function to display the least squares regression line.
   c) Use the *plot()* function to produce diagnostic plots of the least squares regression fit.
4. Take a random data set for sales of an entity, fit *classification models* in order to predict whether the sales for a given month is above or below the median. Explore *logistic regression*, *LDA*, and *KNN* models using various sets of the predictors. Describe your findings.
5. Download the data set from the website, www.StatLearning.com, there is a gene expression data set (Ch10Ex11.csv) that consists of 40 tissue samples with measurements on 1,000 genes. The first 20 samples are from healthy patients, while the second 20 are from a diseased group:
   a) Load in the data using *read.csv()*. You will need to select *header=F*.
   b) Apply hierarchical clustering to the samples using correlation-based distance, and plot the dendrogram. Do the genes separate the samples into the two groups? Do your results depend on the type of linkage used?
   c) Perform K-means clustering of the observations with K = 3. How well do the clusters that you obtained in K-means clustering compare to the true class labels?
      Hint: You can use the table() function in R to compare the true class labels to the class labels obtained by clustering. Be careful how you interpret the results: K-means clustering will arbitrarily number the clusters, so you cannot simply check whether the true class labels and clustering labels are the same.
6. Take a random data set and implement *t* test.
7. Perform the following exercises on a simulated data set:
   a) Generate a simulated data set as follows:
      i. *> set.seed(1)*
      > y=rnorm(100)
      > x=rnorm(100)
      *> y=x-2*x^2+rnorm(100)*

   In this data set, what is *n* and what is *p*? Write out the model used to generate the data in equation form.
   b) Create a scatterplot of *X* against *Y*. Comment on what you find.

Text Books:

1. James, Gareth, et al. An Introduction to Statistical Learning: With Applications in R. Germany, Springer New York, 2013.

Reference Books:

1. Alpaydin, Ethem. Introduction to Machine Learning. United Kingdom, MIT Press, 2014.
2. Murphy, Kevin P. Machine Learning: A Probabilistic Perspective. United States, MIT Press, 2012.

Semester-III

Name of the Course	BIG DATA ANALYTICS		
Course Code	**DSAI-301**	Credits-3	L-3, T-1, P-0
Lectures to be Delivered	52 (1 Hr Each) (L=39, T=13 for each semester)		
Semester End Examination	**Max Marks: 75**	**Min Pass Marks: 40%**	**Max. Time: 3 hrs**
Internal Assessment (based on sessional test (2) 50%, Tutorials/Assignments 30%, Quiz/Seminar 10%, Attendance 10%)			**Max Marks: 25**

Course Outcomes (COs)	At the end of this course, the student will be able to:
CO1	understand Spark, Hive, Pig, NoSQL;
CO2	apply big data management techniques to generate different patterns;
CO3	analyze Big Data and its business implications;
CO4	evaluate data using different tools;
CO5	create mechanisms for reporting and visualizing the big data.

INSTRUCTIONS

For Paper Setters: The question paper will consist of five sections A, B, C, D & E. Section E will be compulsory, it will consist of a single question with 10-20 subparts of short answer type, which will cover the entire syllabus and will carry 20% of the total marks of the semester end examination for the course. Section A, B, C & D will have two questions from the respective sections of the syllabus and each question will carry 20% of the total marks of the semester end examination for the course.

For candidates: Candidates are required to attempt five questions in all selecting one question from each of the sections A, B, C & D of the question paper and all the subparts of the questions in Section E. Use of non-programmable calculators is allowed.

SECTION-A

Introduction: Introduction to Big Data Analytic, Big Data, Scalability and Parallel Processing, Designing Data Architecture, Data Sources, Quality, Pre-Processing and Storing, Data storage and Analysis, Big Data Analytics Applications and Case Studies.

Introduction to Hadoop: Hadoop and its Ecosystem, Hadoop Distributed File System, Mapreduce Framework and Programming Model, Haddop yarn, Hadoop Ecosystem Tools.

SECTION-B

NoSQL Big Data Management: Introduction to NoSQL, NoSQL Data Store, NoSQL Data Architecture Patterns, NoSQL to Manage Big Data, Shared-Nothing Architecture for Big Data Tasks; MongoDB Database.

SECTION-C

MapReduce, Hive and Pig: Introduction, MapReduce Map Tasks, Reduce Tasks and MapReduce Execution, Composing MapReduce for Calculations and Algorithms, Hive, HiveQL, Pig.

SECTION-D

Spark and Big Data Analytics: Introduction, Spark, Introduction to Data Analysis with Spark, Downloading Spark, and Programming using RDDs and MLIB, Data ETL (Extract, Transform and Load) Process, Introduction to Analytics, Reporting and Visualizing.

Text Book:

1. Raj Kamal and Preeti Saxena, BIG DATA ANALYTICS: Introduction to Hadoop, Spark, and Machine-Learning. N.p., McGraw-Hill Education, 2019.

Reference Books:

1. Michael Minelli, Michelle Chambers, and Ambiga Dhiraj, "Big Data, Big Analytics: Emerging Business Intelligence and Analytic Trends for Today's Businesses", Wiley, 2013.
2. P. J. Sadalage, M. Fowler, NoSQL Distilled: A Brief Guide to the Emerging World of Polyglot Persistence, Addison-Wesley Professional, 2012.
3. Tom White, Hadoop: The Definitive Guide, 3/e, O'Reilly, 2012.

Name of the Course	DEEP LEARNING		
Course Code	**DSAI-302**	Credits-3	L-3, T-1, P-0
Lectures to be Delivered	52 (1 Hr Each) (L=39, T=13 for each semester)		
Semester End Examination	**Max Marks: 75**	**Min Pass Marks: 40%**	**Max. Time: 3 hrs**
Internal Assessment (based on sessional test (2) 50%, Tutorials/Assignments 30%, Quiz/Seminar 10%, Attendance 10%)			**Max Marks: 25**

Course Outcomes (COs)	At the end of this course, the student will be able to:
CO1	understand the basic concepts of Neural Networks;
CO2	apply various techniques to train Neural Networks;
CO3	evaluation of deep reinforcement learning;
CO4	implement Neural Networks for problem solving.

INSTRUCTIONS

For Paper Setters: The question paper will consist of five sections A, B, C, D & E. Section E will be compulsory, it will consist of a single question with 10-20 subparts of short answer type, which will cover the entire syllabus and will carry 20% of the total marks of the semester end examination for the course. Section A, B, C & D will have two questions from the respective sections of the syllabus and each question will carry 20% of the total marks of the semester end examination for the course.

For candidates: Candidates are required to attempt five questions in all selecting one question from each of the sections A, B, C & D of the question paper and all the subparts of the questions in Section E. Use of non-programmable calculators is allowed.

SECTION-A

Introduction: The Neural Network – Building Intelligent Machines, The Limits of Traditional Computer Programs, The Mechanics of Machine Learning, The Neuron, Expressing Linear Perceptrons as Neurons, Feed-Forward Neural Networks, Linear Neurons and Their Limitations. Training Feed-Forward Neural Networks – Gradient Descent, The Backpropagation Algorithm.

SECTION-B

Implementing Neural Networks in TensorFlow: Introduction, Comparison of TensorFlow with Alternatives, Installing TensorFlow, Creating and Manipulating Tensor Flow Variables, TensorFlow Operations, Placeholder Tensors, Sessions in TensorFlow, Navigating Variable Scopes and Sharing Variables, Managing Models over the CPU and GPU, Specifying the Logistic Regression Model in TensorFlow.

SECTION-C

Convolutional Neural Networks: Neurons in Human Vision, The Shortcomings of Feature

Selection, Filters and Feature Maps, Full Description of the Convolutional Layer, Max Pooling, Full Architectural Description of Convolution Networks, Closing the Loop on MNIST with convolutional Networks, Image Preprocessing Pipelines Enable More Robust Models, Accelerating Training with Batch Normalization.

SECTION-D

Deep Reinforcement Learning: Introduction, Deep Reinforcement Learning Masters Atari Games Markov Decision Processes (MDP), Explore Versus Exploit, Policy versus Value Learning, Pole-Cart with Policy Gradients- OpenAI Gym; Q-Learning and Deep Q-Networks- Deep Q-Network (DQN), Training DQN.

Text Book:

1. Nikhil Buduma, Nicholas Locascio, Fundamentals of Deep Learning: Designing Next-Generation Machine Intelligence Algorithms, O'Reilly Media, 2017.

Reference Books:

1. Ian Goodfellow, Yoshua Bengio, Aaron Courville, Deep Learning, MIT Press, 2016
2. Michael Nielsen, Neural Networks and Deep Learning, Determination Press, 2015
3. Francois Chollet, Deep Learning with Python, 1/e, Manning Publications Company, 2017

Name of the Course	DATA VISUALIZATION		
Course Code	**DSAI-303**	Credits-3	L-3, T-1, P-0
Lectures to be Delivered	52 (1 Hr Each) (L=39, T=13 for each semester)		
Semester End Examination	**Max Marks: 75**	**Min Pass Marks: 40%**	**Max. Time: 3 hrs**
Internal Assessment (based on sessional test (2) 50%, Tutorials/Assignments 30%, Quiz/Seminar 10%, Attendance 10%)			**Max Marks: 25**

Course Outcomes (COs)	At the end of this course, the student will be able to:
CO1	understand and apply principles of data visualization;
CO2	apply charting primitives to visualize data;
CO3	analyze the relevant libraries to be implemented;
CO4	create visualizations of data items.

INSTRUCTIONS

For Paper Setters: The question paper will consist of five sections A, B, C, D & E. Section E will be compulsory, it will consist of a single question with 10-20 subparts of short answer type, which will cover the entire syllabus and will carry 20% of the total marks of the semester end examination for the course. Section A, B, C & D will have two questions from the respective sections of the syllabus and each question will carry 20% of the total marks of the semester end examination for the course.

For candidates: Candidates are required to attempt five questions in all selecting one question from each of the sections A, B, C & D of the question paper and all the subparts of the questions in Section E. Use of non-programmable calculators is allowed.

SECTION-A

Introduction to Data Visualization: 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, Infographics).

SECTION-B

Basics of Data Visualization – Tables: Reading Data from Standard text files (.txt, .csv, XML), Displaying JSON content Outputting Basic Table Data (Building a table, Using Semantic Table, Configuring the columns), Assuring Maximum readability (Styling your table, Increasing readability, Adding dynamic Highlighting), Including computations, Using data tables library, relating data table to a chart

SECTION-C

Matplotlib: Introduction, Architecture, Elements, High Level Plotting- Historical Background, Matplotlib, NetworkX, Pandas, the grammar of Graphics, Bokeh, New Styles in Matplotlib, Seaborn;

Data Analysis - Pandas, SciPy & Seaborn, Examining & Shaping a database.

SECTION-D

Information Dashboard Design: Introduction, Dashboard design issues and assessment of needs, Considerations for designing dashboard-visual perception, Achieving eloquence, Advantages of Graphics_Library of Graphs, Designing Bullet Graphs, Designing Sparklines, Dashboard Display Media, Critical Design Practices, Putting it all together - Unveiling the dashboard.

Text Books:

1. Jon Raasch, Graham Murray, Vadim Ogievetsky, Joseph Lowery, "JavaScript and jQuery for Data Analysis and Visualization", WROX
2. Scott Murray, Interactive Data Visualization for Web, O'Reilly

Reference Books:

1. Ritchie S. King, Visual story telling with D3" Pearson
2. Ben Fry, Visualizing data: Exploring and explaining data with the processing environment, O'Reilly, 2008.
3. A Julie Steele and Noah Iliinsky, Designing Data Visualizations: Representing Informational Relationships, O'Reilly
4. Andy Kirk, Data Visualization: A Successful Design Process, PAKT
5. Nathan Yau, Data Points: Visualization that means something, Wiley, 2013.
6. Tamara Munzner, Visualization Analysis and Design, AK Peters Visualization Series, CRC Press, Nov. 2014

Name of the Course	EVOLUTIONARY ALGORITHMS		
Course Code	**DSAI-304**	Credits-3	L-3, T-1, P-0
Lectures to be Delivered	52 (1 Hr Each) (L=39, T=13 for each semester)		
Semester End Examination	**Max Marks: 75**	**Min Pass Marks: 40%**	**Max. Time: 3 hrs**
Internal Assessment (based on sessional test (2) 50%, Tutorials/Assignments 30%, Quiz/Seminar 10%, Attendance 10%)			**Max Marks: 25**

Course Outcomes (COs)	At the end of this course, the student will be able to:
CO1	understand the basic concepts of evolutionary algorithms;
CO2	apply fuzzy logic theory to imprecisely defined problems;
CO3	evaluation of advanced genetic algorithms for optimized solutions;
CO4	design high-quality solutions using Genetic Algorithms for optimization and search problems.

INSTRUCTIONS

For Paper Setters: The question paper will consist of five sections A, B, C, D & E. Section E will be compulsory, it will consist of a single question with 10-20 subparts of short answer type, which will cover the entire syllabus and will carry 20% of the total marks of the semester end examination for the course. Section A, B, C & D will have two questions from the respective sections of the syllabus and each question will carry 20% of the total marks of the semester end examination for the course.

For candidates: Candidates are required to attempt five questions in all selecting one question from each of the sections A, B, C & D of the question paper and all the subparts of the questions in Section E. Use of non-programmable calculators is allowed.

SECTION-A

Knowledge: Introduction and Importance of Knowledge, Knowledge based systems, Knowledge Representation, First Order Predicate Logic (FOPL), Syntax and Semantics of FOPL, Knowledge Organization and Manipulation.

SECTION-B

Un–supervised Learning: Kohonen Self Organization Feature maps and Adaptive Resonance Theory. Introduction to Fuzzy Logic and Fuzzy Sets, Fuzzy Relations, Fuzzyfication, Defuzzyfication. Introduction to Hybrid Soft Computing. Applications of Advanced Computing in Pattern Recognition, Signal Processing & Image Retrieval.

SECTION-C

Introduction to Evolutionary Computing & Genetic Algorithms: Introduction to Genetic Algorithms, Goals of Optimization, Working of Genetic Algorithms, A Simple Genetic Algorithm's Computer Implementation highlighting Reproduction by Selection, Crossover, Mutation.

SECTION-D

Advanced GA Techniques: Mapping Objective Function to Fitness Form, Fitness scaling, discretization, Different types of Selection and Crossover techniques. A case study of Travelling Salesman Problem using GA Techniques. Introduction to other Evolutionary Techniques: PSO, Simulated Annealing and Ant Colony Optimization.

Text Books:

1. David E. Goldberg, Genetic Algorithms in Search Optimization and Machine Learning, Pearson Education.
2. S. N. Sivanandam, S. N. Deepa, Principles of Soft Computing, Wiley Publications.

Reference Books:

1. How to Solve It: Modern Heuristics, by Zbigniew Michalewicz, David B.Fogel, second Edition Springer Verlag-2004, ISBN- 3-540-22494-7.
2. Gallant Stephen I, Neural Network Learning & Extent Systems, MIT Press, 1993.
3. Aleksander & Morton, Neural Computing, Chapman & Hall, 1991.
4. Kosko, Neural Networks & Fuzzy Systems, PHI, 1991
5. Dan W. Patterson, 'Introduction to Artificial Intelligence and Expert Systems', Prentice-Hall India Private Limited, 2006.

Name of the Course	**DEEP LEARNING-LAB**		
Course Code	**DSAI-351**	Credits-3	L-0, T-0, P-6
Lectures to be delivered	**32 hours of Lab Sessions**		
Semester End Examination	**Max. Time : 3 hrs**	Max. Marks: 50	Min. Pass Marks:20
Internal Assessment (based on Lab work 30%, Lab record 30%, Viva 30%, Attendance 10%)		Max. Marks: 25	Min. Pass Marks:10

Course Outcomes (COs)	At the end of this course, the student will be able to:
CO1	understand the basic concepts of Neural Network;
CO2	apply various techniques to train Neural Networks;
CO3	evaluation of deep reinforcement learning;
CO4	implement Neural Networks in TensorFlow for problem solving.

List of Experiments:

1. Implement the following using TensorFlow:
   i) An optimization problem
   ii) A linear regression problem, by adjusting a regression line to a dataset
   iii) To solve the "Hello World" of Deep Learning classification projects with the MINST Dataset.
2. Building a Multilayer Model for MNIST in TensorFlow.
3. Building a Convolutional Network for CIFAR-10
4. Implement Pole-Cart with Policy Gradients – Create an Agent.
5. Implement Pole-Cart with Policy Gradients - Building the Model and Optimizer:
   i) Sampling Actions - Keep Track of History
   ii) Policy Gradient Main Function
   iii) PGAgent Performance on Pole-Cart
6. Implementation of Future Return optimization through Agent.
7. Implement Playing Breakout with DQN
   i) Implementing Experience Replay
   ii) DQN Main Loop
   iii) DQNAgent Results on Breakout

Name of the Course	DATA VISUALIZATION Lab		
Course Code	**DSAI-352**	Credits-3	L-0, T-0, P-6
Lectures to be delivered	**32 hours of Lab Sessions**		
Semester End Examination	**Max. Time : 3 hrs**	Max. Marks : 50	Min. Pass Marks:20
Internal Assessment (based on Lab work 30%, Lab record 30%, Viva 30%, Attendance 10%)		Max. Marks: 25	Min. Pass Marks:10

Course Outcomes (COs)	At the end of this course, the student will be able to:
CO1	understand and apply principles of data visualization;
CO2	analyze the relevant libraries to be implemented;
CO3	implementation of charting primitives to visualize data;
CO4	create visualizations of data items.

List of Experiments:

1. Setup Environment for All the Tools
2. Develop the following Program Using HTML5 CANVAS and SVG TAG
    a. Develop the Different basic Graphical Shapes using HTM5 CANVAS
    b. Develop the Different Advanced Graphical Shapes using HTM5 CANVAS
    c. Develop the Different basic Graphical Shapes using HTM5 SVG
    d. Develop the Different Advanced Graphical Shapes using HTM5 SVG
3. Develop Following Program Using HTML5 and JavaScript
    a. Develop the simple bar chart usingTML5 CANVAS
    b. Read the data .txt file and draw Data Table
    c. Read the data .txt file and draw Simple Bar Chart
    d. Read the data .csv file and draw Data Table
    e. Read the data .csv file and draw Column Bar Chart
    f. Read the data XML file and draw Data Table
    g. Read the data XML file and draw Simple Chart
    h. Read JSON Data and draw Data Table
    i. Read JSON Data and draw Simple Chart
4. Develop Following Program Using HTML5 and Canvas.js
    a. Showing the data as a column chart (simple)
    b. Showing the data as a stacked column chart
    c. Showing the Data as a column chart for four age group
    d. Showing the data as a Line chart (single, fewer and multiple lines)
    e. Showing the data as a Pie Chart (single and multiple pie)
    f. Showing the data as a Bar Chart (Simple and multiple)

5. Develop Following Program Using HTML5 and Google Chats API and Map API
    a. Using Google Charts API Basics draw charts like a Bar chart
    b. Using Google Charts API Basics draw charts like a Line chart
    c. Using Google Charts API Basics draw Pie Chart.
    d. Using Google Charts API Basics draw Donut Chart.
    e. Using Google Charts API Basics draw Candle Chart.
    f. Using Google Charts API Basics draw other types of Chart.
    g. Using Google API read JSON file and create Google Map.

Elective Courses

Name of the Course	**CYBER SECURITY**		
Course Code	**DSAI-EL-1**	Credits-3	L-3, T-1, P-0
Lectures to be Delivered	52 (1 Hr Each) (L=39, T=13 for each semester)		
Semester End Examination	**Max Marks: 75**	**Min Pass Marks: 40%**	**Max. Time: 3 hrs**
Internal Assessment (based on sessional test (2) 50%, Tutorials/Assignments 30%, Quiz/Seminar 10%, Attendance 10%)			**Max Marks: 25**

Course Outcomes (COs)	At the end of this course, the student will be able to:
CO1	learn various challenges and constraints in cyber security;
CO2	learn IT ACT (Cyber law) to the given case/problem and analyse it;
CO3	understand the need for Computer Cyber forensics;
CO4	demonstrate the network defence tools to provide security of information.

INSTRUCTIONS

For Paper Setters: The question paper will consist of five sections A, B, C, D & E. Section E will be compulsory, it will consist of a single question with 10-20 subparts of short answer type, which will cover the entire syllabus and will carry 20% of the total marks of the semester end examination for the course. Section A, B, C & D will have two questions from the respective sections of the syllabus and each question will carry 20% of the total marks of the semester end examination for the course.

For candidates: Candidates are required to attempt five questions in all selecting one question from each of the sections A, B, C & D of the question paper and all the subparts of the questions in Section E. Use of non-programmable calculators is allowed.

SECTION-A

Introduction to Cyber Security: Overview of Cyber Security, Internet Governance: Challenges and Constraints, Cyber Threats, Cyber Warfare, Cyber Crime, Cyber terrorism, Cyber Espionage, Need for a Comprehensive Cyber Security Policy, Need for a Nodal Authority, International convention on Cyberspace.

SECTION-B

Introduction to Cybercrime and Laws: Origins of Cybercrime, Classifications of Cyber Crimes, Information Security, Cybercriminals, Criminals Plan for Attacks, Cybercafe, Botnets, Attack Vector, The Indian IT ACT 2000 and amendments.

Tools and Methods used in Cybercrime: Introduction, Proxy Server and Anonymizers, Password Cracking, Keyloggers and Spyware, Virus and Warms, Trojan and backdoors, DOS and DDOS attack, SQLinjection.

SECTION-C

Phishing and Identity Theft: Introduction to Phishing, Methods of Phishing, Phishing Techniques, Phishing Toolkits and Spy Phishing. Identity Theft: PII, Types of Identity Theft, Techniques of ID Theft. Digital Forensics Science, Need for Computer Cyber forensics and Digital Evidence, Digital Forensics Life Cycle.

Introduction to Intellectual Property Law – The Evolutionary Past - The IPR Tool Kit- Para -Legal Tasks in Intellectual Property Law – Ethical obligations in Para Legal Tasks in Intellectual Property Law –types of intellectual property rights.

SECTION-D

Network Defence tools: Firewalls and Packet Filters: Firewall Basics, Packet Filter Vs. Firewall, Packet Characteristic to Filter, Stateless Vs. Stateful Firewalls, Network Address Translation (NAT) and Port Forwarding, Virtual Private Networks, Linux Firewall, Windows Firewall, Snort Detection System, Introduction to block chain technology and its applications.

Text Books:

1. Mike Shema, Anti-Hacker Tool Kit (Indian Edition), McGraw Hill.
2. Nina Godbole and Sunit Belpure, Cyber Security: Understanding Cyber Crimes, Computer Forensics and Legal Perspectives, Wiley.

Reference Books:

1. Marjie T. Britz, Computer Forensics and Cyber Crime: An Introduction, Pearson Education
2. Chwan-Hwa (John) Wu,J. David Irwin, Introduction to Computer Networks and Cyber security, CRC Press
3. Bill Nelson, Amelia Phillips, Christopher Steuart, Guide to Computer Forensics and Investigations, Cengage Learning
4. DebiragE.Bouchoux, Intellectual Property,CengageLearning.

Name of the Course	VIRTUAL REALITY AND AUGMENTED REALITY		
Course Code	**DSAI-EL-2**	Credits-3	L-3, T-1, P-0
Lectures to be Delivered	52 (1 Hr Each) (L=39, T=13 for each semester)		
Semester End Examination	**Max Marks: 75**	**Min Pass Marks: 40%**	**Max. Time: 3 hrs**
Internal Assessment (based on sessional test (2) 50%, Tutorials/Assignments 30%, Quiz/Seminar 10%, Attendance 10%)			**Max Marks: 25**

Course Outcomes (COs)	At the end of this course, the student will be able to:
CO1	learn the characteristics, fundamentals and architecture of AR /VR. Also, understand the scope for AR/VR
CO2	understand the Hardware & Software Requirements, Selection of Hardware & Software for the AR / VR application development
CO3	analyze and build AR/VR applications for chosen industry, healthcare, education case study
CO4	implement software development aspects for AR / VR
CO5	design and develop the interactive AR / VR applications

INSTRUCTIONS

For Paper Setters: The question paper will consist of five sections A, B, C, D & E. Section E will be compulsory, it will consist of a single question with 10-20 subparts of short answer type, which will cover the entire syllabus and will carry 20% of the total marks of the semester end examination for the course. Section A, B, C & D will have two questions from the respective sections of the syllabus and each question will carry 20% of the total marks of the semester end examination for the course.

For candidates: Candidates are required to attempt five questions in all selecting one question from each of the sections A, B, C & D of the question paper and all the subparts of the questions in Section E. Use of non-programmable calculators is allowed.

SECTION-A

Introduction & New Applications: New Industrial applications- Virtual reality in industry, Augmented reality and industrial applications, VR-AR for industrial renewal, And about augmented reality; Computer – Assisted Surgery- Introduction, Virtual reality and simulation for learning, Augmented reality and intervention planning, Augmented reality in surgery, Current conditions and future prospects; Sustainable cities- Mobility aids in an urban environment, Building and architecture, Cities and urbanism, Towards sustainable urban systems; Innovative, integrative and adaptive societies- Education, Arts and cultural heritage.

SECTION-B

The Democratization of VR-AR: New equipment- Introduction, Positioning and Orientation devices, Restitution devices, Technological challenges and perspectives; New Software- Introduction, Developing 3D Applications, Managing peripheral devices, Dedicated VR_AR Software solutions.

SECTION-C

Scientific and Technical Prospects: The promised revolution in the field of entertainment- Introduction, Defining a new, polymorphic immersive medium, Promised experiences, Prospects; Brain-computer interfaces- Brain-computer interfaces: introduction and definition, Working principle of BCIs, Current applications of BCIs, The future of BCIs; Alternative perceptions in virtual reality- Introduction, Pseudo-sensory feedback, Alternative perception of movement, Altered perception of one's body.

SECTION-D

Towards VE that are More Closely Related to the Real World: "Tough" scientific challenges for AR, Topics in AR that are rarely or never approached, Spatial augmented reality, Presence in augmented reality, 3D interaction on tactile surfaces.

The Challenges and Risks of Democratization of VR-AR: Introduction, Health and comfort problems, Solutions to avoid discomfort and unease.

Text Book:

1. Bruno Arnaldi, Pascal Guitton, Guillaume Moreau, Virtual Reality and Augumented Reality: Myths and Reality, John Wiley & Sons, Inc., 2018.

Reference Books:

1. Alan B Craig, William R Sherman, Jeffrey D Will, Developing Virtual Reality Applications: Foundations of Effective Design, Morgan Kaufmann, 2009.
2. Gerard Jounghyun Kim, Designing Virtual Systems: The Structured Approach, 2005.
3. Doug A Bowman, Ernest Kuij, Joseph J La Viola, Jr and Ivan Poupyrev, 3D User Interfaces, Theory and Practice, Addison Wesley, USA, 2005.
4. Oliver Bimber, Ramesh Raskar, Spatial Augmented Reality: Meging Real and Virtual Worlds, 2005.
5. Burdea, Grigore C, Philippe Coiffet, Virtual Reality Technology, Wiley Interscience, India, 2003.
6. John Vince, Virtual Reality Systems, Addison Wesley, 1995.
7. Howard Rheingold, Virtual Reality: The Revolutionary Technology and how it Promises to Transform Society, Simon and Schuster, 1991.
8. William R Sherman, Alan B Craig, Understanding Virtual Reality

Semester-IV

Name of the Course	**PROJECT WORK**		
Course Code	**DSAI-401**	Credits-18	L-0, T-0, P-0
Semester End Examination	External Marks: 350		Min. Pass Marks:140
Internal Assessment (based on Seminar 50% and 50% Log Book & Interim Report)		Max. Marks:100	Min. Pass Marks:40

Course Outcomes (COs)	At the end of this course, the student will be able to:
CO1	understand the methods and techniques of system development
CO2	apply best practices for effective project management
CO3	analyze the real life problems in order to develop optimum solutions
CO4	evaluation of project deliverables
CO5	creation of team spirit and profession ethics

In the Fourth semester, the Chairman/Head of the Department will assign a guide/supervisor to each candidate for his/her Project Work. The candidate shall be required to maintain his/her Project diary (logbook) of work in the Organization / Department. Each student will be required to give at least two seminars on his/her project work . Each student is required to submit three copies of his/her project reports in the Department after completion of the project work which will be evaluated by an external examiner.

Further, the Project work (final semester) will be jointly evaluated by an internal guide and external examiner. Internal assessment will be given on Seminar and Log Book & Interim Report, be evaluated by the department and the award list shall be sent to the examination branch by the Chairman/HOD.