Annamalai University

Faculty of Science

DEPARTMENT OF COMPUTER AND INFORMATION SCIENCE

M. Sc. DataScience (TANSCHE syllabus)

Programme Code: SCIS22

These rules and regulations shall govern the Two year post graduate studies leading to the award of degree of **Master of Science in DataScience** in the Faculty of Science. These academic Regulations shall be called "**Annamalai University, Faculty of Science Two year M.Sc. Data Science Regulations 2023**". They shall come into force with effect from the academic year 2023 – 2024.

1. Definitions and Nomenclature

1.1 **University** refers to Annamalai University.

1.2 **Department** means any of the academic departments and academic centers at the University.

1.3 **Discipline** refers to the specialization or branch of knowledge taught and researched in higher education. For example, Data Science is a discipline in the Computer Science, while Economics is a discipline in Social Sciences.

1.4 **Programme** encompasses the combination of courses and/or requirements leading to a degree. For example, M.A., M.Sc.

1.5 **Course** is an individual subject in a programme. Each course may consist of Lectures / Laboratory / Seminar / Project work / viva-voce etc. Each course has a course title and is identified by a course code.

1.6 **Curriculum** encompasses the totality of student experiences that occur during the educational process.

1.7 **Syllabus** is an academic document that contains the complete information about an academic programme and defines responsibilities and outcomes. This includes course information, course objectives, policies, evaluation, grading, learning resources and course calendar.

1.8 **Academic Year** refers to the annual period of sessions of the University that comprises two consecutive semesters.

1.9 **Semester** is a half-year term that lasts for a minimum duration of 90 days.

1.10 **Choice Based Credit System**: A mode of learning in higher education that enables a student to have the freedom to select his/her own choice of elective courses across various disciplines for completing the Degree programme.

1.11 **Credit** refers to the quantum of course work in terms of number of class hours in a semester required for a programme. The credit value reflects the content and duration of a particular course in the curriculum.

1.12 **Credit Hour** refers to the number of class hours per week required for a course in a semester. It is used to calculate the credit value of a particular course.

1.13 **Programme Outcomes** (POs) are statements that describe crucial and essential knowledge, skills and attitudes that students are expected to achieve and can reliably manifest at the end of a programme.

1.14 **Programme Specific Outcomes** (PSOs) are statements that list what the graduate of a

specific programme should be able to do at the end of the programme.

1.15 **Course Objectives**are statements that define the expected goal of a course in terms of demonstrable skills or knowledge that will be acquired by a student.

1.16 **Course Outcomes** (COs) are statements that describe what students should be able to achieve/demonstrate at the end of a course. They allow follow-up and measurement of learning objectives.

1.17 **Grade Point Average** (GPA) is the average of the grades acquired in various courses that a student has taken in a semester. The formula for computing GPA is given in section 11.3

1.18 **Cumulative Grade Point Average** (CGPA) is a measure of overall cumulative performance of a student over all the semesters. The CGPA is the ratio of total credit points secured by a student in various courses in all semesters and the sum of the total credits of all courses in all the semester is given in section11.4.

1.19 **Letter Grade** is an index of the performance of a student in a particular course. Grades are denoted by the letters S, A, B, C, D, E, RA, and W.

2. Programme Offered and Eligibility Criteria:

The Department of Computer and Information Science offers a Two Year M.Sc. in Data Science programme. A pass in any Bachelor's degree programme of minimum 3 years duration with Mathematics or Statistics as any of the core/ancillary course at Graduate level or an examination accepted by the Syndicate of Annamalai University as equivalent thereto are eligible for admission.

2.1 In the case of SC/ST and Differently-abled candidates, a pass is the minimum qualification for all the above Programmes.

3. Reservation Policy: Admission to the various programmes will be strictly based on the reservation policy of the Government of Tamil Nadu.

4. Programme Duration

4.1 The Two Year Master's Programme consist of two academic years.

4.2 Each academic year is divided into two semesters, the first being from July to November and the second from December to April.

4.3 Each semester will have 90 working days (18 weeks).

5. Programme Structure

5.1 The Two Year Master's Programme consists of Core Courses, Elective Courses (Discipline Centric/Generic), Project, Skill Enhancement Course, Internship/industrial visit and extension activity.

5.2 Core courses

5.2.1 Core Course is mandatory and an essential requirement to qualify for the Degree.

5.2.2 These are a set of compulsory courses essential for each programme.

5.2.3 The core courses include both Theory (Core Theory) and Practical (Core Practical)courses.

5.3 Project

5.3.1 Each student shall undertake a Project and submit a dissertation as per guidelines in the final semester.

5.3.2 The Head of the Department shall assign a Research Supervisor/Project Guide to the student.

5.3.3 The Research Supervisor/Project Guide shall assign a topic for research and monitor the progress of the student periodically.

5.3.4 Students who wish to undertake project work in recognized institutions/industry shall obtain prior permission from the Department. The Research Supervisor/Project Guide will be from the host institute/Department.

5.4 **Elective courses**

5.4.1 **Generic/Discipline Centric** is a course that a student can choose from a range of alternatives.

5.5 **Internship/Industrial Activity (Experiential Learning)**

5.5.1 Experiential learning in the form of internship/industrial activity provides opportunities to students to connect principles of the discipline with real-life situations.

5.5.2 In-plant training/field trip/internship/industrial visit fall under this category.

5.5.3 Experiential learning is categorized as non-core course.

5.6 **Industry/Entrepreneurship**

This course is to introduce students to the activity of setting up a business or businesses, taking on financial risks in the hope of profit.

5.7 **Skill Enhancement Course (SEC):** is a course designed to provide value-based or skill-based knowledge. The main purpose of this course is to provide students with skills in the hands-on-mode to increase their employability.

5.8 Extension Activity The basic objective of extension activity is to create social awareness among the students by providing the opportunities to work with people and also to create an awareness and knowledge of social realities to have concern for the welfare of the community and engage in creative and constructive societal development.

5.8.1 It is mandatory for every student to participate in extension activity.

5.8.2 All the students should enroll under NSS/NCC/CYRC/RRC or any other service organization in the University.

5.8.3 Students should put a minimum attendance of 40 hours in a year duly certified by the Programme Co-Ordinator.

5.8.4 Extension activity shall be conducted outside the class hours.

5.8.5 Extension activity is categorized as non-core course.

5.9 Value Added Course (VAC)

5.9.1 Students may opt to take Value Added Course beyond the minimum credits required for the award of the degree. VACs are outside the normal credit paradigm.

5.10 Online Courses

5.10.1 The Heads of Departments shall facilitate enrolment of students in Massive Open Online Courses (MOOCs) platform such as SWAYAM to provide academic flexibility and enhance the academic career of students.

5.10.2 Students who successfully complete a course in the MOOCs platform shall be exempted from one elective course of the programme.

5.11 Credit Distribution: The credit distribution is organized as follows:

Component	Course	Credits
Part A	**Core (Theory)**	**45**
	Core (Practical)	**12**
	Project with Viva voce	**7**
Part B (i)	**Elective (Generic/Discipline Centric)**	**18**
Part B (ii)	**Internship/Industrial Visit**	**02**
Part B (iii)	**Skill Enhancement Course/Professional Competency Skill**	**06**
Part C	**Extension Activity**	**01**
	TOTAL CREDITS	**91**

Part A component and Part B (i) will be taken into account for CGPA calculation for the post graduate programme and the other components of Part B and Part C will not be included for CGPA calculation and have to be completed during the duration of the programme as per norms, to be eligible for obtaining the PG degree.

5.12 Credit Assignment

Each course is assigned credits and credit hours on the following basis:
1 Credit is defined as
1 Lecture period of one hour duration per week over a semester
1 Tutorial period of one hour duration per week over a semester
1 Practical/Project period of two hours duration per week over a semester.

6 Attendance

6.1 Each faculty handling a course shall be responsible for the maintenance of Attendance and Assessment Record for candidates who have registered for the course.

6.2 The Record shall contain details of the students' attendance, marks obtained in the Continuous Internal Assessment (CIA) Tests, Assignments and Seminars. In addition the Record shall also contain the organization of lesson plan of the Course teacher.

6.3 The record shall be submitted to the Head of the Department and Dean once a month for monitoring the attendance and syllabus coverage.

6.4 At the end of the semester, the record shall be placed in safe custody for any future verification.

6.5 The Course teacher shall intimate to the Head of the Department at least seven calendar days before the last instruction day in the semester about the attendance particulars of all students.

6.6 Each student shall have a minimum of 75% attendance in all the courses of the particular semester failing which he or she will not be permitted to write the End-Semester Examination. The student has to redo the semester in the next year.

6.7 Relaxation of attendance requirement up to 10% may be granted for valid reasons such as illness, representing the University in extracurricular activities and participation in NCC/NSS/YRC/RRC.

7 Mentor-Mentee System

7.1 To help the students in planning their course of study and for general advice on the academic programme, the Head of the Department will attach certain number of students to a member of the faculty who shall function as a Mentor throughout their period of study.

7.2 The Mentors will guide their mentees with the curriculum, monitor their progress, and provide intellectual and emotional support.

7.3 The Mentors shall also help their mentees to choose appropriate electives and value-

added courses, apply for scholarships, undertake projects, prepare for competitive examinations such as NET/SET, GATE etc., attend campus interviews and participate in extracurricular activities.

8 Examinations

8.1 The examination system of the University is designed to systematically test the student's progress in class, laboratory and field work through Continuous Internal Assessment (CIA) Tests and End-Semester Examination (ESE).

8.2 There will be two CIA Tests and one ESE in each semester.

8.3 The Question Papers will be framed to test different levels of learning based on Bloom's taxonomy viz. Knowledge, Comprehension, Application, Analysis, Synthesis and Evaluation/Creativity.

8.4 Continuous Internal Assessment Tests

8.4.1 The CIA Tests shall be a combination of a variety of tools such as class tests, assignments and seminars. This requires an element of openness.

8.4.2 The students are to be informed in advance about the assessment procedures.

8.4.3 The pattern of question paper will be decided by the respective faculty.

8.4.4 CIA Tests will be for one- or two-hours duration depending on the quantum of syllabus.

8.4.5 A student cannot repeat the CIA Test-I and CIA Test-II. However, if for any valid reason, the student is unable to attend the test, the prerogative of arranging a special test lies with the teacher in consultation with the Head of the Department.

8.4.6 For the CIA Tests, the assessment will be done by the Course teacher

8.5 End Semester Examinations (ESE)

8.5.1 The ESE for the first and third semester will be conducted in November and for the second and fourth semester in May.

8.6 Candidates who failed in any course will be permitted to reappear in failed course in the subsequent examinations.

8.7 The ESE will be of three hours duration and will cover the entire syllabus of the course.

9 Evaluation

9.1 Marks Distribution

9.1.1 For each course, the Theory, Practical and project shall be evaluated for a maximum of 100 marks.

9.1.2 For the theory courses, CIA Tests will carry 25% and the ESE 75% of the marks.

9.1.3 For the Practical courses, the CIA Tests will carry 25% and the ESE 75% of the marks.

9.2 Assessment of CIA Tests

9.2.1 For the CIA Tests, the assessment will be done by the Course Instructor

9.2.2 For the Theory Courses, the break-up of marks shall be as follows:

	Marks
Test-I and Test-II	15
Seminar	5
Assignment	5
Total	25

9.2.3 For the Practical Courses (wherever applicable), the break-up of marks shall be as follows:

	Marks
Test-I	10
Test-II	10
Viva-voce and Record	05
Total	25

9.3 Assessment of End-Semester Examinations

9.3.1 Evaluation for the ESE is done by internal examiners.

9.4 Assessment of Project/Dissertation

9.4.1 The Project Report/Dissertation shall be submitted as per the guidelines.

9.4.2 The Project Work/Dissertation shall carry a maximum of 100 marks.

9.4.3 CIA for Project will consist of a Review of literature survey, experimentation/field work, attendance etc.

9.4.4 The Project Report evaluation and viva-voce will be conducted by a committee constituted by the Head of the Department.

9.4.5 The Project Evaluation Committee will comprise the Head of the Department, Project Supervisor, and a senior faculty.

9.4.6 The marks shall be distributed as follows:

Continuous Internal Assessment (25 Marks)		**End Semester Examination (75 Marks)**	
Review-I - 10	Review-II -15	Project / Dissertation Evaluation	Vivavoce
		50	25

9.5 Assessment of Value-added Courses

9.5.1 Assessment of VACs shall be internal. Two CIA Tests shall be conducted during the semester by the Department(s) offering VAC.

9.5.2 The grades obtained in VACs will not be included for calculating the GPA/CGPA.

9.6 Passing Minimum

9.6.1 A student is declared to have passed in each course if he/she secures not less than 50% marks in the ESE and not less than 50% marks in aggregate taking CIA and ESE marks together.

9.6.2 A candidate who has not secured a minimum of 50% of marks in a course (CIA + ESE) shall reappear for the course in the next semester/year.

10. Conferment of the Master's Degree

A candidate who has secured a minimum of 50% marks in all courses prescribed in the programme and earned the minimum required credits shall be considered to have passed the Master's Programme.

11. Marks and Grading

11.1 The performance of students in each course is evaluated in terms Grade Point (GP).

11.2 The sum total performance in each semester is rated by Grade Point Average (GPA) while Cumulative Grade Point Average (CGPA) indicates the Average Grade Point obtained for all the courses completed.

11.3 **The GPA** is calculated by the formula

$$GPA = \frac{\sum_{i=1}^{n} C_i G_i}{\sum_{i=1}^{n} C_i}$$

where, C_i is the Credit earned for the Course i in any semester;

G_i is the Grade Point obtained by the student for the Course i and

n is the number of Courses passedin that semester.

11.4 **CGPA** is the Weighted Average Grade Point of all the Courses passed starting from the first semester to the current semester.

$$CGPA = \frac{\sum_{i=1}^{m} \sum_{i=1}^{n} C_i G_i}{\sum_{i=1}^{m} \sum_{i=1}^{n} C_i}$$

Where, C_i is the Credit earned for the Course i in any semester;

G_i is the Grade Point obtained by the student for the Course i and

n is the number of Courses passedin that semester.

m is the number of semesters.

11.5 **Evaluation:**

11.5.1 **Performance of the student for each course will be rated as shown in the Table.**

Range of Marks	Grade Points	Letter Grade
90 and above	10	S
80-89	9	A
70-79	8	B
60-69	7	C
55-59	6	D
50-54	5	E
Less than 50	0	RA
Withdrawn from the examination	0	W

11.5.2 A ten-point rating scale is used for evaluation of the performance of the student to provide overall grade for the Master's Programme.

CGPA	CLASSIFICATION OF FINAL RESULT
8.25 and above	First Class with Distinction
6.5 and above but below 8.25	First Class
5.0 and above but below 6.5	Second Class
0.0 and above but below 5.0	Re-appear

11.6 **Classification of Results**. The successful candidates are classified as follows:

11.6.1 **For First Class with Distinction:** Candidates who have passed all the courses prescribed in the Programme in the first attempt with a CGPA of 8.25and above within the programme duration. Candidates who have withdrawn from the End Semester Examinations are still eligible for First Class with Distinction (See Section 12 for details).

11.6.2 **For First Class:** Candidates who have passed all the courses with a CGPA of 6.5and above.

11.6.3 **For Second Class:** Candidates who have passed all the courses with a CGPA between 5.0 and less than 6.5.

11.6.4 Candidates who obtain overall highest CGPA in all examinations in the first appearance itself are eligible for University Rank.

11.6.5 **Formula for Conversion of CGPA into Percentage**

CGPA × 9.5 = Percentage

11.7 **Course-Wise Letter Grades**

11.7.1 The percentage of marks obtained by a candidate in a course will be indicated in a letter grade.

11.7.2 A student is considered to have completed a course successfully and earned the credits if he/she secures an overall letter grade other than RA.

11.7.3 A course successfully completed cannot be repeated for the purpose of improving the Grade Point

11.7.4 A letter grade RA indicates that the candidate shall reappear for that course. The RA Grade once awarded stays in the grade sheet of the student and is not deleted even when he/she completes the course successfully later. The grade acquired later by the student will be indicated in the grade sheet of the Odd/Even semester in which the candidate has appeared for clearance of the arrears.

11.7.5 If a student secures RA grade in the Project Work/Field Work/Practical Work/Dissertation, he/she shall improve it and resubmit if it involves only rewriting/ incorporating the clarifications suggested by the evaluators or he/she can re-register and carry out the same in the subsequent semesters for evaluation.

12. Provision for Withdrawal from the End Semester Examination

12.1 The letter grade W indicates that a candidate has withdrawn from the examination.

12.2 A candidate is permitted to withdraw from appearing in the ESE for one course or courses in ANY ONE of the semesters ONLY for exigencies deemed valid by the University authorities.

12.3 Permission for withdrawal from the examination shall be granted only once during the entire duration of the programme.

12.4 Application for withdrawal shall be considered only if the student has registered for the course(s), and fulfilled the requirements for attendance and CIA tests.

12.5 The application for withdrawal shall be made ten days prior to the commencement of the examination and duly approved by the Controller of Examinations. Notwithstanding the mandatory prerequisite of ten days notice, due consideration will be given under extraordinary circumstances.

12.6 Withdrawal will not be granted for arrear examinations of courses in previous semesters and for the final semester examinations.

12.7 Candidates who have been granted permission to withdraw from the examination shall reappear for the course(s) when the course(s) are offered next.

12.8 Withdrawal shall not be taken into account as an appearance for the examination when considering the eligibility of the candidate to qualify for First Class with Distinction.

13. Academic misconduct: Any action that results in an unfair academic advantage/interference with the functioning of the academic community constitutes academic misconduct. This includes but is not limited to cheating, plagiarism, altering academic documents, fabrication/falsification of data, submitting the work of another student, interfering with other students' work, removing/defacing library or computer resources, stealing other students' notes/assignments, and electronically interfering with other students'/University's intellectual property. Since many of these acts may be committed unintentionally due to lack of awareness, students shall be sensitized on

issues of academic integrity and ethics.

14. **Transitory Regulations:** Wherever there has been a change of syllabi, examinations based on the existing syllabus will be conducted for two consecutive years after implementation of the new syllabus in order to enable the students to clear the arrears. Beyond that, the students will have to take up their examinations in equivalent subjects, as per the new syllabus, on the recommendation of the Head of the Department concerned.

15. Notwithstanding anything contained in the above pages as Rules and Regulations governing the Two-Year Master's Programmes at Annamalai University, the Syndicate is vested with the powers to revise them from time to time on the recommendations of the Academic Council.

CURRICULUM AND SCHEME OF EXAMINATIONS
M.Sc. Data Science (Two yearprogramme)
Programme Code: SCIS22

Programme Structure
(For students admitted from the academic year 2023-2024)

Course Code	Titleof theCourse	Credits	Hours	Maximum Marks		
				CIA	ESE	Total
FIRSTSEMESTER						
23DSCC101	Core I - Fundamentals of Data Science	5	7	25	75	100
23DSCC102	Core II - Mathematics for Data Science	5	7	25	75	100
23DSCC103	Core III - Statistics – I	4	6	25	75	100
23DSCE104	Elective I	3	5	25	75	100
23DSCE105	Elective II	3	5	25	75	100
	Total	**20**	**30**			500
SECONDSEMESTER						
23DSCC201	Core IV – Python Programming	5	6	25	75	100
23DSCP202	Core V – Python Programming - Lab	5	6	25	75	100
23DSCC203	Core VI - Statistics – II	4	6	25	75	100
23DSCE204	Elective III	3	4	25	75	100
23DSCE205	ElectiveIV	3	4	25	75	100
23DSCS206	Skill Enhancement Course I	2	4	25	75	100
	Total	**22**	**30**			600

THIRD SEMESTER						
23DSCC301	Core VII - Machine Learning	5	6	25	75	100
23DSCP302	Core VIII - Machine Learning - Lab	5	6	25	75	100
23DSCC303	Core IX – Databases for Data Science	5	6	25	75	100
23DSCC304	Core X – (Industry Module)	4	6	25	75	100
23DSCE305	ElectiveV	3	3	25	75	100
23DSCS306	Skill Enhancement Course II	2	3	25	75	100
23DSCI307	Internship/Industrial Activity	2				100
	Total	**26**	**30**			700
FOURTHSEMESTER						
23DSCC401	Core XI: Cloud Computing	5	6	25	75	100
23DSCC402	Core XII: Big Data Analytics	5	6	25	75	100
23DSCD403	ProjectworkandViva-Voce	7	10	25	75	100
23DSCE404	ElectiveVI	3	4	25	75	100
23DSCS405	Skill Enhancement Course III	2	4	25	75	100
23DSCX406	Extension Activity	1				
	Total	**23**	**30**			500
GrandTotal		**91**	**120**			2300

Elective Courses

Courses are grouped (Group A to Group F) so as to include topics from Data Science, Applied Data Science, Industrial Componentsand IT Oriented courses for flexibility of choice by the stakeholders / institutions.

Semester I: Elective I and Elective II

23DSCE104 - Elective I to be chosen from Group A and

23DSCE105 - Elective II to be chosen from Group B

Group A:

1. Research Methodology for Computer Science
2. Data Structures & Algorithms
3. Internet of Things

Group B:

1. Web Programming
2. Java Programming
3. Operating Systems (Linux Based Commands for Practicals)

Semester II: Elective III & Elective IV

23DSCE204 - Elective III to be chosen from **Group C** and

23DSCE205 - Elective IV to be chosen from **Group D**

Group C:

1. Information Security and Ethics
2. Distributed Systems
3. Software Engineering for Data Science

Group D:

1. Applied Probability
2. Optimisation Techniques
3. Discrete Mathematics

Semester III: Elective V

23DSCE305 - Elective V to be chosen from Group E.

Group E:

1. Natural Language Processing
2. Reinforcement Learning
3. Social Network Analysis

Semester IV: Elective VI

23DSCE404 - Elective VI to be chosen from Group F.

Group F

1. Artificial Intelligence and Data Science
2. Image Recognition
3. Deep Learning

Title of the Course: CORE INDUSTRY MODULES

Paper :23DSCC304 - CORE X

Topics for Core Industry Modules:

1. Business Analytics
2. Health care Analytics
3. Financial Analytics

Skill Enhancement Courses

Skill Enhancement Courses are chosen so as to keep in pace with the latest developments in the academic / industrial front and provides flexibility of choice by the stakeholders / institutions.

Group G (Skill Enhancement Courses) SEC:

23DSCS206 - SEC-I:

- Data Science using Excel
- Data Mining using R

23DSCS306 - SEC-II:

- Emerging Technologies in Data Science
- Cyber Security

23DSCS405 - SEC-III:

- Cloud Computing – Lab
- Block Chain Technology Lab

Syllabus for the Courses of M.Sc. Data Science

<table>
<tr><td colspan="2">Title of the Course</td><td colspan="6">FUNDAMENTALS OF DATA SCIENCE</td></tr>
<tr><td colspan="2">Paper Number</td><td colspan="6">CORE I</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">Core</td><td>Year</td><td>I</td><td rowspan="2">Credits</td><td rowspan="2">5</td><td rowspan="2">Course Code</td><td rowspan="2">23DSCC101</td></tr>
<tr><td>Semester</td><td>I</td></tr>
<tr><td colspan="2" rowspan="2">Instructional Hours per week</td><td>Lecture</td><td colspan="2">Tutorial</td><td colspan="2">Lab Practice</td><td>Total</td></tr>
<tr><td>6</td><td colspan="2">1</td><td colspan="2">--</td><td>7</td></tr>
<tr><td colspan="2">Pre-requisite</td><td colspan="6">Basic understanding of data and process</td></tr>
<tr><td colspan="2">Objectives of the Course</td><td colspan="6">To introduce the concepts and fundamentals of data science and its life cycle</td></tr>
<tr><td colspan="2">Course Objectives</td><td colspan="6">1. To study the concepts of data science.
2. To learn the mechanisms for data storage, wrangling, and aggregation.
3. To understand high dimensional space and singular value decomposition.
4. To acquire knowledge on algorithms for massive data problems and random graphs.
5. To achieve hands-on experience with real-world data analysis.</td></tr>
<tr><td colspan="2" rowspan="3">Course Outline</td><td colspan="6">UNIT-I :INTRODUCTION OF DATA SCIENCE
Data Science – Data science Venn diagram - Basic terminology – Data science case studies- Types of data – levels of data- Types of data analytics - Descriptive analytics-Diagnostic analytics-Predictive analytics- Prescriptive analytics- Five steps of Data science
Book 1 - Chapter 1,2,3</td></tr>
<tr><td colspan="6">UNIT-II :MATHEMATICAL PRELIMINARIES
2.1 Basic Maths – mathematics as discipline – basic symbols and terminology –linear algebra
2.2 Basic Probability – definitions- probability – Bayesian vs frequentist – compound events – conditional probability – rules of probability
Book 1: Unit 2.1 – Chapter 4, Unit 2.2 – Chapter 5</td></tr>
<tr><td colspan="6">UNIT-III :DATA MINING AND DATA WAREHOUSING
Introduction to Data warehousing – Design consideration of data warehouse - Data loading process – case study – Data mining – Data mining techniques – Tools and platforms – case study
Book 2 – Chapter 3 and 4</td></tr>
</table>

	UNIT-IV :VISUALIZING DATA Exploratory Data Analysis –Developing the visual aesthetic – chart types – Great visualizations – Reading graphs – Interactive visualizations **Book 3 - Chapter 6**
	UNIT-V:Data Science – Recent Trends Applications of Data Science, recent trends in various data collection and analysis techniques, various visualization techniques, application development methods of used in data science.
Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper)	Case study on recent developments and presentation
Skills acquired from this course	Data Science Process, Fundamentals, Applications
Recommended Text	1. Ozdemir, Sinan. Principles of data science. Packt Publishing Ltd, 2016.(Unit 1- Chapter 1,2,3 Unit 2.1 – Chapter 4, Unit 2.2 – Chapter 5) 2. Maheshwari, Anil. "Data analytics made accessible." Seattle: Amazon Digital Services, 2 ndedition (2023).(Unit 3 – Chapter 3 and 4) 3. Skiena, Steven S. The data science design manual. Springer, 2017.(Unit 4- chapter 6)
Reference Books	1. Hadrien Jean.Education, C. (2023). Data Science. Certybox Education. 2. Pierson, Lillian. Data science for dummies. John Wiley & Sons, 2021. 3. Grus, Joel. Data science from scratch: first principles with python. O'Reilly Media, 2019. 4. Blum, Avrim, John Hopcroft, and Ravindran Kannan. Foundations of data science. Cambridge University Press, 2020.
Website and e-Learning Source	https://www.analyticsvidhya.com/ https://www.simplilearn.com https://www.ibm.com/in-en/topics/data-science https://www.mygreatlearning.com/blog/what-is-data-science/

COURSE OUTCOMES :

At the end of the course Students will be able to,

PO1 : Understand the types of data and analytics , data science process, and its life cycle.

PO2: Apply math in data science

PO3: Analyze the various data intensive operations and tools

PO4: Evaluate the tools and methods for analyzing the data

PO5: Investigate the recent potential applications and development of data science with real time case studies

OUTCOME MAPPING:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	2	3	3	2
CO2	3	2	2	3	3	2
CO3	3	2	3	3	3	3
CO4	3	2	3	3	3	3
CO5	3	2	2	3	3	3
Weightage ofcoursecontributedtoeachPO	15	10	12	15	15	13

1 – Low 2 – Medium 3 – High --- No Correlation

Title of the Course	**MATHEMATICS FOR DATA SCIENCE**					
Paper Number	**CORE II**					
Category Core	**Year** I	**Credits** 5	**Course Code** 23DSCC102			
	Semester I					
Instructional Hours per week	**Lecture**	**Tutorial**	**Lab Practice**	**Total**		
	6	1	--	7		
Pre-requisite	UG level Mathematics					
Objectives of the Course	To build the mathematical background necessary to understand and implement in data science practical/research work					
Course Objectives	1. To study the characteristics of Linear Equations. 2. To understand types of fundamental Subspaces. 3. To explain about the concepts of vectors and matrices. 4. To describe the Eigenvalues and Eigenvectors. 5. To acquire the knowledge of Linear Transformations.					

Course Outline	**UNIT-I:** **1.1 Vectors and Matrices** Vectors and Linear Combinations-Lengths and Angles from Dot Products-Matrices and Their Column Spaces-Matrix Multiplication AB and CR **1.2 Solving Linear Equations Ax = b** Elimination and Back Substitution-Elimination Matrices and Inverse Matrices-Matrix Computations and A = LU-Permutations and Transposes
	UNIT-II: **2.2 The Four Fundamental Subspaces** Vector Spaces and Subspaces-Computing the Nullspace by Elimination: A = CR-The Complete Solution to Ax = b-Independence, Basis, and Dimension-Dimensions of the Four Subspaces
	UNIT-III: **3.1 Orthogonality** Orthogonality of Vectors and Subspaces-Projections onto Lines and Subspaces-Least Squares Approximations-Orthonormal Bases and Gram-Schmidt-The Pseudoinverse of a Matrix **3.2 Determinants** 3 by 3 Determinants and Cofactors-Computing and Using Determinants-Areas and Volumes by Determinants
	UNIT-IV : **4.1 Eigenvalues and Eigenvectors** Introduction to Eigenvalues : $Ax = \lambda x$ - Diagonalizing a Matrix-Symmetric Positive Definite Matrices-Complex Numbers and Vectors and Matrices-Solving Linear Differential Equations
	UNIT-V: **5.1 The Singular Value Decomposition (SVD)** Singular Values and Singular Vectors-Image Processing by Linear Algebra-Principal Component Analysis (PCA by the SVD) **5.2 Linear Transformations** The Idea of a Linear Transformation-The Matrix of a Linear Transformation-The Search for a Good Basis

Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper)	Problems related to the above topics to be solved (To be discussed during the Tutorial hour)
Skills acquired from this course	Knowledge, Problem Solving, Analytical ability, Professional Competency
Recommended Text	[1] Gilbert Strang, Introduction to Linear Algebra, Wellesley - Cambridge Press, Sixth Edition, 2023
Reference Books	[1] David Lay, Steven Lay, Judi McDonald, Linear Algebra and Its Applications 5th Edition, Pearsons [2] Sheldon Axler, Linear Algebra Done Right (Undergraduate Texts in Mathematics) 3rd ed., Springer, 2015 Edition [3] Jim Hefferon, Linear Algebra, Fourth edition [4] Jeff M Philips, Mathematical Foundations for Data Analysis
Website and e-Learning Source	**https://joshua.smcvt.edu/linearalgebra/**

COURSE OUTCOMES:

Students will be able to,

PO1: Demonstrate understanding of basic mathematical concepts in data science, relating to linear algebra

PO2: Describe properties of linear systems using vectors, perform and interpret matrix operations.

PO3: Describe and compute orthogonality and determinants

PO4: Solve linear differential equations

PO5: Understand and apply the concept of Linear transformations

OUTCOME MAPPING:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	2	3	3	3
CO2	3	3	2	3	3	3
CO3	3	2	3	3	3	3
CO4	3	3	2	3	3	3
CO5	3	3	2	3	3	3
Weightage ofcoursecontributedtoeachPO	15	13	11	15	15	15

<table>
<tr><td colspan="2">Title of the Course</td><td colspan="8">STATISTICS - I</td></tr>
<tr><td colspan="2">Paper Number</td><td colspan="8">CORE III</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">Core</td><td>Year</td><td>I</td><td rowspan="2">Credits</td><td rowspan="2">4</td><td rowspan="2">Course Code</td><td rowspan="2">23DSCC103</td></tr>
<tr><td>Semester</td><td>I</td></tr>
<tr><td colspan="2" rowspan="2">Instructional Hours per week</td><td colspan="2">Lecture</td><td colspan="2">Tutorial</td><td colspan="2">Lab Practice</td><td>Total</td></tr>
<tr><td colspan="2">5</td><td colspan="2">1</td><td colspan="2">--</td><td>6</td></tr>
<tr><td colspan="2">Pre-requisite</td><td colspan="8">Basic Statistics</td></tr>
<tr><td colspan="2">Objectives of the Course</td><td colspan="8">To develop knowledge and understand fundamental concepts in probability and statistics</td></tr>
<tr><td colspan="2">Course Objectives</td><td colspan="8">1. To study the characteristics of Data.
2. To understand Correlation types.
3. To explain certain random variables and distributions.
4. To describe the theory of sampling and the test of hypothesis.
5. To experience about elements of probability based on experiments.</td></tr>
<tr><td colspan="2">Course Outline</td><td colspan="8">UNIT-I:
1.1 Introduction to Statistics
Introduction-Data Collection and Descriptive Statistics-Inferential Statistics and Probability Models-Populations and Samples-A Brief History of Statistics
1.2 Organization and Presentation of Data
Origin and development of Statistics, Scope, limitation and misuse of statistics. Types of data: primary, secondary, quantitative and qualitative data. Types of Measurements: nominal, ordinal, discrete and continuous data. Presentation of data by tables: construction of frequency distributions for discrete and continuous data, graphical representation of a frequency distribution by histogram and frequency polygon, cumulative frequency distributions</td></tr>
</table>

	UNIT-II: **2.1 Descriptive statistics** Introduction-Describing Data Sets-Frequency Tables and Graphs-Relative Frequency Tables and Graphs-Grouped Data, Histograms, Ogives, and Stem and Leaf Plots-Summarizing Data Sets-Sample Mean, Sample Median, and Sample Mode-Sample Variance and Sample Standard Deviation-Sample Percentiles and Box Plots-Chebyshev's Inequality-Normal Data Sets-Paired Data Sets and the Sample Correlation Coefficient **2.2 Correlation** Scatter plot, Karl Pearson coefficient of correlation, Spearman's rank correlation coefficient, multiple and partial correlations (for 3 variates only).
	UNIT-III: **3.1 Random variables and expectation** Random Variables-Types of Random Variables-Jointly Distributed Random Variables-Independent Random Variables-Conditional Distributions-Expectation-Properties of the Expected Value-Expected Value of Sums of Random Variables-Variance-Covariance and Variance of Sums of Random Variables-Moment Generating Functions-Chebyshev's Inequality and the Weak Law of Large Numbers **3.2 Special random variables** The Bernoulli and Binomial Random Variables-Computing the Binomial Distribution Function-The Poisson Random Variable-Computing the Poisson Distribution Function-The Hypergeometric Random Variable-The Uniform Random Variable- Normal Random Variables-Exponential Random Variables-The Poisson Process-The Gamma Distribution-Distributions Arising from the Normal-The Chi-Square Distribution-The t-Distribution-The F Distribution-The Logistics Distribution

	UNIT-IV: **4.1 Distributions of sampling statistics** Introduction-The Sample Mean-The Central Limit Theorem-Approximate Distribution of the Sample Mean, How Large a Sample Is Needed?-The Sample Variance-Sampling Distributions from a Normal Population-Distribution of the Sample Mean, Joint Distribution of X and S-Sampling from a Finite Population **4.2 Parameter estimation** Introduction-Maximum Likelihood Estimators-Interval Estimates-Confidence Interval for a Normal Mean When the Variance is Unknown-Confidence Intervals for the Variance of a Normal Distribution - Estimating the Difference in Means of Two Normal Populations-Approximate Confidence Interval for the Mean of a Bernoulli Random Variable-Confidence Interval of the Mean of the Exponential Distribution-The Bayes Estimator
	UNIT-V : **5.1 Basics and Elements of Probability** Random experiment, sample point and sample space, event, algebra of events. Definition of Probability: classical, empirical and axiomatic approaches to probability, properties of probability. Theorems on probability, conditional probability and independent events, Laws of total probability, Baye's theorem and its applications-Introduction-Sample Space and Events-Venn Diagrams and the Algebra of Events-Axioms of Probability-Sample Spaces Having Equally Likely Outcomes
Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper)	Problems related to the above topics to be solved (To be discussed during the Tutorial hour)
Skills acquired from this course	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill

Recommended Text	[1] Sheldon M. Ross, Introduction to Probability and Statistics for Engineers And Scientists, Elsevier Academic Press, UK, Fifth Edition, 2023 [2]. Rohatgi V.K and Saleh E, An Introduction to Probability and Statistics, 3rd edition, John Wiley & Sons Inc., New Jersey, 2015. [3]. Gupta S.C and Kapoor V.K, Fundamentals of Mathematical Statistics, 11th edition, Sultan Chand & Sons, New Delhi, 2014.
Reference Books	Jim Frost, Introduction to Statistics: An Intuitive Guide for Analyzing Data and Unlocking Discoveries
Website and e-Learning Source	https://onlinestatbook.com/2/ https://www.simplilearn.com/tutorials/statistics-tutorial https://towardsdatascience.com/fundamentals-of-statistics-for-data-scientists-and-data-analysts-69d93a05aae7

COURSE OUTCOMES:

Students will be able to

PO1: Organize, manage and present data.

PO2: Understand, describe, and calculate the measures of data and correlation.

PO3: Recognize and understand various probability distribution functions, calculate and interpret expected results

PO4: Apply the methods of estimating a parameter.

PO5: Understand the concept of probability and apply for simple events

OUTCOME MAPPING:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	**3**	**3**	**2**	**3**	**3**	**3**
CO2	**2**	**3**	**3**	**3**	**3**	**2**
CO3	**2**	**3**	**3**	**3**	**3**	**2**
CO4	**3**	**3**	**3**	**3**	**3**	**2**
CO5	**3**	**3**	**2**	**3**	**3**	**3**
Weightage ofcoursecontributedtoeachPO	**13**	**15**	**13**	**15**	**15**	**12**

<table>
<tr><td colspan="2">Title of the Course</td><td colspan="6">Python Programming</td></tr>
<tr><td colspan="2">Paper Number</td><td colspan="6">CORE IV</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">Core</td><td>Year</td><td>I</td><td rowspan="2">Credits</td><td rowspan="2">5</td><td rowspan="2">Course Code</td><td rowspan="2">23DSCC201</td></tr>
<tr><td>Semester</td><td>II</td></tr>
<tr><td colspan="2" rowspan="2">Instructional Hours per week</td><td colspan="2">Lecture</td><td colspan="2">Tutorial</td><td colspan="2">Lab Practice</td><td>Total</td></tr>
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<tr><td colspan="2">Pre-requisite</td><td colspan="6">NA</td></tr>
<tr><td colspan="2">Objectives of the Course</td><td colspan="6">To be able to think logically and develop interactive programs using the python constructs, functions, data structures, classes and objects, files.</td></tr>
<tr><td colspan="2">Course Objectives</td><td colspan="6">1. To understand the variables, conditionals, loops, recursion and function calls in Python.
2. To use basic data structures such as List, Dictionary and be able to manipulate text files and images.
3. To learn the object oriented concepts in Python.
4. To experiment about file and exception handling in python
5. To acquire skills in database and GUI programming through Python.</td></tr>
<tr><td colspan="2">Course Outline</td><td colspan="6">UNIT-I : Introduction to Computers, Programs and Python -
Introduction - Computer and its components - Programming Languages - Operating Systems - The history of Python - Introduction to python programming - Programming Style and Documentation - Programming Errors - Introduction to Graphics Programming
Chapter - 1
Elementary Programming - Input - Output - Identifiers - Variables, Assignment Statements and Expressions - Simultaneous Assignments - Named Constants - Numeric Data Types and Operators - Evaluating Expressions and Operator Precedence - Augmented Assignment Operators - Type Conversion and Rounding
Chapter - 2
Mathematical Functions, Strings and Objects - Introduction - Common Python Functions - Strings and Characters - Introduction to Objects and Methods - Formatting Numbers and Strings - Drawing various shapes with Colors and Fonts
Chapter - 3</td></tr>
</table>

	UNIT-II : Selections - Introduction - Boolean Types, Values and Expressions - Generating Random Numbers - Different forms of if statements - Logical Operators - Conditional Expressions - Operator Precedence and Associativity **Chapter - 4** **Loops** - Introduction - while, for , Nested Loops - break and Continue **Chapter - 5**
	UNIT-III : Functions - Introduction - Defining and calling a function - Return single and multiple values - Positional, Keyword and Default Arguments - Passing Arguments by Reference Values - Modularizing Code - Function Abstraction and Stepwise Refinement - Recursion **Chapter - 6, Chapter 15 - 15.1,15.2,15.4** **Objects and Classes -** Introduction - Defining Classes for Objects - UML Class Diagrams - Immutable vs Mutable Objects - Hiding Data Fields - Class Abstraction and Encapsulation - Object Oriented Thinking **Chapter - 7** **Inheritance and Polymorphism -** Superclasses and Subclasses - Overriding methods - Object class - Polymorphism and Dynamic binding **Chapter - 12**
	UNIT-IV : More on Strings and Special Methods - Introduction - Str class - Operator Overloading and Special Methods - **Chapter - 8** **Lists -** Basics - Copying Lists - Passing Lists to Functions - Returning a List from a Function - Searching, Sorting Lists - **Chapter 10** **Multidimensional Lists** - Processing Two - Dimensional Lists - Passing Two - Dimensional Lists to Functions - Multidimensional Lists **Chapter 10**
	UNIT-V: Tuples, Sets and Dictionaries – Introduction - Tuples - Sets - Comparing the Performance of Sets and Lists - Dictionaries - **Chapter - 14** **Files and Exception Handling** – Introduction - Text Input and Output - File Dialogs - Retrieving Data from Web - Exception Handling - Raising Exceptions - Processing Exceptions using Exception Objects - Defining Custom Exception Classes - Binary IO Using Pickling **Chapter - 13**

Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper)	Case Studies related to the above topics given in the Text Book to be solved. (To be discussed during the Tutorial hour)
Skills acquired from this course	Problem Solving, Analytical ability, Professional Competency, Programming Knowledge
Recommended Text	Y. Daniel Lang, *Introduction to Programming using Python*, 2nd Edition, Pearson Education Inc., 2013.
Reference Books	1. Allen B. Downey. Think Python. How to Think Like a Computer Scientist, 2ndedition, O'Reilly Publishers, 2016. 2. Corey Wade, et al :*The Python Workshop*, 2nd Edition, Packt, 2022. 3. David Beazley, Brian K. Jones. Python Cookbook: Recipes for Mastering Python 3, 3rd Edition, 2013 Harsh Bhasin. Python for Beginners. New Age International Publishers,2018. 4. Martin C. Brown. Python: The Complete Reference. McGraw Hill Education; Fourth edition, 2018.
Website and e-Learning Source	https://realpython.com, http://docs.python.org, http://diveintopython.org/, https://www.w3schools.com/python/ , https://www.tutorialspoint.com/python/index.htm

COURSE OUTCOMES :

Students will be able to

PO1: Recall the components of a computer, demonstrate the appropriate use of data types, mathematical functions and strings in a program

PO2: State the use of selection and looping constructs, compare and choose an appropriate construct for a given problem

PO3: Define Functions, Classes and Objects, defend the use of functions, classes and objects in a given problem

PO4: Define Strings and Lists, implement Lists and Strings appropriately, design new problems using appropriate data structures

PO5: Define Tuples, sets, dictionaries and files, compare programs with and without files,develop applications using the different data structures.

OUTCOME MAPPING:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	2	3	3	3
CO2	2	3	3	3	3	2
CO3	2	3	3	3	3	2
CO4	3	3	3	3	3	2
CO5	3	3	2	3	3	3
Weightage ofcoursecontributedtoeachPO	13	15	13	15	15	12

<table>
<tr><td colspan="2">Title of the Course</td><td colspan="6">Python Programming - Lab</td></tr>
<tr><td colspan="2">Paper Number</td><td colspan="6">CORE V</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">Core</td><td>Year</td><td>I</td><td rowspan="2">Credits</td><td rowspan="2">5</td><td rowspan="2">Course Code</td><td rowspan="2">23DSCP202</td></tr>
<tr><td>Semester</td><td>II</td></tr>
<tr><td colspan="2" rowspan="2">Instructional Hours per week</td><td colspan="2">Lecture</td><td colspan="2">Tutorial</td><td colspan="2">Lab Practice</td><td>Total</td></tr>
<tr><td colspan="2">—</td><td colspan="2">—</td><td colspan="2">6</td><td>6</td></tr>
<tr><td colspan="2">Pre-requisite</td><td colspan="6">NA</td></tr>
<tr><td colspan="2">Objectives of the Course</td><td colspan="6">To be able to apply appropriately the python programming knowledge gained and develop computer based solutions for a given problem</td></tr>
<tr><td colspan="2">Course Objectives</td><td colspan="6">1. To learn to implement the concepts of data science through Python programs.
2. To know about usage of various python libraries.
3. To load various kinds of data and display them in various formats for better understanding.
4. To learn to collect, explore, clean, munge and manipulate data.
5. To understand how statistics and probability is used in data science applications.</td></tr>
<tr><td colspan="2">Course Outline</td><td colspan="6">UNIT-I :
1. Installation of the required software
2. Programs using basic data types and operators
3. Programs involving Mathematical functions
4. Program in String Manipulations</td></tr>
</table>

	UNIT-II : 1. Programs using different forms of if statement 2. Drawing various shapes using turtle 3. Programs involving repeated execution of a set of statements 4. Programs using break and continue 5. Programs using random
	UNIT-III : 1. Modular programming using functions 2. Programs using positional, keyword and default argument 3. Programs using pass by value, pass by reference 4. Programs using classes and objects 5. Programs using Inheritance
	UNIT-IV : 1. Programs on Str class and special methods 2. Programs using Lists and List manipulation 3. Programs using Two-Dimensional Lists
	UNIT-V: 1. Programs using Tuple and its methods 2. Programs with Set and Set manipulation 3. Programs using Dictionaries 4. Program comparing the performance of Sets and Lists 5. Programs handling Text Files 6. Programs handling Binary Files 7. Programs handling exceptions
Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper)	Case Studies related to the above topics given in the Text Book to be solved.
Skills acquired from this course	Problem Solving, Analytical ability, Professional Competency, Programming Knowledge
Recommended Text	Y. Daniel Lang, *Introduction to Programming using Python*, 2nd Edition, Pearson Education Inc., 2013.

Reference Books	1. Allen B. Downey. Think Python. How to Think Like a Computer Scientist, 2ndedition, O'Reilly Publishers, 2016. 2. Corey Wade, et al :*The Python Workshop*, 2nd Edition, Packt, 2022. 3. David Beazley, Brian K. Jones. Python Cookbook: Recipes for Mastering Python 3, 3rd Edition, 2013 Harsh Bhasin. Python for Beginners. New Age International Publishers,2018. 4. Martin C. Brown. Python: The Complete Reference. McGraw Hill Education; Fourth edition, 2018.
Website and e-Learning Source	https://realpython.com, http://docs.python.org, http://diveintopython.org/, https://www.w3schools.com/python/ , https://www.tutorialspoint.com/python/index.htm

COURSE OUTCOMES:

Students will be able to

PO1: Recall the components of a computer, demonstrate the appropriate use of data types, mathematical functions and strings in a program

PO2: State the use of selection and looping constructs, compare and choose an appropriate construct for a given problem

PO3: Develop modular programming using functions , Design program using OO constructs

PO4: Demonstrate Strings and Lists, implement Lists and Strings appropriately, design new problems using appropriate data structures

PO5: Demonstrate Tuples, sets, dictionaries and files, compare programs with and without files, develop applications using different data structures

OUTCOME MAPPING:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	1	3	3	3
CO2	3	3	3	3	3	3
CO3	3	3	2	3	3	3
CO4	3	3	2	3	3	2
CO5	3	3	3	3	3	3
Weightage ofcoursecontributedtoeachPO	15	15	11	15	15	14

<table>
<tr><td colspan="2">Title of the Course</td><td colspan="8">STATISTICS - II</td></tr>
<tr><td colspan="2">Paper Number</td><td colspan="8">CORE VI</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">Core</td><td>Year</td><td>I</td><td rowspan="2">Credits</td><td rowspan="2">4</td><td rowspan="2">Course Code</td><td rowspan="2">23DSCC203</td></tr>
<tr><td>Semester</td><td>II</td></tr>
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<tr><td colspan="2">Pre-requisite</td><td colspan="8">Statistics in Semester I</td></tr>
<tr><td colspan="2">Objectives of the Course</td><td colspan="8">To develop knowledge and understand fundamental concepts in probability and statistics</td></tr>
<tr><td colspan="2">Course Objectives</td><td colspan="8">1. To understand probability theory for investigating the important features of the Random experiments.
2. To explain certain probability distribution which is useful in constructing probabilistic models for observed phenomena.
3. To learn about Regression.
4. To describe the theory of sampling and the test of hypothesis.
5. To study the characteristics of a population through a sample of population with variates.</td></tr>
<tr><td colspan="2">Course Outline</td><td colspan="8">UNIT-I:
1.1 INTRODUCTION
Population and Statistics – Finite and Infinite population – Parameter and Statistics – Types of sampling - Sampling Distribution – Sampling Error - Standard Error – Test of significance –concept of hypothesis – types of hypothesis – Errors in hypothesis-testing – Critical region – level of significance - Power of the test – p-value.
1.2 Hypothesis testing
Introduction-Significance Levels-Tests Concerning the Mean of a Normal Population-Case of Known Variance-Case of Unknown Variance: The t-Test-Testing the Equality of Means of Two Normal Populations-Case of Known Variances-Case of Unknown Variances-Case of Unknown and Unequal Variances-The Paired t-Test- Hypothesis Tests Concerning the Variance of a Normal Population-Testing for the Equality of Variances of Two Normal Populations-Hypothesis Tests in Bernoulli Populations-Testing the Equality of Parameters in Two Bernoulli Populations-Tests Concerning the Mean of a Poisson Distribution-Testing the Relationship Between Two Poisson Parameters</td></tr>
</table>

	UNIT-II: **2.1 Hypothesis Testing-II** Students t-distribution and its properties (without proofs) – Single sample mean test – Independent sample mean test – Paired sample mean test – Tests of proportion (based on t distribution) – F distribution and its properties (without proofs) – Tests of equality of two variances using F-test – Chi-square distribution and its properties (without proofs) – chisquare test for independence of attributes – Chi-square test for goodness of fit.
	UNIT-III: **3.1 Regression** Introduction-Least Squares Estimators of the Regression Parameters-Distribution of the Estimators-Statistical Inferences About the Regression Parameters-Inferences Concerning β - Inferences Concerning α- Inferences Concerning the Mean Response $\alpha+\beta x_0$ - Prediction Interval of a Future Response-Summary of Distributional Results- The Coefficient of Determination and the Sample Correlation Coefficient-Analysis of Residuals: Assessing the Model-Transforming to Linearity-Weighted Least squares-Polynomial Regression - Multiple Linear Regression-Predicting Future Responses - Logistic Regression Models for Binary Output Data
	UNIT-IV: **4.1 Analysis of variance** Introduction-An Overview-One-Way Analysis of Variance-Multiple Comparisons of Sample Means-One-Way Analysis of Variance with Unequal Sample Sizes-Two-Factor Analysis of Variance: Introduction and ParameterEstimation-Two-Factor Analysis of Variance: Testing Hypotheses-Two-Way Analysis of Variance with Interaction **4.2 Goodness of fit tests and categorical data analysis** Introduction-Goodness of Fit Tests When All Parameters Are Specified-Determining the Critical Region by Simulation-Goodness of Fit Tests When Some Parameters Are Unspecified-Tests of Independence in Contingency Tables -Tests of Independence in Contingency Tables Having Fixed Marginal Totals-The Kolmogorov–Smirnov Goodness of Fit Test for Continuous Data

	UNIT-V : **5.1 Nonparametric hypothesis tests** Introduction-The Sign Test-The Signed Rank Test-The Two-Sample Problem-The Classical Approximation and Simulation-Wilcoxon Signed Rank Test for one and paired samples-The Runs Test for Randomness -Median test and Mann-Whitney-Wilcoxon tests for two samples.
Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper)	Problems related to the above topics to be solved (To be discussed during the Tutorial hour)
Skills acquired from this course	Knowledge, Problem Solving, Analytical ability, Professional Competency
Recommended Text	[1] Sheldon M. Ross, Introduction to Probability and Statistics for Engineers And Scientists, Elsevier Academic Press, UK, Fifth Edition, 2023 [2] Gupta S.C and Kapoor V.K, Fundamentals of Mathematical Statistics, 12th edition, Sultan Chand & Sons, New Delhi, 2020. [3] Brian Caffo, Statistical Inference for Data Science, Learnpub, 2016.
Reference Books	[1] Allen B. Downey,Think Stats- Exploratory data analysis, O'reilly, 2nd Edition [2] Erwin Kreyszig, Advanced Engineering Mathematics, Wiley Publications, Tenth Edition [3] Jim Frost, Introduction to Statistics: An Intuitive Guide for Analyzing Data and Unlocking Discoveries
Website and e-Learning Source	https://onlinestatbook.com/2/ https://www.simplilearn.com/tutorials/statistics-tutorial https://towardsdatascience.com/fundamentals-of-statistics-for-data-scientists-and-data-analysts-69d93a05aae7

COURSE OUTCOMES:
Students will be able to

PO1: Identify the four steps of hypothesis testing.
PO2: Gain a thorough understanding of applied principles of statistics.
PO3: To develop knowledge and skills in theoretical, computational and application-oriented statistics
PO4: Apply the methods of analysis of variance
PO5: Understand and apply the concept of non-parametric tests

OUTCOME MAPPING:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	3	1	1	2	2
CO2	3	3	2	2	2	2
CO3	3	2	2	3	2	2
CO4	3	2	2	2	2	3
CO5	3	3	2	3	2	3
Weightage ofcourse contributedtoeachPO	14	13	9	11	10	12

Title of the Course		**Machine Learning**					
Paper Number		**CORE VII**					
Category	Core	**Year**	II	**Credits**	5	**Course Code**	23DSCC301
		Semester	III				
Instructional Hoursper week		**Lecture**	**Tutorial**	**Lab Practice**	**Total**		
		5	1	--	6		
Pre-requisite		Basic Programming Skill and Data Knowledge					
Objectives of the Course		To understand the different types, steps and algorithms involved in Machine Learning Process					
Course Objectives		1. To describe the data, essential steps for creating a typical ML model and the fundamentals of pattern classification 2. To examine different ML algorithms and unprocessed data and features 3. To Implement the essential techniques to reduce the number of features in a dataset and test the performance of predictive models 4. To learn multiple algorithms, combine and produce ensembles, discuss the essential techniques for modeling linear relations 5. To discuss the clustering algorithms, develop a Web application embedding a ML model.					

Course Outline	**UNIT-I : Data Analytics with pandas and NumPy -** NumPy and basic stats - Matrices - pandas library - Working with data - Null Values - Creating statistical graphs **Book 1, Chapter -10** **Giving Computers the ability to learn from data -** Introduction - Building intelligent systems to transform data into knowledge - The three different types of Machine Learning(ML) - Introduction to basic terminology and notations - A roadmap for building ML systems - Using Python for ML **Book 2, Chapter - 1** **Training Simple ML Algorithms for Classification -** Early History of ML - Implementing a Perceptron learning algorithm - Adaptive linear neurons and the convergence of learning **Book 2, Chapter - 2**
	UNIT-II : ML Classifiers using sckikit-learn - Choosing a classification algorithm - Training a perceptron - Modeling class probabilities via logistic regression - Maximum margin classification with support vector machines(SVM) - Solving nonlinear problems using a kernel SVM - Decision tree learning - K-nearest neighbours: a lazy learning algorithm **Book 2 , Chapter 3** **Data Preprocessing -** Missing data - Categorical data - Partitioning a dataset into separate training and test datasets - Bringing features onto the same scale - Selecting meaningful features - Assessing feature importance with random forests **Book 2, Chapter - 4**
	UNIT-III : Compressing Data via Dimensionality Reduction - Unsupervised dimensionality reduction via principal component analysis - Supervised data compression via linear discriminant analysis - Using kernel principal component analysis for nonlinear mappings **Book 2, Chapter - 5** **Learning Best Practices for Model Evaluation and Hyperparameter Tuning -** Streamlining workflows with pipelines - Using k-fold cross-validation to assess model performance - Debugging algorithms with learning and validation curves - Fine-tuning ML models via grid search - Looking at different performance evaluation metrics **Book 2, Chapter - 6**

	UNIT-IV : Combining different models for ensemble learning - Learning with ensembles - Combining classifiers via majority vote - Bagging: building an ensemble of classifiers from bootstrap samples - Leveraging weak learners via adaptive boosting **Book 2, Chapter - 7** **Predicting Continuous Target Variables with Regression Analysis - Introducing Linear regression -** Implementing an ordinary least squares linear regression model - Fitting a robust regression model using RANSAC - Evaluating the performance of linear regression models - Using regularised methods for regression - Turning a linear regression model into a curve -polynomial regression - Dealing with nonlinear relationships using random forests **Book 2, Chapter - 10**
	UNIT-V: Working with Unlabelled Data – Grouping objects by similarity using k-means - Organising clusters as a hierarchical tree - Locating regions of high density via DBSCAN **Book 2, Chapter - 11** **Introduction to Embedding a ML model into a Web Application** - Serialising fitted scikit-learn estimators - Setting up an SQLite database for data storage - Developing a web application with Flask - Turning any classifier into a web application - Deploying the web application to a public server **Book 2, Chapter - 9**
Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper)	Mini project applying ML concepts in existing / real time data
Skills acquired from this course	Preprocessing, ML steps, Prediction and Performance evaluation , Embedding ML model into a web application
Recommended Text	1. Corey Wade et al, Vahid Mirjalili, The Python Workshop, 2nd Edition, packs publishing, 2022 2. Sebastian Raschka and VahidMirjalili, Python Machine Learning, 3rd Edition, packt publishing, 2019

Reference Books	1. Andreas C. Mueller, Sarah Guido. Introduction to Machine Learning with Python. O'Reilly Media, Inc., 2016. 2. Ethem Alpaydin, Introduction to Machine Learning, 2nd Edition, http://mitpress.mit.edu/catalog/item/default.asp?ttype=2&tid=12012, 2010 3. Wes McKinney. Python for Data Analysis. O′Reilly Media, Inc., 1005 Gravenstein Highway North, Sebastopol, second edition, 2018
Website and e-Learning Source	1. https://data-flair.training/blogs/machine-learning-tutorial/ 2. https://www.geeksforgeeks.org/machine-learning/

Course Outcomes :
Upon completion of the course, the student will be able to,

PO1: To understand, impart and analyze the concepts and of Machine Learning Techniques and types of data
PO2: To comprehend, apply and evaluate the classification techniques for real-world applications
PO3: To understand, use and perform evaluation of Regression methods
PO4: To recognize, implement and analysethe unsupervised techniques for real-world applications
PO5: To understand, identify, implement and review the deep learning techniques for real-time applications

OUTCOME MAPPING:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	**3**	**3**	**2**	**2**	**2**	**2**
CO2	**3**	**3**	**2**	**3**	**3**	**2**
CO3	**3**	**2**	**3**	**2**	**3**	**3**
CO4	**3**	**2**	**3**	**2**	**3**	**3**
CO5	**3**	**3**	**3**	**3**	**3**	**3**
Weightageof course contributedtoeachPO	**15**	**13**	**13**	**12**	**14**	**13**

<table>
<tr><td colspan="2">Title of the Course</td><td colspan="6">Machine Learning - Lab</td></tr>
<tr><td colspan="2">Paper Number</td><td colspan="6">CORE VIII</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">Core</td><td>Year</td><td>II</td><td rowspan="2">Credits</td><td rowspan="2">5</td><td rowspan="2">Course Code</td><td rowspan="2">23DSCP302</td></tr>
<tr><td>Semester</td><td>III</td></tr>
<tr><td colspan="2" rowspan="2">Instructional Hours per week</td><td colspan="2">Lecture</td><td>Tutorial</td><td colspan="2">Lab Practice</td><td>Total</td></tr>
<tr><td colspan="2">—</td><td>--</td><td colspan="2">6</td><td>6</td></tr>
<tr><td colspan="2">Pre-requisite</td><td colspan="6">Basic Programming Skill and Data Knowledge</td></tr>
<tr><td colspan="2">Objectives of the Course</td><td colspan="6">To preprocess the data and build ML models using appropriate techniques and evaluate the model</td></tr>
<tr><td colspan="2">Course Objectives</td><td colspan="6">1. To learn about algorithms and visualization
2. To understand the Gaussian densities and its implementation using Python
3. To implement classification, clustering and regression algorithms in Python
4. To implement the convolution neural network architecture using Python
5. To solve the challenging research problems in the area of Speech and Image processing</td></tr>
<tr><td colspan="2" rowspan="3">Course Outline</td><td colspan="6">UNIT-I :
1. Programs using NumPy and pandas
2. Visualising using graphs
3. Perceptron learning algorithm
4. Adaline</td></tr>
<tr><td colspan="6">UNIT-II :
5. Training a perceptron
6. Modeling class probabilities via logistic regression
7. Maximum margin classification with support vector machines(SVM)
8. Solving nonlinear problems using a kernel SVM
9. Decision tree</td></tr>
<tr><td colspan="6">UNIT-III :
10. Unsupervised dimensionality reduction via principal component analysis
11. Supervised data compression via linear discriminant analysis
12. Using k-fold cross-validation to assess model performance
13. Debugging algorithms with learning and validation curves
14. Fine-tuning ML models via grid search
15. Implementing different performance evaluation metrics</td></tr>
</table>

	UNIT-IV : **16.** Ensemble Learning 17. Ordinary least squares linear regression model 18. Evaluating the performance of linear regression models 19. Regularised methods for regression 20. Nonlinear relationships using random forests
	UNIT-V: **21.** Grouping objects by similarity using k-means 22. Organising clusters as a hierarchical tree 23. Locating regions of high density via DBSCAN 24. Embedding a ML model into a Web Application
Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper)	1. Mini project applying ML concepts in existing / real time data 2. Comparing the performance of different ML algorithms on a given dataset
Skills acquired from this course	Preprocessing, ML steps, Prediction and Performance evaluation , Embedding ML model into a web application
Recommended Text	1. Corey Wade et al, Vahid Mirjalili, The Python Workshop, 2nd Edition, packs publishing, 2022 2. Sebastian Raschka and VahidMirjalili, Python Machine Learning, 3rd Edition, packt publishing, 2019

Reference Books	1. Andreas C. Mueller, Sarah Guido. Introduction to Machine Learning with Python. O'Reilly Media, Inc., 2016. 2. Ethem Alpaydin, Introduction to Machine Learning, 2nd Edition, http://mitpress.mit.edu/catalog/item/default.asp?ttype=2&tid=12012, 2010 3. Wes McKinney. Python for Data Analysis. O′Reilly Media, Inc., 1005 Gravenstein Highway North, Sebastopol, second edition, 2018
Website and e-Learning Source	1. https://machinelearningmastery.com/machine-learning-in-python-step-by-step/ 2. https://www.tutorialspoint.com/machine_learning_with_python/index.htm 3. https://pythonprogramming.net/machine-learning-tutorial-python-introduction/

COURSE OUTCOMES :

Upon completion of the course, the student will be able to

CO1: Apply pandas, NumPy and Matplotlib to read in , process and visualise data, implement linear classification algorithms

CO2: Compare classifiers with linear and non-linear decision boundaries, select relevant features for the model construction

CO3: Apply data compression and best practices for model evaluation and hyper parameter tuning

CO4: Select appropriate algorithms and ensemble

CO5: Apply clustering algorithms on unlabelled data, construct a web application embedding a ML model

OUTCOME MAPPING :

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	2	3	3	3
CO2	3	3	2	3	2	2
CO3	3	2	3	3	2	2
CO4	3	2	3	2	3	2
CO5	3	3	2	3	3	2
Weightageofcoursecontributed to eachPO	15	13	12	14	13	11

<table>
<tr><td colspan="2">Title of the Course</td><td colspan="8">Databases for Data Science</td></tr>
<tr><td colspan="2">Paper Number</td><td colspan="8">CORE IX</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">Core</td><td>Year</td><td>II</td><td rowspan="2">Credits</td><td rowspan="2">5</td><td rowspan="2">Course Code</td><td rowspan="2">23DSCC303</td></tr>
<tr><td>Semester</td><td>III</td></tr>
<tr><td colspan="2" rowspan="2">Instructional Hours per week</td><td colspan="2">Lecture</td><td colspan="2">Tutorial</td><td colspan="2">Lab Practice</td><td>Total</td></tr>
<tr><td colspan="2">4</td><td colspan="2">--</td><td colspan="2">2</td><td>6</td></tr>
<tr><td colspan="2">Pre-requisite</td><td colspan="8">Fundamental computer knowledge including computer storage and hardware</td></tr>
<tr><td colspan="2">Objectives of the Course</td><td colspan="8">To provide fundamentals of database design, modeling systems, data storage, world of data warehousing and NoSQL</td></tr>
<tr><td colspan="2">Course Objectives</td><td colspan="8">1. To understand the fundamental concepts of DBMS.
2. To learn about E-R Diagrams, Relational model and SQL.
3. To disseminate the knowledge on various Normal Forms.
4. To inculcate the fundamentals of transaction management and Query processing.
5. To give an introduction on current trends in data base technologies.</td></tr>
<tr><td colspan="2" rowspan="2">Course Outline</td><td colspan="8">Unit 1
1.1 Fundamental Concepts of Database Management
Applications of Database Technology - Key Definitions - File versus Database Approach to Data Management - Elements of a Database System - Advantages of Database Systems and Database Management - Architecture and Categorization of DBMSs
1.2 Conceptual Data Modeling using the ER Model and UML Class Diagram
Phases of Database Design - The Entity Relationship Model - UML Class Diagram</td></tr>
<tr><td colspan="8">Unit 2
2.1 Types of Database Systems
Legacy Databases - Relational Databases: The Relational Model - Normalization
2.2 Relational Databases
Structured Query Language - SQL Data Definition Language - SQL Data Manipulation Language
Lab: SQL DDL and DML</td></tr>
</table>

	Unit 3 **3.1 Data Warehousing and Business Intelligence** Operational versus Tactical/Strategic Decision-Making - Data Warehouse Definition - Data Warehouse Schemas - The Extraction, Transformation, and Loading (ETL) Process - Data Marts - Virtual Data Warehouses and Virtual Data Marts - Operational Data Store - Data Warehouses vs Data Lakes - Business Intelligence **3.2 Introduction of NO SQL** Overview and History of NoSQL Databases. Definition of the Four Types of NoSQL Database, The Value of Relational Databases, Getting at Persistent Data, Concurrency, Integration, Impedance Mismatch, Application and Integration Databases, Attack of the Clusters, The Emergence of NoSQL, Key Points Comparison of relational databases to new NoSQL stores, Mongo DB, Cassandra, HBASE, Neo4j use and deployment, Application, RDBMS approach, Challenges NoSQL approach, Key-Value and Document Data Models, Column-Family Stores, AggregateOriented Databases. sharding, MapReduce on databases. Distribution Models, Single Server, Sharding, Master-Slave Replication, Peer-to-Peer replication, Combining Sharding and Replication.
	Unit 4 **4.2 Key Value Data Stores** NoSQL Key/Value databases using MongoDB, Document Databases, Document oriented Database Features, Consistency, Transactions, Availability, Query Features, Scaling, Suitable Use Cases, Event Logging, Content Management Systems, Blogging Platforms, Web Analytics or Real-Time Analytics, E-Commerce Applications, Complex Transactions Spanning Different Operations, Queries against Varying Aggregate Structure. Lab: Key-value databases, Replica of existing database,Backup of existing database, Restore database from the backup Demonstration: Connecting python with mongodb and inserting, retrieving, updating anddeleting.

	Unit 5 **5.1 Document Oriented Database** Column- oriented NoSQL databases using Apache HBASE, Column-oriented NoSQL databases using Apache Cassandra, Architecture of HBASE, Column-Family Data Store Features, Consistency, Transactions, Availability, Query Features, Scaling, Suitable Use Cases, Event Logging, Content Management Systems, Blogging Platforms, Counters, Expiring Usage. **5.2Data Modeling with Graph** Comparison of Relational and Graph Modeling, Property Graph Model Graph Analytics: Link analysis algorithm- Web as a graph, Page RankMarkov chain, page rank computation, Topic specific page rank Page Ranking Computation techniques iterative processing, Random walk distribution Querying Graphs Lab: Implement with column-family stores(cassandra), Graph databases (neo4j) Aggregate function, Push and addtoset expression, First and last expression.
Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper)	Case studies to understand the limitations of Relational DBMS and the need for NoSQL database Mini project - create a data store and process the data
Skills acquired from this course	Database designer, Data owner of different types of data, Data Scientist fluent in data, Business Professional
Recommended Text	Lemahieu, W., Broucke, S.vanden and Baesens, B. (2018) Principles of database management: The Practical Guide to storing, managing and analyzing big and small data. Cambridge, United Kingdom: Cambridge University Press. Sadalage, P. &Fowler,NoSQL Distilled: A Brief Guide to the Emerging World of PolyglotPersistence, Wiley Publications,1st Edition,2022

Reference Books	1. SQL for Data Scientists: A Beginner's Guide for Building Datasets for Analysis Renee M. P. Teate 2. SQL for Data Science: Data cleaning, wrangling and analytics with relational databases, Antonio Badia 3. Guy Harrison, Next Generation Database: NoSQL and big data, Apress
Website and e-Learning Source	**https://www.geeksforgeeks.org/introduction-to-nosql/**

COURSE OUTCOMES:

Students will be able to

CO1: Understand and discuss the importance of relational data modeling and conceptual modelling

CO2: Experiment with various database and compose effective queries

CO3:Analyse the process of OLAP system construction

CO4: Evaluate the use of NOSQL and its approach to the database

CO5: Develop applications using Relational and NoSQL databases

OUTCOME MAPPING :

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	3	2	2	3	3
CO2	2	3	2	2	3	3
CO3	2	3	2	2	3	3
CO4	3	3	2	2	3	3
CO5	3	3	2	2	3	3
Weightage of coursecontributed to eachPO	12	15	10	10	15	15

<table>
<tr><td>Title of the Course</td><td colspan="6">Cloud Computing</td></tr>
<tr><td>Paper Number</td><td colspan="6">CORE XI</td></tr>
<tr><td rowspan="2">Category Core</td><td>Year</td><td>II</td><td rowspan="2">Credits</td><td rowspan="2">5</td><td rowspan="2">Course Code</td><td rowspan="2">23DSCC401</td></tr>
<tr><td>Semester</td><td>IV</td></tr>
<tr><td rowspan="2">Instructional Hours per week</td><td colspan="2">Lecture</td><td>Tutorial</td><td>Lab Practice</td><td colspan="2">Total</td></tr>
<tr><td colspan="2">5</td><td>1</td><td>--</td><td colspan="2">6</td></tr>
<tr><td>Pre-requisite</td><td colspan="6">Basic concepts of Operating System. Familiar with using computers for different office duties</td></tr>
<tr><td>Objectives of the Course</td><td colspan="6">To provide an understanding of how cloud computing evolved, its acceptance world-wide and integral part of several organization</td></tr>
<tr><td>Course Objectives</td><td colspan="6">1. To know the fundamentals of cloud computing.
2. To acquire the knowledge of cloud computing technologies and architecture.
3. To be familiar with cloud services and applications of cloud computing.
4. To understand the role of Networks in Cloud Computing
5. To learn more about web services</td></tr>
<tr><td rowspan="2">Course Outline</td><td colspan="6">Unit 1
1.1 Introduction to Cloud Computing
Introduction – History-Fundamentals of Cloud computing – characteristics- Advantages and Disadvantages- Comparison of traditional and cloud computing paradigms-Evaluating the impact and economics -Business drivers-Future of cloud
1.2 Services and Deployment model
Cloud deployment models-Cloud service models – Cloudinfrastructure mechanisms -Cloud service management</td></tr>
<tr><td colspan="6">Unit 2
2.1 Cloud Computing Architecture
Cloud computing architecture -Design principle-Life cycle (CCLC)-Reference architecture-Load balancingapproach-Mobile cloud computing (MCC)-Case study of oracle cloud management
2.2 Virtualization
Understanding - Adoption – Techniques – Working of Virtualizaton - Kernel-based virtual machine (KVM) – VMware – VirtualBox – Citrix - Types of virtualization-Virtualisation in cloud</td></tr>
</table>

	Unit 3 **3.1 Service Oriented Architecture** Objectives-SOA foundation-Web services and SOA-SOA communication-SOA components-SOA Infrastructure-Need of SOA-Business Process Management (BPM) – Services of BPM **3.2 Cloud Computing Applications** Introduction-Google App Engine-Google Apps-Google Cloud Data store-Dropbox Cloud-Apple iCloud-Microsoft Windows Azure Cloud-Amazon Web Services (AWS)
	Unit 4 **4.1 Cloud Security and Privacy** Cloud Security - Cloud CIA security model - Cloud computing security Architecture - Service provider security issues - Security issues in Virtualization - Data security in cloud – Data privacy risks - Business continuity and disaster recovery - Threats in cloud – Security techniques for threats - Cloud service level agreements (SLA): Components – Types - Cloud vendors - Quality of Cloud Services - Techniques – Migration - Trust management
	Unit 5 **5.1 Cloud Computing Technologies** Cloud Computing Technologies - High performance Computing - Message Passing Interface(MPI) - MapReduce programming model -Dryad and Dryad LINQ -Eucalyptus cloud platform: Components – OpenNebula: Layers – Features – OpenStack: components-Benefits – The Apache Hadoop ecosystem **5.2 Adoption of Cloud Computing** Factors affecting the adoption-Existing areas of application-Case studies-Certifications.
Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper)	More Case studies and Demonstration (To be discussed during the Lecture hour)
Skills acquired from this course	Platform expertise, selecting the right services, Managing an integrated environment and Securing the cloud environment

Recommended Text	Kant Hiran, Kamal, Ruchi Doshi, Temitayo Fagbola, Mehul Mahrishi, Cloud Computing: Master theConcepts, Architecture and Applications with Real-world examples and Case studies, BPB Publishers,2019
Reference Books	Ben Piper and David Clinton, AWS Certified Solutions Architect Study Guide: Associate SAA-C01 Exam,Googel Book, 2019 Legorie Rajan Ps, Steven Porter, and Ted Hunter, Building Google Cloud Platform Solutions: DevelopScalable Applications from Scratch and Make Them Globally Available in Almost Any Language, Packt, 2019 Rajkumar Buyya, Christian Vecchiola, S. Thamarai Selvi, Mastering Cloud Computing, Tata McGrawHill Education Private Limited, 2013
Website and e-Learning Source	**https://acloudguru.com** **https://www.cloudcomputing-news.net/** **https://cloudtweaks.com/**

COURSE OUTCOMES :

Students will be able to

PO1: Understand the models, principles, and benefits of Cloud Computing
PO2: Understand virtualization foundations to cater the needs of elasticity, portability and resilience bycloud service providers.
PO3: Identify the applications of Cloud Computing
PO4: Analyse the security aspects of Cloud Computing
PO5: Evaluate the importance of message passing and map reduce in Cloud Computing

OUTCOME MAPPING :

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	**3**	**3**	**2**	**3**	**3**	**2**
CO2	**3**	**3**	**2**	**3**	**3**	**2**
CO3	**3**	**3**	**2**	**3**	**3**	**2**
CO4	**3**	**3**	**2**	**3**	**3**	**2**
CO5	**3**	**3**	**2**	**3**	**3**	**2**
Weightage of coursecontributed to eachPO	**15**	**15**	**10**	**15**	**15**	**10**

<table>
<tr><td>Title of the Course</td><td colspan="6">BIG DATA ANALYTICS</td></tr>
<tr><td>Paper Number</td><td colspan="6">CORE 12</td></tr>
<tr><td rowspan="2">Category Core</td><td>Year</td><td>II</td><td rowspan="2">Credits</td><td rowspan="2">5</td><td rowspan="2">Course Code</td><td rowspan="2">23DSCC402</td></tr>
<tr><td>Semester</td><td>IV</td></tr>
<tr><td>Instructional Hours per week</td><td>Lecture</td><td>Tutorial</td><td colspan="2">Lab Practice</td><td colspan="2">Total</td></tr>
<tr><td></td><td>5</td><td>1</td><td colspan="2">--</td><td colspan="2">6</td></tr>
<tr><td>Pre-requisite</td><td colspan="6">Basic understanding of programming and logical thinking</td></tr>
<tr><td>Objectives of the Course</td><td colspan="6">To introduce the concepts of big data analytics and developing a real time applications</td></tr>
<tr><td>Course Objectives</td><td colspan="6">1. To familiarize the students with the basic concepts
2. To analyse various levels in hadoop and their related technologies.
3. To understand the basics of Resilient Distributed Datasets programming.
4. To gain knowledge on hadoop components.
5. To acquire basic understanding on how a Machine Learning pipeline works on hadoop programming.</td></tr>
<tr><td rowspan="2">Course Outline</td><td colspan="6">UNIT-I :INTRODUCTION TO BIG DATA ANALYTICS
Classification of Digital Data, Structured and Unstructured Data - Introduction to Big Data: Characteristics – Evolution – Definition - Challenges with Big Data - Other Characteristics of Data - Why Big Data - Traditional Business Intelligence versus Big Data - Data Warehouse and Hadoop Environment Big Data Analytics: Classification of Analytics – Challenges - Big Data Analytics important - Data Science - Data Scientist - Terminologies used in Big Data Environments.
Book 1 - Chapter 1,2,3</td></tr>
<tr><td colspan="6">UNIT-II :BIG DATA TECHNOLOGY LANDSCAPE

NoSQL, Comparison of SQL and NoSQL, Hadoop -RDBMS Versus Hadoop - Distributed Computing Challenges – Hadoop Overview - Hadoop Distributed File System - Processing Data with Hadoop - Managing Resources and Applications with Hadoop YARN - Interacting with Hadoop Ecosystem

Book 1: Chapter 4, 5</td></tr>
</table>

	UNIT-III :HADOOP AND HDFS Introduction to Hadoop – RDBMS vs Hadoop- distributed computing challenges - A Brief History of Hadoop- The Hadoop Distributed Filesystem- Processing Data with Hadoop - Anatomy of a MapReduce Works - Anatomy of a MapReduce Job Run- Job Scheduling- Shuffle and Sort- Task Execution **Book 2 – Chapter 1, 3,6**
	UNIT-IV :HADOOP ECO SYSTEM Hive: Introduction – Architecture - Data Types - File Formats - Hive Query Language Statements – Partitions – Bucketing – Views - Sub- Query – Joins – Aggregations - Group by and Having - RCFile Implementation - Hive User Defined Function - Serialization and Deserialization. Pig: Introduction - Anatomy – Features – Philosophy - Use Case for Pig - Pig Latin Overview - Pig Primitive Data Types - Running Pig - Execution Modes of Pig - HDFS Commands - Relational Operators - Eval Function - Complex Data Types - Piggy Bank - User-Defined Functions - Parameter Substitution - Diagnostic Operator - Word Count Example using Pig - Pig at Yahoo! - Pig Versus HiveHbase - HBasics, Concepts. **Book 1 - Chapter 9, 10** **Book 2 - Chapter 11, 12,13**
	UNIT-V:Case Studies Hadoop Usage at Last.fm - Hadoop and Hive at Facebook- Nutch Search Engine- Log Processing at Rackspace – Cascading - TeraByte Sort on Apache Hadoop 601 - Using Pig and Wukong to Explore Billion-edge Network Graphs - Recent Trends in Big Data Analytics **Book 2 - Chapter 16**
Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper)	Case study on recent developments and presentation
Skills acquired from this course	Developing application using big data analytic techniques

Recommended Text	1. Big Data and Analytics, Seema Acharya, SubhashiniChellappan, First Edition, 2015, Wiley. 2. Tom White, Hadoop: The Definitive Guide, O'Reilly Media Inc., 2015.
Reference Books	1. Lublinsky, Boris, Kevin T. Smith, and Alexey Yakubovich. Professional hadoop solutions. John Wiley & Sons, 2013. 2. Big Data Analytics, RadhaShankarmani, M Vijayalakshmi, Second Edition, 2017, Wiley 3. Hadoop Essentials: A Quantitative Approach, Henry H. Liu, First Edition, 2012, PerfMath Publishers
Website and e-Learning Source	https://www.ibm.com/analytics/big-data-analytics https://www.simplilearn.com/what-is-big-data-analytics-article https://azure.microsoft.com/en-us/resources/cloud-computing-dictionary/what-is-big-data-analytics

COURSE OUTCOMES:

Students will be able to

PO1: Understand the basic concepts of big data analytics and technologies
PO2: Apply the concept of HDFS, Map reduce for storing and processing of Big data
PO3: Analyze and perform different operations on data using Pig, Hive, and Hbase
PO4: Evaluate the tools and methods for analyzingBig data analytics model
PO5: Develop real time big data analytics applications

OUTCOME MAPPING :

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	**3**	**3**	**2**	**3**	**3**	**3**
CO2	**3**	**3**	**2**	**3**	**3**	**3**
CO3	**3**	**3**	**2**	**3**	**3**	**3**
CO4	**3**	**3**	**2**	**3**	**3**	**3**
CO5	**3**	**3**	**2**	**3**	**3**	**3**
Weightageofcoursecontributedtoeach PO/PO	**15**	**15**	**10**	**15**	**15**	**15**

Title of the Course		PROJECT WITH VIVA VOCE					
Paper Number		CORE IVX					
Category	Core	Year	II	Credits	7	Course Code	23DSCD403
		Semester	IV				
Instructional Hours per week		Lecture	Tutorial	Lab Practice	Total		
				10	10		
Pre-requisite		Programming and Logical reasoning					

GROUP A

Elective I to be chosen from Group A

Title of the Course		Research Methodology for Computer Science					
Paper Number		Group A					
Category	Elective-I	Year	I	Credits	3	Course Code	23DSCE104
		Semester	I				
Instructional Hours per week		Lecture	Tutorial	Lab Practice	Total		
		4	1	--	5		
Pre-requisite		Not Required					
Objectives of the Course		To develop an understanding of the research methods relevant to effectively address a research problem					
Course Objectives		1. To Introduce the concepts involved in scientific research 2. To Detail the process of conducting a literature review for a given scientific problem 3. To learn about Literature Review 4. To know about Data collection 5. To Impart the basics of scientific/technical writing					
Course Outline		**UNIT-I:** **1.1 Introduction to Research** Meaning, Objectives and Characteristics of research - Research Methods Vs. Methodology - Types of research- Research process - Criteria of good research **1.2 Research Project** Shaping a Research Project-Research Planning-Students and Advisors – Checklist					

	UNIT-II: **2.1 Literature Review** Reading and Reviewing - Hypotheses, Questions, and Evidence
	UNIT-III: **3.1 Experiments for Computing** Experimentation-Statistical Principles **3.2 Writing a Paper** Organization-Good Style-Style Specifics-Punctuation-Mathematics-Algorithms- Graphs, Figures, and Tables -Other Professional Writing
	UNIT-IV: **4.1 Presentation** Editing- Presentations-Slides-Posters-Ethics
	UNIT-V: **5.1 Report writing** Report writing using LATEX for a research problem
Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper)	Literature Review and Problem Identification Writing a research Paper (To be discussed during the Tutorial hour)
Skills acquired from this course	Knowledge, Problem Solving, Analytical ability, Professional Competency, Research skill, Professional Communication and Transferrable Skill
Recommended Text	[1] Kothari C. R. Research Methodology Methods and Techniques. 2nd ed. New Delhi: New Age, 2004. (Unit 1.1) [2] Justin Zobel. Writing for Computer Science.3rd ed. Springer-Verlag,2014
Reference Books	[1] Ranjit Kumar. Research Methodology -a step-by-step guide for beginners. 3rd ed. SAGE Publications India Pvt Ltd, 2011. [2] Panneerselvam R. Research Methodology. 2nd ed. New Delhi: Prentice Hall, 2014.
Website and **e-Learning Source**	https://www2.le.ac.uk/offices/red/rd/research-methods-and-methodologies http://www.socscidiss.bham.ac.uk/methodologies.html

Course Outcome (for Mapping with POs and POs)

Students will be able to

PO1: Develop an understanding of research methods

PO2: Formulate a research problem

PO3: Collect and analyse data

PO4: Effectively write a research paper

PO5: Present the Paper more professionally.

OUTCOME MAPPING :

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	3	2	1	1
CO2	3	3	3	2	1	1
CO3	3	3	3	2	1	1
CO4	3	3	3	2	1	1
CO5	3	3	3	2	1	1
Weightage of course contribute to each PO						

<table>
<tr><td colspan="2">Title of the Course</td><td colspan="6">Data Structures and Algorithms</td></tr>
<tr><td colspan="2">Paper Number</td><td colspan="6">Group A</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">Elective-I</td><td>Year</td><td>I</td><td rowspan="2">Credits</td><td rowspan="2">3</td><td rowspan="2">Course Code</td><td rowspan="2">23DSCE104</td></tr>
<tr><td>Semester</td><td>I</td></tr>
<tr><td colspan="2" rowspan="2">Instructional Hours per week</td><td>Lecture</td><td>Tutorial</td><td colspan="2">Lab Practice</td><td colspan="2">Total</td></tr>
<tr><td>4</td><td>1</td><td colspan="2">--</td><td colspan="2">5</td></tr>
<tr><td colspan="2">Pre-requisite</td><td colspan="6">Not Required</td></tr>
<tr><td colspan="2">Objectives of the Course</td><td colspan="6">To develop an understanding of the research methods relevant to effectively address a research problem</td></tr>
</table>

Course Objectives	1. To understand various types of linear and non-linear data structures. 2. To learn about Linked Lists and its types. 3. To analyze algorithms for run time complexities and the space requirements. 4. To understand algorithms that use data structures for operations such as storing, searching, hashing etc. 5. To apply various data structures and algorithms to design, formulate and implement solution for any real time problem
Course Outline	**UNIT-I:** **1.1 Basic Concepts** Basic steps in complete development of Algorithm - Analysis and complexity of Algorithm – Asymptotic notations - Problem Solving techniques and examples **1.2 ADT** List ADT, Stacks ADT, Queue ADT
	UNIT-II: **2.1 Algorithm Design Model** Greedy Method - Divide and Conquer - Dynamic Programming – Backtracking – Branch and Bound **2.2 Trees** Preliminaries Binary Tree, Search Tree ADT, Binary Search Trees, AVL Trees, Tree Traversals, B-Trees
	UNIT-III: **3.1 Hashing** General Idea, Hash Function, Separate Chaining, Open Addressing, Rehashing, Extendible Hashing, Priority Queues, Model, Simple Implementations, Binary Heap, Applications
	UNIT-IV: **4.1 Sorting** Sorting - Preliminaries, Insertion Sort, Shell Sort, Heap Sort, Merge Sort, Quick Sort, External Sorting
	UNIT-V: **5.1 Graphs** Definitions, Topological Sort, Shortest Path Algorithm, Minimum Spanning Tree, Application of Depth First Search **5.2 Theory of NP-Completeness** Formal language framework, Complexity classes – P, NP - NP Reducibility and NP-Complete, NP-Hard

Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper)	Problems related to above topics to be solved (To be discussed during the Tutorial hour)
Skills acquired from this course	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill
Recommended Text	[1] Aho, J. E. Hopcroft and J. D. Ullman. Design and Analysis of Computer Algorithms. 1st ed. Addison-Wesley, 2009. [2] Horowitz and Sahani. Fundamentals of Computer Algorithms. 2nd ed. Galgotia, 2008. [3] Weiss, M. A. Data Structure and Algorithm analysis in C. 2nd ed. Pearson Education Asia, 2002.
Reference Books	[1] Baase, S. and Allen Van Gelder. Computer Algorithms-Introduction to Design and Analysis.New Delhi: Pearson Education, 2008 [2] Goodrich, M.T. and R. Tamassia. Algorithm Design: Foundations, Analysis, and Internet Examples. New Delhi: Wiley, 2006.
Website and **e-Learning Source**	

Course Outcome (for Mapping with POs and POs)

Students will be able to

PO1: To understand the design of algorithms and analysis techniques

PO2: To enable the students to analyse the time and space complexity of algorithms

PO3: To have a good understanding on different data structures

PO4: To understand the kinds of problems that uses the data structures and the algorithms for solving them

PO5: Identify appropriate data structures for real time applications

OUTCOME MAPPING :

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	3	2	1	1
CO2	3	3	3	2	1	1
CO3	3	3	3	2	1	1
CO4	3	3	3	2	1	1
CO5	3	3	3	2	1	1
Weightage of course contribute to each PO						

<table>
<tr><td colspan="2">Title of the Course</td><td colspan="6">Internet of Things</td></tr>
<tr><td colspan="2">Paper Number</td><td colspan="6">Elective 1</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">Core</td><td>Year</td><td>I</td><td rowspan="2">Credits</td><td rowspan="2">3</td><td rowspan="2">Course Code</td><td rowspan="2">23DSCE104</td></tr>
<tr><td>Semester</td><td>I</td></tr>
<tr><td colspan="2" rowspan="2">Instructional Hours per week</td><td colspan="2">Lecture</td><td>Tutorial</td><td>Lab Practice</td><td colspan="2">Total</td></tr>
<tr><td colspan="2">4</td><td>1</td><td>--</td><td colspan="2">5</td></tr>
<tr><td colspan="2">Pre-requisite</td><td colspan="6">Knowledge in Computing and Networking</td></tr>
<tr><td colspan="2">Objectives of the Course</td><td colspan="6">To understand the concepts, data, framework, standards, protocols, reliability, security and privacy involved in IOT</td></tr>
<tr><td colspan="2">Course Objectives</td><td colspan="6">1. To get familiar with the evolution of IOT with its design principles
2. To outline the functionalities and protocols of internet communication
3. To analyze the hardware and software components needed to construct IOT applications
4. To identify the appropriate protocol for API construction and writing embedded code
5. To realize various business models and ethics in Internet of Things</td></tr>
</table>

Course Outline	**UNIT-I : IoT Ecosystem Concepts and Architectures** Introduction – IoT definition and evolution – IoT Architectures - OpenIoT Architecture for IoT/Cloud Convergence - Resource Management – IoT Data Management and Analytics - Communication Protocols – Internet of Things applications-Scheduling Process and IoT Services Lifecycle - IoT enabling technologies – IoT levels and Deployments templates – Introduction to M2M - Difference between IoT and M2M – SDN and NFV for IoT
	UNIT-II : IoT Data and Framework Essentials - Introduction - Programming framework for IoT– The foundation of Stream processing in IoT - Continuous Logic processing system – Challenges and Future directions – Anomaly detection – Problem statement and definitions – Efficient incremental local modelling – IoT Governance.
	UNIT-III : RF Protocols RFID, NFC;IEEE 802.15.4: ZigBee - ZWAVE, THREAD - Bluetooth Low Energy (BLE) - IPv6 for Low Power and Lossy Networks (6LoWPAN) - Routing Protocol for Low power and lossy networks (RPL) - CoAP - XMPP - Web Socket-AMQP – MQTT – WebRTC - PuSH Architectural Considerations in Smart Object Networking - TinyTO Protocol. 3.2 Introduction to IoT based applications – Scenarios – Architecture overview – Sensors – The gateway – Data Transmission – Internet of Vehicles (IoV) – IoV Characteristics, technologies and its application.
	UNIT-IV : Developing Internet of Things : Introduction – IoT Design Methodology – Case study on IoT system for Weather monitoring – IoT Device - IoT physical devices and endpoints - Exemplary Device: Raspberry Pi - Linux on Raspberry Pi - Raspberry Pi interfaces – Programming Raspberry Pi and with python – Other IoT devices.

	UNIT-V: IoT Reliability, Security and Privacy: Introduction - Concepts - IoT Security Overview – Security Frameworks for IoT – Privacy in IoT networks – IoT characteristics and reliability issues - Addressing reliability
Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper)	Case Studies (To be discussed during the Tutorial hour)
Skills acquired from this course	Knowledge on IOT Technology and its reliability, security and privacy, Developing a basic IOT system
Recommended Text	1. Arshdeep Bahga, Vijay Madisetti, "Internet of Things, A Hands - on Approach", 1st Edition 2015, University Press, ISBN: 978-81-7371- 954-7 2. Buyya, Rajkumar, and Amir Vahid Dastjerdi, eds. Internet of Things: Principles and paradigms. Elsevier, 2016. 3. Hersent, Olivier, David Boswarthick, and Omar Elloumi. The internet of things: Key applications and protocols. John Wiley & Sons, 2011.

Reference Books	1. Bernd Scholz-Reiter, Florian Michahelles, "Architecting the Internet of Things", ISBN 978- 3-642-19156-5 e-ISBN 978-3-642-19157-2, Springer 2. Jan Holler, VlasiosTsiatsis, Catherine Mulligan, Stefan Avesand, StamatisKarnouskos, David Boyle, "From Machine-to-Machine to the Internet of Things: Introduction to a New Age of Intelligence", 1st Edition, Academic Press, 2014. 3. Peter Waher, "Learning Internet of Things", PACKT publishing, BIRMINGHAM – MUMBAI
Website and e-Learning Source	https://thingsee.com/blog/quality-hardware-list-for-your-iot-projects https://tools.ietf.org/html/rfc7452. http://dret.net/lectures/iot-spring15/protocols http://iot.intersog.com/blog/overview-of-iot-development-standards-andframeworks.

Course Outcomes :

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

PO1: To describe the concepts of IoT

PO2: To describe the essentials IOT data and framework

PO3: To discuss IOT protocols

PO4: To design a basic IOT system

PO5: To examine the reliability, security and privacy of an IOT system

OUTCOME MAPPING :

	POs					
	1	2	3	4	5	6
CO1	3	3	1	2	2	3
CO2	3	3	1	2	2	3
CO3	3	3	1	2	2	3
CO4	3	3	3	2	2	3
CO5	3	3	1	2	2	3

Group B

Elective II to be chosen from Group B

<table>
<tr><td colspan="2">Title of the Course</td><td colspan="6">WEB PROGRAMMING</td></tr>
<tr><td colspan="2">Paper Number</td><td colspan="6">GROUP B</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">Elective II</td><td>Year</td><td>I</td><td rowspan="2">Credits</td><td rowspan="2">3</td><td rowspan="2">Course Code</td><td rowspan="2">23DSEP105</td></tr>
<tr><td>Semester</td><td>I</td></tr>
<tr><td colspan="2" rowspan="2">Instructional Hours per week</td><td>Lecture</td><td colspan="2">Tutorial</td><td>Lab Practice</td><td colspan="2">Total</td></tr>
<tr><td>--</td><td colspan="2">--</td><td>5</td><td colspan="2">5</td></tr>
<tr><td colspan="2">Pre-requisite</td><td colspan="6">Basic programming knowledge</td></tr>
<tr><td colspan="2">Objectives of the Course</td><td colspan="6">To introduce students about web application and state management</td></tr>
<tr><td colspan="2">CourseObjectives</td><td colspan="6">1. Understand the fundamentals of the web and thereby develop web applications using various development languages and tools.
2. Enrich knowledge about .NET controls.
3. Provide in-depth knowledge about C#.
4. To enhance knowledge in XML.NET.
5. Deliver depth knowledge about ASP.NET, AJAX.</td></tr>
<tr><td colspan="2">Course Outline</td><td colspan="6">UNIT-I:

1.1 Overview of .NET Framework:
CLR-CTS- Metadata and Assemblies-.NET Framework Class Library – BCL- Windows Forms – ASP.NET and ASP.NET AJAX- ADO.NET – Tools in the .NET Framework- New Features of .NET Framework: Portable Class Libraries.
1.2 Introducing Windows Application
Introduction – Creating WindowsForms- Customizing a Form
1.3 Collecting User Input in windows Forms and Events
Buttons-Text Boxes- Check Boxes- Radio Buttons –Combo Boxes –Date and TimePicker – Calendar-List Boxes –Checked List Box – List View – Tree View</td></tr>
</table>

	UNIT-II: **2.1 Presentation and Informational Controls in Windows Forms and Events** Labeling- Link Label- Status Bar- Picture Box-Image List-Progress Bar-Tool Tip –MDI and Menus Creation **2.2 Data Types in C#** Type Conversions – Boxing and Unboxing **2.3 Namespaces** Introduction – Adding a reference to the Namespace – Accessing a predefined Namespace through the using Directive **2.4 Introducing to ADO.net** Understanding ADO.NET- Creating Connection Strings –Creating a Connection to a Database- Creating a Command Object- Working with DataAdapters –Using DataReader work with Database.
	UNIT-III: **3.1 ASP.NET** Life cycle- Specifying a Location for a Web Application -Single-File Page Model - Code-Behind Page Model- Adding controls to web form. **3.2 Web Server Controls** The Control Class - The WebControl Class - The Button Control - The TextBox Control -The Label Control - The HyperLink Control -The LinkButton Control -The PlaceHolder Control -The HiddenField Control - The CheckBox Control -The RadioButton Control -The ListBox Control -The DropDownList Control -The Image Control -The ImageButton Control - The Table Control - Menus - Validation Server Controls - Master Page - Web.Config

	UNIT-IV : **4.1 State Management** Understanding the session object Sessions and the Event Model, Configuring, In-Process Session State, Out-of-Process Session state Application Object, Query strings, Cookies, ViewState, Global.asax. **4.2 XML and .NET** Basics of XML, Create XML Document - Reading XML with XmlReader – Reading XML with XmlDocument - Working with XmlNode **4.3 Animations** Understanding WPF's Animation services – The Role of the Animation class types-The To, From and by properties – The Role of the Timeline Base Class – Authoring and Animation in C# Code – Controlling the pace of an animation – Reversing and Looping an Animation – The Role of StoryBoards
	UNIT-V: **5.1 LINQ** Introducing LINQ Queries- Standard Query Operators- Introducing LINQ to Dataset, SQL and XML- The LinqDataSource Control. Data Binding – Grid View, Details view, Forms view **5.2 ASP. NET AJAX** Understanding the need for AJAX, Building a simple ASP.NET page without AJAX, Building a simple ASP.NET page with AJAX
Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper)	Lab Exercises
Skills acquired from this course	Website creation
Recommended Text	[1] C# 2012 Programming Covers .NET 4.5 Black Book. Dreamtech press, Kogent Learning Solutions, 2013.(Unit 1.1,Unit 2.2,Unit 2.3,Unit 2.4, Unit 3,Unit 4, Unit 5) [2] Liberty, Jesse, and Dan Hurwitz. Programming. NET Windows Applications. " O'Reilly Media, Inc.", 2004. (Unit 1.2,1.3, 2.1) [3] Troelsen, Andrew, and Philip Japikse, C# 6.0 and the .NET 4.6 Framework. Apress, 2015. (Unit 4.3)

Reference Books	[1] Albahan Joseph, and Ben Albahari. C# 5.0 in a NutShell: The Definitive Reference. "Orielly Media Inc", 2012 [2] Anne Boehm . Joel. Murach's C# 2015. United States of America: Murach's,2016. [3] Delamater. Mary. Anne Boehm. ASP.NET 4.5 Web Programming with C# 2012. United States of America: Murach's, 2013. [4] John Sharp. Microsoft Visual C# Step by Step. United States of America: Pearson Edition,2018. [5] Price, Jason, and Mike Gunderlov. Mastering Visual C#.Net. John Wiley & Sons, 2006
Website and **e-Learning Source**	http://www.w3schools.com/aspnet/aspnet.asp http://csharp.net-tutorials.com/xml/introduction/ http://ajax.net-tutorials.com/basics/introduction/ http://www.c-sharpcorner.com/

Course Outcome (for Mapping with POs and POs)

Students will be able to

PO1	Comprehend.NET Framework and Windows Application
PO2	Know about presentation controls and namespaces
PO3	Connect with backend using ADO.NET
PO4	Get the knowledge about web application and state management
PO5	Gain knowledge on connecting XML, LINQ and AJAX

OUTCOME MAPPING :

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	3	2	1	1
CO2	3	3	3	2	1	1
CO3	3	3	3	2	1	1
CO4	3	3	3	2	1	1
CO5	3	3	3	2	1	1

<table>
<tr><td colspan="2">Title of the Course</td><td colspan="8">JAVA PROGRAMMING</td></tr>
<tr><td colspan="2">Paper Number</td><td colspan="8">GROUP B</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">Elective -II</td><td>Year</td><td>I</td><td rowspan="2">Credits</td><td rowspan="2">3</td><td rowspan="2">Course Code</td><td rowspan="2">23DSEP105</td></tr>
<tr><td>Semester</td><td>II</td></tr>
<tr><td colspan="2" rowspan="2">Instructional Hours per week</td><td colspan="2">Lecture</td><td colspan="2">Tutorial</td><td colspan="2">Lab Practice</td><td>Total</td></tr>
<tr><td colspan="2">--</td><td colspan="2">--</td><td colspan="2">5</td><td>5</td></tr>
<tr><td colspan="2">Pre-requisite</td><td colspan="8">Basic programming knowledge</td></tr>
<tr><td colspan="2">Objectives of the Course</td><td colspan="8">To enable the students to understand and appreciate the need for Object Oriented Programming</td></tr>
<tr><td colspan="2">CourseObjectives</td><td colspan="8">1. To gain knowledge of Object Oriented Programming Concept in Java
2. To understand usages of String functions in Java
3. To familiarize with the applet and swing
4. To grasp the concepts on Java Beans
5. To comprehend the connection between Relational Database and Java.</td></tr>
<tr><td colspan="2" rowspan="2">Course Outline</td><td colspan="8">UNIT-I:

1.1 Introduction to Java
Overview – Features - Fundamental OOPS concepts – JDK – JRE – JVM -Structure of a Java program - Data types – Variables – Arrays – Operators –Keywords - Naming Conventions - Control statements, Type conversion and Casting - Scanner - String - equals(), equalsIgnoreCase(), length()</td></tr>
<tr><td colspan="8">UNIT-II:

2.1 Classes and Objects
Class – Objects – Methods - Method Overloading - Constructors – Constructor Overloading - this keyword - usage of static with data and methods – Garbage Collection - Access Control
2.2 Inheritance
Concept – extends keyword - Single and Multilevel Inheritance – Composition – super keyword - Method Overriding - Abstract Classes - Dynamic Method Dispatch – Usage of final with data, methods and classes
2.3 Packages and Interfaces
Concepts - package and import keywords - Defining, Creating and Accessing a Package – Interfaces - Multiple Inheritance in Java, Extending and Initialising fields in Interfaces</td></tr>
</table>

	UNIT-III: **3.1 Exception Handling** Exception handling- Types of Exceptions- try, catch, throw, throws and finally keywords - User defined Exceptions **3.2 JDBC** Database Connectivity- Types of JDBC drivers- Executing statements- Prepared statements- Callable statements - Mapping SQL types to Java- ResultSetMetadata
	UNIT-IV : **4.1 Multithreading** Introduction - Life Cycle of a Thread, Thread class and Runnable Interface, Thread Priorities, Synchronisation **4.2 GUI Programming with JavaFX** JavaFX Basic Concepts – Packages - Stage and Scene Classes - Nodes and Scene Graphs – Layouts - The Application Class and the Lifecycle Methods - Launching a JavaFX Application - JavaFX Application Skeleton - Compiling and Running -Application Thread **4.3 JavaFX Controls** Label – Button – Image – RadioButton – CheckBox – ListView- ComboBox- TextField – ScrollPane
	UNIT-V: **5.1 Event** Event Handling – Input Event, Action Event and Window Event **5.2 Java Library** Java.util – List, ArrayList
Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper)	Lab Exercises
Skills acquired from this course	Object oriented Programming knowledge
Recommended Text	Schildt, Herbert. Java: The Complete Reference. McGraw-Hill Education Group, 2014

Reference Books	Eckel, Bruce. Thinking in Java. 4th ed. Pearson Education, 2006. Liang, Y. Daniel. Intro to Java Programming, Brief Version. Pearson Higher Ed, 2015. Holmes, J. Barry, Joyce, T. Daniel. Object-oriented Programming with Java. Jones & Bartlett Learning. 2001
Website and e-Learning Source	http://docs.oracle.com/javase/tutorial/java/index.html/ http://www.java2s.com/Tutorial/Java/CatalogJava.htm/ https://www.edureka.co/blog/object-oriented-programming/

Course Outcomes (for Mapping with POs and POs)

Students will be able to

PO1	Understand the concepts of object-oriented programming
PO2	Use Java programming language at a basic level and construct simple software applications
PO3	Understand classes, objects and implementing inheritance
PO4	Analyze and understand the functionality of Inheritance, Interface and develop simple applications
PO5	To develop software applications and services using Java code

OUTCOME MAPPING :

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	3	2	1	1
CO2	3	3	3	2	1	1
CO3	3	3	3	2	1	1
CO4	3	3	3	2	1	1
CO5	3	3	3	2	1	1
Weightage of course contribute to each PO						

<table>
<tr><td colspan="2">Title of the Course</td><td colspan="8">Operating Systems</td></tr>
<tr><td colspan="2">Paper Number</td><td colspan="8">GROUP B</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">Elective II</td><td>Year</td><td>I</td><td rowspan="2">Credits</td><td rowspan="2">3</td><td rowspan="2">Course Code</td><td rowspan="2">23DSEP105</td></tr>
<tr><td>Semester</td><td>II</td></tr>
<tr><td colspan="2" rowspan="2">Instructional Hours per week</td><td colspan="2">Lecture</td><td colspan="2">Tutorial</td><td>Lab Practice</td><td>Total</td></tr>
<tr><td colspan="2">--</td><td colspan="2">--</td><td>5</td><td>5</td></tr>
<tr><td colspan="2">Pre-requisite</td><td colspan="8">Basic programming knowledge</td></tr>
<tr><td colspan="2">Objectives of the Course</td><td colspan="8">To introduce students about web application and state management</td></tr>
<tr><td colspan="2">CourseObjectives</td><td colspan="8">1. To enable the students to study and understand the efficiency of Linux shell script.
2. To demonstrate the File Backup process.
3. To develop and implement the shell script for GUI processing.
4. To develop and implement the shell script for IPC and Networking.
5. To demonstrate PostgreSQL.</td></tr>
</table>

Course Outline	**List of Programs:** 1. Write a Shell Script program to calculate the number of days between two dates. 2. Write a Shell Script program to check systems on local network using control structures with user input. 3. Write a Shell Script program to check systems on local network using control structures with file input. 4. Write a Shell Script program to demonstrate the script control commands. 5. Write a Shell Script program to demonstrate the Shell script function. 6. Write a Shell Script program to demonstrate the Regular Expressions. 7. Write a Shell Script program to demonstrate the sed and awk Commands. 8. Write a Shell Script program to demonstrate the File Backup process through creating a daily archive location. 9. Write a Shell Script program to create a following GUI tools. a) Creating text menus b) Building text window widgets 10. Write a Shell Script program to demonstrate to connect a PostgreSQL database and performing CRUD operations.
Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper)	Linux based Commands Execution
Skills acquired from this course	Knowledge and working of different operating system
Website and **e-Learning Source**	www.tutorialspoint.com/Linux www.guru99.com/unix-linux-tutorial.html

Course Outcome (for Mapping with POs and POs)

Students will be able to

PO1	To understand, apply and analyze the concepts and methodology of Linux shell programming
PO2	To comprehend, impart and apply fundamentals of control structure and script controls
PO3	To understand, analyses and evaluate the functions, graphical desktop interface and editors
PO4	To collaborate, apply and review the concepts and methodology of regular expression and advanced gawk
PO5	To comprehend, use and analyze the advance concepts such as alternate shell script, dyand bash scripting using PostgreSQL

OUTCOME MAPPING :

CO/PO	PO1	PO2	PO3	PO4	PO5
CO1	3	3	3	3	2
CO2	3	3	3	3	2
CO3	3	3	3	3	2
CO4	3	3	3	3	2
CO5	3	3	3	3	2
Weightage of course contribute to each PO					

Group C

Elective III to be chosen from Group C

<table>
<tr><td colspan="2">Title of the Course</td><td colspan="6">Information Security and Ethics</td></tr>
<tr><td colspan="2">Paper Number</td><td colspan="6">Group C</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">Elective III</td><td>Year</td><td>I</td><td rowspan="2">Credits</td><td rowspan="2">3</td><td rowspan="2">Course Code</td><td rowspan="2">23DSCE204</td></tr>
<tr><td>Semester</td><td>II</td></tr>
<tr><td colspan="2">Instructional Hours per week</td><td>Lecture</td><td colspan="2">Tutorial</td><td>Lab Practice</td><td colspan="2">Total</td></tr>
<tr><td colspan="2"></td><td>3</td><td colspan="2">1</td><td>--</td><td colspan="2">4</td></tr>
<tr><td colspan="2">Pre-requisite</td><td colspan="6">Knowledge of Computer Basics</td></tr>
<tr><td colspan="2">Objectives of the Course</td><td colspan="6">To introduce and familiarize the students to security issues in computing, core concepts and vocabulary of computer security</td></tr>
<tr><td colspan="2">Course Objectives</td><td colspan="6">1. To understand the legal and social issues in Information Security.
2. To understand the need of Information security and its related threats and attacks.
3. To learn methods of secure information communication.
4. To study about the privacy in computing.
5. To know about Legal and Ethical Issues in Computer Security.</td></tr>
<tr><td colspan="2">Course Outline</td><td colspan="6">UNIT-I :

1.1 Security Problem in Computing
Meaning of "Secure" – Attacks - Meaning of Computer and information Security - Computer Criminals - Methods of Defense
1.2 Cryptography
Terminology and Background - Principles of Cryptography - Cryptography tools - Substitution Ciphers - Transpositions (Permutations) – Making "Good" Encryption Algorithms - The Data Encryption Standard (DES) – The AES Encryption Algorithm - Public Key Encryption - The Uses of Encryption - Digital Signatures and Certificates - Hybrid Cryptography Systems - Steganography - Protocols for secure communication</td></tr>
</table>

	UNIT-II : **2.1 Program Security** Secure Programs - Nonmalicious Program Errors - Viruses and Other Malicious Code - Targeted Malicious Code - Controls against Program Threats **2.2 Security Issues in Social Networking** Acceptable Use Policies - Reasons for social media being hazardous to the corporate network - Balancing Security and Social Networking in business - Precautions that can be taken to secure the private information
	UNIT-III : **3.1 Database and Data Mining Security** Introduction to Databases - Security Requirements - Reliability and Integrity – Sensitive Data - Inference - Multilevel Databases - Proposals for Multilevel Security – Data Mining **3.2 Security in Networks** Network Concepts - Threats in Networks - Network Security Controls - Firewalls – Intrusion Detection Systems - Secure E-Mail
	UNIT-IV : **4.1 Administering Security** Security Planning - Risk Analysis - Organisational Security Policies - Physical Security **4.2 The Economics of Cyber security** Making a Business Case - Quantifying Security - Modeling Cyber security
	UNIT-V: **5.1 Privacy in Computing** Privacy Concepts - Privacy Principles and Policies - Authentication and Privacy – Data Mining - Privacy on The Web - E-Mail Security - Impacts on Emerging Technologies **5.2 Legal and Ethical Issues in Computer Security** Protecting Programs and Data - Information and the Law - Rights of Employees and Employers - Redress for Software Failures - Computer Crime - Ethical Issues in Computer Security - Case Studies of Ethics
Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper)	Demonstration on computer security Case Studies (To be discussed during the Tutorial hour)

Skills acquired from this course	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill
Recommended Text	Pfleeger ,Charles P and Shari Lawrence Pfleeger. Security in Computing, Released January 2015, Pearson, ISBN: 9780134085074
Reference Books	Bahadur ,Gary. Securing the Clicks Network Security in the Age of Social Media. 1st ed. McGraw-Hill, 2012. Daswani, Neil, Christoph Kern and Anita Kesavan. Foundations of Security: What Every Programming Needs to Know. Apress, 2007
Website and e-Learning Source	http://www.trendmicro.fr/media/wp/securityguide-social-networks-whitepaper-en.pdf http://paper.ijcsns.org/07_book/201306/20130619.pdf

Course Outcomes (for Mapping with POs and POs)

Students will be able to

PO1	Understand all aspects of computer security, including users, software, devices, operating systems, networks, law, and ethics
PO2	Apply cryptography an essential tool that is critical to computer security
PO3	Analyse the different aspects of computer security and privacy
PO4	Evaluate the aspects of computer security
PO5	Develop a system that uses user authentication, prevents malicious code execution, encrypts the data, protects privacy, implements firewall, detects intrusion, and more.

OUTCOME MAPPING :

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	3	2	1	1
CO2	3	3	3	2	1	1
CO3	3	3	3	2	1	1
CO4	3	3	3	2	1	1
CO5	3	3	3	2	1	1
Weightage of course contribute to eachPO						

<table>
<tr><td colspan="2">Title of the Course</td><td colspan="6">Distributed Systems</td></tr>
<tr><td colspan="2">Paper Number</td><td colspan="6">Elective 3</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">Elective III</td><td>Year</td><td>I</td><td rowspan="2">Credits</td><td rowspan="2">3</td><td rowspan="2">Course Code</td><td rowspan="2">23DSCE204</td></tr>
<tr><td>Semester</td><td>II</td></tr>
<tr><td colspan="2" rowspan="2">Instructional Hours per week</td><td colspan="2">Lecture</td><td colspan="2">Tutorial</td><td>Lab Practice</td><td>Total</td></tr>
<tr><td colspan="2">3</td><td colspan="2">1</td><td>--</td><td>4</td></tr>
<tr><td colspan="2">Pre-requisite</td><td colspan="6">Fundamentals of Operating Systems concepts and Networking</td></tr>
<tr><td colspan="2">Objectives of the Course</td><td colspan="6">To learn the principles, architectures, Processes, Communication, Co-ordination, consistency and Replication in Distributed Systems</td></tr>
<tr><td colspan="2">CourseObjectives</td><td colspan="6">1. To understand the fundamentals of Distributed System.
2. To learn Distributed System Models.
3. To introduce the concepts of peer to peer systems.
4. To understand the components and support required for distributed system.
5. To understand the process management and resource management in distributed systems.</td></tr>
<tr><td colspan="2" rowspan="3">Course Outline</td><td colspan="6">UNIT-I :Introduction - Introduction to Distributed Systems - Design Goals - Types of Distributed Systems
Chapter 1</td></tr>
<tr><td colspan="6">UNIT-II : Architectures - Architectural Styles - Middleware Organization - System Architecture - Example Architectures
Chapter 2</td></tr>
<tr><td colspan="6">UNIT-III :Processes : Threads - Virtualisation - Clients - Servers - Code Migration
Chapter 3</td></tr>
</table>

	UNIT-IV : Communications : Foundations - Remote Procedure Call - Basic RPC operation, Parameter Passing, RPC based Application Support - Message Oriented Communication - Simple transient Messaging with Sockets, Advanced Transient Messaging, Message Oriented Persistent Communication — Multicast Communication **Chapter 4** **Naming:** Names, Identifiers and Addresses - Flat naming - Structured naming - Attribute-based naming **Chapter 5**
	UNIT-V: Co-ordination: Clock Synchronisation - Logical Clocks - Mutual Exclusion - Election Algorithms - Distributed Event Management **Chapter 6 - 6.1,6.2,6.3,6.4,6.6** **Consistency and Replication:** Introduction - Data-centric Consistency Models - Client- Centric Consistency Models - Replica Management **Chapter 7-7.1 to 7.4** **Fault Tolerance: Introduction** **Chapter 8-8.1**
Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper)	Applications of Distributed Systems (To be discussed during the Tutorial hour)
Skills acquired from this course	Knowledge of Distributed Systems Concepts and its Architecture
Recommended Text	1. Andrew S. Tannenbaum and Maarten Van Steen, "Distributed Systems: Principles and Paradigms", Third Edition, Pearson, 2017.

Reference Books	1. George Coulouris, Jean Dollimore, Tim Kindberg, and Gordon Blair, "Distributed Systems: Concepts and Design", Fifth Edition, Addison Wesley, 2011. 2. James E. Smith, and Ravi Nair, "Virtual Machines: Versatile Platforms for Systems and Processes", First Edition, Morgan Kaufmann, 2005.
Website and e-Learning Source	1. https://www.tutorialspoint.com/Distributed-Systems 2. https://link.springer.com/article/10.1007/s00607-016-0508-7

Course Outcomes :
On successful completion of the course, the student will be able:
PO1: To explain the significance of Distributed Systems
PO2: To explain the architecture of Distributed Systems
PO3: To relate the different types of Processes's role in Distributed Systems
PO4: To describe the rules the communicating processes must adhere to
PO5: To examine the issues in Distributed Systems

OUTCOME MAPPING :

	POs					
	1	2	3	4	5	6
CO1	3	3	2	2	1	1
CO2	3	3	2	2	1	1
CO3	3	3	2	2	1	1
CO4	3	3	2	2	1	1
CO5	3	3	2	2	2	3

<table>
<tr><td colspan="2">Title of the Course</td><td colspan="8">Software Engineering for Data Science</td></tr>
<tr><td colspan="2">Paper Number</td><td colspan="8">Elective III</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">Elective III</td><td>Year</td><td>I</td><td rowspan="2">Credits</td><td rowspan="2">3</td><td rowspan="2">Course Code</td><td rowspan="2">23DSCE204</td></tr>
<tr><td>Semester</td><td>II</td></tr>
<tr><td colspan="2" rowspan="2">Instructional Hours per week</td><td colspan="2">Lecture</td><td colspan="2">Tutorial</td><td colspan="2">Lab Practice</td><td>Total</td></tr>
<tr><td colspan="2">3</td><td colspan="2">1</td><td colspan="2">--</td><td>4</td></tr>
<tr><td colspan="2">Pre-requisite</td><td colspan="8">Basic Knowledge in Programming</td></tr>
<tr><td colspan="2">Objectives of the Course</td><td colspan="8">To understand the software engineering principles and ensure software quality</td></tr>
<tr><td colspan="2">CourseObjectives</td><td colspan="8">1. To understand the phases of development of a Software Project.
2. To understand the major considerations for enterprise integration and deployment concepts of requirements engineering and Analysis Modeling.
3. To learn various testing, maintenance measures and risk management methods.
4. To learn the Software quality management and configuration management concepts.
5. To study about the Software Project Estimation Models.</td></tr>
<tr><td colspan="2">Course Outline</td><td colspan="8">UNIT-I :
Software and Software Engineering: The nature of software - Software Engineering - The Software Process - Software Engineering Practice - Software Myths
Chapter 1
Process Models :A Generic Process Model - Process Assessment and Improvement - Prescriptive Process Models - Product and Process
Chapter 2
Agile Development :Introduction - Agility and Cost of Change - Agile Process - Scrum - Other Agile Frameworks
Chapter 3</td></tr>
</table>

	UNIT-II : Recommended Process Model : Requirements Definition - Preliminary Architectural Design - Resource Estimation - First Prototype Construction - Prototype Evaluation - Prototype Evolution - Prototype Release - Maintain Release Software **Chapter 4** **Human Aspects of Software Engineering:** Characteristics of a Software Engineer - The Psychology of Software Engineer - The Software Team - Team Structures - The impact of Social Media - Global Teams **Chapter 5** **Principles that guide practice** : Core Principles - Principles that guide each Framework Activity - Communication Principles - Planning Principles - Modeling Principles - Construction Principles - Deployment Principles **Chapter 6**
	UNIT-III : **Understanding Requirements:** Requirements Engineering - Establishing the groundwork - Requirements Gathering - Developing Use Cases -Building the Analysis Model - Negotiating Requirements - Requirements Monitoring - Validating Requirements **Chapter 7** **Requirements Modeling - A Recommended Approach:** Requirements Analysis - Scenario-Based Modeling - Class-Based Modeling - Functional Modeling - Behavioural Modeling **Chapter 8**

	UNIT-IV : Design Concepts: Design within the context of Software Engineering - The Design Process - Design Concepts - The Design Model **Chapter 9** **Quality and Security** : Introduction - Software Quality - The Software Quality Dilemma - Achieving Software Quality **Chapter 15** **Software Quality Assurance:** Background Issues - Elements of Software Quality Assurance - SQA Process and Product Characteristics - SQA Tasks, Goals and Metrics - Formal Approaches - Statistical SQA - Software Reliability - ISO 9000 Quality standards - SQA Plan **Chapter 17**
	UNIT-V: Software Testing -Component Level: A Strategic Approach to Software Testing - Planning and RecordKeeping - Test-Case Design - White-box Testing - Black-Box Testing - Object-oriented Testing **Chapter 19** **Software Testing - Integration Level:** Software Testing Fundamentals - Integration Testing - Artificial Intelligence and Regression Testing - Integration Testing in the OO context - Validation Testing - Testing Patterns **Chapter 20** **Data Science for Software Engineers** **Appendix 2**
Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper)	Case Studies (To be discussed during the Tutorial hour)
Skills acquired from this course	Software Engineering approaches for tradition software and Data Science

Recommended Text	1. Pressman, Roger S., and Bruce R. Maxim. Software Engineering: A Practitioner's Approach, Ninth Edition, 2020.
Reference Books	1. Martin, Robert C. Agile software development: principles, patterns, and practices. Prentice Hall, 2002. 2. Schach, Stephen R. Object-oriented software engineering. McGraw-Hill, 2008. 3. Sommerville, Ian. "Software engineering 9th Edition." ISBN-10 137035152 (2011).
Website and e-Learning Source	https://www.d.umn.edu/~gshute/softeng/principles.html

Course Outcomes :
On successful completion of the course, the student will be able:
PO1: To describe the Software Engineering Principles
PO2: To apply Software Life Cycle Models for Software Development
PO3: To use Requirements Engineering skills and gather Requirements
PO4: To develop a quality Software
PO5: To apply appropriate testing methodologies

OUTCOME MAPPING :

	POs					
	1	2	3	4	5	6
CO1	3	3	1	2	2	1
CO2	3	3	1	2	2	3
CO3	3	3	1	2	2	2
CO4	3	3	3	2	2	2
CO5	3	3	1	2	2	2

Group D

Elective IV to be Chosen from Group D

<table>
<tr><td colspan="2">Title of the Course</td><td colspan="6">Applied Probability</td></tr>
<tr><td colspan="2">Paper Number</td><td colspan="6">ELECTIVE IV</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">Elective-IV</td><td>Year</td><td>I</td><td rowspan="2">Credits</td><td rowspan="2">3</td><td rowspan="2">Course Code</td><td rowspan="2">23DSCE205</td></tr>
<tr><td>Semester</td><td>II</td></tr>
<tr><td colspan="2">Instructional Hours per week</td><td>Lecture</td><td colspan="2">Tutorial</td><td colspan="2">Lab Practice</td><td>Total</td></tr>
<tr><td colspan="2"></td><td>3</td><td colspan="2">1</td><td colspan="2">--</td><td>4</td></tr>
<tr><td colspan="2">Pre-requisite</td><td colspan="6">Basic Probability</td></tr>
<tr><td colspan="2">Objectives of the Course</td><td colspan="6">To develop knowledge and understand fundamental concepts and applications of probability</td></tr>
<tr><td colspan="2">CourseObjectives</td><td colspan="6">1. To Obtain knowledge on sampling.
2. To study about tests of hypothesis, and statistical tests like t-test, F-test, Goodness of Fit, and Confidence interval.
3. To use discrete and continuous random variables.
4. To learn about Markov models.
5. To gain knowledge on model fitting.</td></tr>
<tr><td colspan="2" rowspan="2">Course Outline</td><td colspan="6">UNIT-I:
1.1 Basic Notions of Probability Theory
Introduction-Probability and Expectation-Sample Spaces and Events-Random Experiments, Sample Spaces, Events, Counting Techniques-Interpretations and Axioms of Probability-Addition Rules-Conditional Probability-Multiplication and Total Probability Rules-Independence-Bayes' Theorem-Random Variables-Distributions, Densities, and Moments-Convolution-Random Vectors-Multivariate Normal Random Vectors
1.2 Calculation of Expectations
Introduction-Indicator Random Variables and Symmetry-Conditioning-Moment Transforms-Tail Probability Methods-Moments of Reciprocals and Ratios-Reduction of Degree-Spherical Surface Measure</td></tr>
<tr><td colspan="6">UNIT-II:
Convexity and Combinatorics
Introduction-Convex Functions-Minimization of Convex Functions-The MM Algorithm-Moment Inequalities-Combinatorics-Introduction-Bijections-Inclusion-Exclusion -Applications to Order Statistics-Catalan Numbers-Pigeonhole Principle-Combinatorial Optimization-Introduction-Quick Sort-Data Compression and Huffman Coding-Graph Coloring</td></tr>
</table>

	UNIT-III: **3.1 Discrete Random Variables** Probability Distributions and Probability Mass Functions-Cumulative Distribution Functions-Mean and Variance of a Discrete Random Variable-Discrete Uniform Distribution-Binomial Distribution-Geometric and Negative Binomial Distributions-Hypergeometric Distribution-Poisson Distribution **3.2 Continuous Random Variables** Probability Distributions and Probability Density Functions-Cumulative Distribution Functions-Mean and Variance of a Continuous Random Variable-Continuous Uniform Distribution-Normal Distribution - Normal Approximation to the Binomial and Poisson Distributions-Exponential Distribution-Erlang and Gamma Distributions-Weibull Distribution-Lognormal Distribution-Beta Distribution
	UNIT-IV: **4.1 Two or More Random Variables** Joint Probability Distributions-Marginal Probability Distributions-Conditional Probability Distributions-Independence-More Than Two Random Variables- Covariance and Correlation-Common Joint Distributions-Multinomial Distribution-Bivariate Normal Distribution-Linear Functions of Random Variables-General Functions of Random Variables **4.2 Sampling Distributions and Point Estimation of Parameters** Point Estimation-Sampling Distributions and the Central Limit Theorem-General Concepts of Point Estimation-Unbiased Estimators-Variance of a Point Estimator -Standard Error: Reporting a Point Estimate-Mean Squared Error of an Estimator-Methods of Point Estimation-Method of Moments-Method of Maximum Likelihood-Bayesian Estimation of Parameters
	UNIT-V: **5.1 Discrete-Time Markov Chains** Introduction-Definitions and Elementary Theory-Examples-Coupling-Convergence Rates for Reversible Chains-Hitting Probabilities and Hitting Times-Markov Chain Monte Carlo-simulated annealing **5.2 Continuous-Time Markov Chains** Introduction-Finite-Time Transition Probabilities-Derivation of the Backward Equations-Equilibrium Distributions and Reversibility-Examples-Calculation of Matrix Exponentials-Kendall's Birth-Death-Immigration Process

Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper)	Problems related to the above topics to be solved (To be discussed during the Tutorial hour)
Skills acquired from this course	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill
Recommended Text	[1] Lange, Kenneth. Applied probability. Vol. 224. New York: Springer, 2003. [2] Douglas C. Montgomery, George C. Runger,Applied Statistics and Probability for Engineers, Fifth Edition, John Wiley & Sons, Inc.
Reference Books	[1] Mario Lefebvre, Applied Probability and Statistics, Springer Newyork, 2006 [2]Michael Mitzenmacher Eli Upfal, Probability and Computing Randomized Algorithms and Probabilistic Analysis, Cambridge University press, 2005
Website and **e-Learning Source**	https://open.umn.edu/opentextbooks/textbooks/256 https://www.intechopen.com/books/12021

Course Outcomes (for Mapping with POs and POs)

Students will be able to

PO1: Define the principal concepts about probability.
PO2: Understand combinatorics and convexity
PO3: Understand the nature and properties of density functions and hence determine the moments and moment generating functions of any random variable
PO4: Obtain the value of the point estimators using the method of moments and method of maximum likelihood
PO5: Define and formulate discrete-time and continuous-time Markov chains

OUTCOME MAPPING:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	3	2	1	1
CO2	3	3	3	2	1	1
CO3	3	3	3	2	1	1
CO4	3	3	3	2	1	1
CO5	3	3	3	2	1	1
Weightage of course contribute to each PO						

Title of the Course		**Optimization Techniques**					
Paper Number		**Group D**					
Category	Elective-IV	**Year**	I	**Credits**	3	**Course Code**	23DSCE205
		Semester	II				
Instructional Hours per week		**Lecture**	**Tutorial**	**Lab Practice**	**Total**		
		3	1	--	4		
Pre-requisite		Fundamentals of optimization and Linear algebra					
Objectives of the Course		To study of model formulation and apply the mathematical results and numerical techniques of optimization theory to real world problems					
Course Objectives		1. To understand the concept of Linear optimization 2. To develop mathematical models of transportation and assignment Problems 3. To understand the Networking models 4. To study non-linear optimization models 5. To develop optimization algorithms based on Evolutionary concepts					

Course Outline	**UNIT-I:** **1.1 Modelling with Linear programming** Two variable LP model – Graphical LP solution – Applications. **1.2 Simplex method and sensitivity analysis** Simplex method- Artificial starting solution - Special cases in simplex method- Graphical sensitivity analysis.
	UNIT-II: **2.1 Duality and post-optimal Analysis** Definition of Dual problem - Primal-Dual Relationships-Additional Simplex algorithms- Post optimal analysis **2.2 Advanced Linear Programming** Simplex method fundamentals-Revised Simplex Method, Bounded-Variable Algorithm, Duality, Parametric programming
	UNIT-III: **3.1 Goal Programming** Goal programming formulation - Goal Programming algorithms **3.2 Integer Programming** Formulation and Applications-Cutting Plane Algorithm-Branch and Bound Method
	UNIT-IV: **4.1 Heuristic Programming** Greedy Heuristics- Meta heuristic - Tabu Search algorithm - Constraint programming **4.2 Deterministic dynamic programming** Recursive nature of Dynamic programming computations - Forward and backward recursion- Selected DP applications - Knapsack/Fly-away kit/cargo-loading model- Investment models-Inventory models
	UNIT-V: **5.1 Queuing Systems** Pure birth and Pure death models- Generalized Poisson queuing model, single server models. **5.2 Classical optimization theory** Unconstrained problems - Constrained problems
Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper)	Implement Lab Exercises in python and solve problems related to the above topics (To be discussed during the Tutorial hour)

Skills acquired from this course	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill
Recommended Text	[1] Hamdy A.Taha, Operations Research- An Introduction, 10th Edition, Pearson Education – 2017.
Reference Books	[1] L.R.Foulds, Optimization Techniques , Springer ,Utm , 1981 [2] Garrido José M. Introduction to Computational Models with Python. CRC Press, 2016.
Website and **e-Learning Source**	https://www.pre-scient.com/knowledge-center/optimization-problems/optimization-problems.html https://www.shsu.edu/~eco_dgf/web_chapter_a.pdf

Course Outcomes (for Mapping with POs and POs)

Students will be able to

PO1: Explain the fundamental knowledge of Linear Programming
PO2: Use classical optimization techniques and numerical methods of optimization.
PO3: Enumerate fundamentals of Integer programming technique and apply different techniques to solve various optimization problems
PO4: Describe the basics of different Heuristic algorithms and solve dynamic programming problems.
PO5: Understand Queuing systems and understand constrained and unconstrained problems

OUTCOME MAPPING :

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	3	2	1	1
CO2	3	3	3	2	1	1
CO3	3	3	3	2	1	1
CO4	3	3	3	2	1	1
CO5	3	3	3	2	1	1

<table>
<tr><td colspan="2">Title of the Course</td><td colspan="6">Discrete Mathematics</td></tr>
<tr><td colspan="2">Paper Number</td><td colspan="6">ELECTIVE IV</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">Elective-IV</td><td>Year</td><td>I</td><td rowspan="2">Credits</td><td rowspan="2">3</td><td rowspan="2">Course Code</td><td rowspan="2">23DSCE205</td></tr>
<tr><td>Semester</td><td>II</td></tr>
<tr><td colspan="2" rowspan="2">Instructional Hours per week</td><td>Lecture</td><td>Tutorial</td><td colspan="2">Lab Practice</td><td colspan="2">Total</td></tr>
<tr><td>3</td><td>1</td><td colspan="2">--</td><td colspan="2">4</td></tr>
<tr><td colspan="2">Pre-requisite</td><td colspan="6">Basic mathematics</td></tr>
<tr><td colspan="2">Objectives of the Course</td><td colspan="6">To develop knowledge and understand concepts of mathematical induction, logic, functions and relations</td></tr>
<tr><td colspan="2">Course Objectives</td><td colspan="6">1. To know the concepts of relations and functions
2. To distinguish among different normal forms and quantifiers
3. To solve recurrence relations and permutations & combinations
4. To know and solve matrices , rank of matrix & characteristic equations
5. To study the graphs and its types</td></tr>
<tr><td colspan="2" rowspan="2">Course Outline</td><td colspan="6">UNIT-I:
1.1 Sets, Sequences and Functions
Sets-Some Special Sets-Set Operations-Functions-Sequences-Properties of Functions-Propositions-Conditional Propositions and Logical Equivalence-Arguments and Rules of Inference-Quantifiers-Nested Quantifiers
1.2 Elementary Logic
Informal Introduction-Propositional Calculus-Getting Started with Proofs-Methods of Proof-Logic in Proofs-Analysis of Arguments</td></tr>
<tr><td colspan="6">UNIT-II:
2.1 Relations
Relations-Digraphs and Graphs-Matrices-Equivalence Relations and Partitions-The Division Algorithm and Integers Mod p
2.2 Induction and Recursion
Loop Invariants-Mathematical Induction-Big-Oh Notation-Recursive Definitions-Recurrence Relations-More Induction-The Euclidean Algorithm</td></tr>
</table>

	UNIT-III: **3.1 Counting** Basic Counting Techniques-Elementary Probability-Inclusion-Exclusion and Binomial Methods-Counting and Partitions-Permutations and Combinations, Binomial Coefficients and Identities, Equivalence Relations, Generalized Permutations and Combinations, Generating Functions, Inclusion-Exclusion, Applications of Inclusion-Exclusion-Pigeon-Hole Principle **3.2 Algorithms** Introduction-Examples of Algorithms-Analysis of Algorithms-Recursive Algorithms
	UNIT-IV: **4.1 Graphs** Graphs-Paths and Cycles-Edge Traversal Problems-Hamiltonian Cycles and the Traveling Salesperson Problem-A Shortest-Path Algorithm-Representations of Graphs-Isomorphisms of Graphs-Planar Graphs **4.2 Trees** Trees-Terminology and Characterizations of Trees-Rooted Trees-Vertex Traversal Problems-Spanning Trees-Minimal Spanning Trees-Binary Trees- Tree Traversals-Decision Trees and the Minimum Time for Sorting - Isomorphism of Trees
	UNIT-V: **Recursion and Digraphs** General Recursion-Depth-First Search Algorithms-Polish Notation-Weighted Trees-Digraphs-Digraphs Revisited-Weighted Digraphs and Scheduling Networks-Digraph Algorithms
Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper)	Problems related to the above topics to be solved (To be discussed during the Tutorial hour)
Skills acquired from this course	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill
Recommended Text	[1] Kenneth A. Ross and Charles R. B. Wright, Discrete Mathematics, Pearson Education,Fifth Edition [2] Richard Johnsonbaugh, Discrete Mathematics, Pearson Education,Eighth Edition, 2018

Reference Books	[1] Discrete Mathematics and its Applications (6th edition), Kenneth H. Rosen, Tata McGraw Hill, Bombay, India [2] Discrete Mathematics with Applications Susanna S. Epp, Brooks/Cole 2011 [3] Discrete Mathematics an Introduction to Proofs and Combinatorics, Kevin Ferland, Houghton Mifflin Company, 2009
Website and e-Learning Source	https://www.tutorialspoint.com/discrete_mathematics/discrete_mathematics_introduction.htm https://www.cs.odu.edu/~toida/nerzic/content/intro2discrete/intro2discrete.html

Course Outcomes (for Mapping with POs and POs)

Students will be able to

PO1: To introduce Mathematical Logic to understand the equivalence of statements
PO2: To acquaint the students with Inference Theory and predicate calculus to understand partial order and partition.
PO3: To introduce fundamental principles of Combinatorial Counting techniques
PO4: To explain generating functions and their utility in solving recurrence relations
PO5: To introduce graph models and tree structures with basics and significance of traversability.

OUTCOME MAPPING:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	3	2	1	1
CO2	3	3	3	2	1	1
CO3	3	3	3	2	1	1
CO4	3	3	3	2	1	1
CO5	3	3	3	2	1	1
Weightage of course contribute to each PO						

Group E

Elective V to be chosen from Group E

<table>
<tr><td colspan="2">Title of the Course</td><td colspan="6">NATURAL LANGUAGE PROGRAMMING</td></tr>
<tr><td colspan="2">Paper Number</td><td colspan="6">ELECTIVE V</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">ELECTIVE V</td><td>Year</td><td>II</td><td rowspan="2">Credits</td><td rowspan="2">3</td><td rowspan="2">Course Code</td><td rowspan="2">23DSCE305</td></tr>
<tr><td>Semester</td><td>III</td></tr>
<tr><td colspan="2" rowspan="2">Instructional Hours per week</td><td>Lecture</td><td colspan="2">Tutorial</td><td colspan="2">Lab Practice</td><td>Total</td></tr>
<tr><td>2</td><td colspan="2">1</td><td colspan="2">--</td><td>3</td></tr>
<tr><td colspan="2">Pre-requisite</td><td colspan="6">Basic understanding of programming and machine learning</td></tr>
<tr><td colspan="2">Objectives of the Course</td><td colspan="6">To explore the concepts and fundamentals of Natural Language Programming</td></tr>
<tr><td colspan="2">CourseObjectives</td><td colspan="6">1. To provide an insight into the concepts of Natural Language Processing and its applications
2. To implement NLP applications using deep learning algorithms.
3. To learn Syntatic Analysis.
4. To learn Semantic Analysis.
5. To understand various word/text representation algorithms.</td></tr>
<tr><td colspan="2" rowspan="2">Course Outline</td><td colspan="6">UNIT-I:INTRODUCTION TO NLP

Knowledge in Speech and Language Processing – Ambiguity - Models and Algorithms- Language, Thought, and Understanding - The State of the Art - History - Applications – Basic NLP

Book1 : Chapter 1, Book 2: Chapter 1</td></tr>
<tr><td colspan="6">UNIT-II:WORD ANALYSIS

Regular Expressions - Words & Transducers- Survey of English Morphology- Finite-State Morphological Parsing - Word and Sentence Tokenization- N-grams- Counting Words in Corpora- Simple (Unsmoothed) N-grams- Training and Test Sets- Part-of-Speech Tagging- English Word Classes- Tagsets for English- Part-of-Speech Tagging- Rule-Based Part-of-Speech Tagging- Evaluation and Error Analysis

Book1 : Chapter 2, 3,4,5</td></tr>
</table>

	UNIT-III:SYNTACTIC ANALYSIS Formal Grammars of English- Constituency- Context-Free Grammars- Grammar Rules for English - Treebanks - Finite-State and Context-Free Grammars - Dependency Grammars - Parsing with Context-Free Grammars - Parsing as Search- Dynamic Programming Parsing Methods- Statistical Parsing- Probabilistic Context-Free Grammars- Probabilistic CKY Parsing of PCFGs- Learning PCFG Rule Probabilities **Book1 : Chapter 12, 13, 14**
	UNIT-IV:SEMANTICS AND PRAGMATICS Computational Desiderata for Representations- First-Order Logic, Computational Semantics –Syntax Driven Semantic analysis, Semantic attachments Semantic Attachments for a Fragment of English, Lexical Semantics- Word Senses, Relations between Senses, WordNet: A Database of Lexical Relations- Event Participants: Semantic Roles and Selectional Restriction **Book1: Chapter 17, 18,19**
	UNIT-V:APPLICATIONS Applications - Information Extraction, Question Answering and Summarization, Dialogue and Conversational Agents **Book1 : Chapter 22, 23,24**
Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper)	Case study on recent developments and presentation

Skills acquired from this course	Apply NLP programming to real time problems.
Recommended Text	1. Daniel Jurafsky, James H. Martin—Speech and Language Processing: An Introduction to Natural Language Processing, Computational Linguistics and Speech, Pearson Publication, 2014. 2. Patel, Ankur A., and Ajay UppiliArasanipalai. Applied Natural Language Processing in the Enterprise. " O'Reilly Media, Inc.", 2021.
Reference Books	1. Breck Baldwin, —Language Processing with Java and LingPipe Cookbook, Atlantic Publisher, 2015. 2. Richard M Reese, —Natural Language Processing with Java‖, O_Reilly Media, 2015. 3. Nitin Indurkhya and Fred J. Damerau, —Handbook of Natural Language Processing, Second Edition, Chapman and Hall/CRC Press, 2010. 4. Tanveer Siddiqui, U.S. Tiwary, —Natural Language Processing and Information Retrieval‖, Oxford University Press, 2008.
Website and e-Learning Source	https://www.simplilearn.com/tutorials/artificial-intelligence-tutorial/what-is-natural-language-processing-nlp https://towardsdatascience.com/your-guide-to-natural-language-processing-nlp-48ea2511f6e1 https://www.oracle.com/in/artificial-intelligence/what-is-natural-language-processing/

Course Outcomes (for Mapping with POs and POs)

Students will be able to

PO1	Understand the fundamentals of Natural Language Processing.
PO2	Apply the NLP techniques for word and syntactic analysis.
PO3	Analyze the natural language text.
PO4	Evaluate the tools and methods for understanding semantics of sentences and pragmatics.
PO5	Develop an innovative application using NLP components

OUTCOME MAPPING:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	3	2	1	1
CO2	3	3	3	2	1	1
CO3	3	3	3	2	1	1
CO4	3	3	3	2	1	1
CO5	3	3	3	2	1	1

<table>
<tr><td colspan="2">Title of the Course</td><td colspan="6">REINFORCEMENT LEARNING</td></tr>
<tr><td colspan="2">Paper Number</td><td colspan="6">ELECTIVE V</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">ELECTIVE V</td><td>Year</td><td>II</td><td rowspan="2">Credits</td><td rowspan="2">3</td><td rowspan="2">Course Code</td><td rowspan="2">23DSCE305</td></tr>
<tr><td>Semester</td><td>III</td></tr>
<tr><td colspan="2" rowspan="2">Instructional Hours per week</td><td>Lecture</td><td colspan="2">Tutorial</td><td>Lab Practice</td><td colspan="2">Total</td></tr>
<tr><td>2</td><td colspan="2">1</td><td>--</td><td colspan="2">3</td></tr>
<tr><td colspan="2">Pre-requisite</td><td colspan="6">Basic understanding of machine learning types</td></tr>
<tr><td colspan="2">Objectives of the Course</td><td colspan="6">To introduce the concepts and fundamentals of reinforcement learning and methods</td></tr>
<tr><td colspan="2">Course Objectives</td><td colspan="6">1. To know how to define RL tasks and the core principals behind the RL
2. To learn about Tabular methods
3. To Understand and work with approximate solutions (deep Q network-based algorithms)
4. To Explore imitation learning tasks and solutions
5. To Recognize current advanced techniques and applications in RL</td></tr>
<tr><td colspan="2" rowspan="2">Course Outline</td><td colspan="6">UNIT-I: INTRODUCTION AND BASICS OF REINFORCEMENT LEARNING

The Reinforcement Learning Problem - Reinforcement Learning- Examples- Elements of Reinforcement Learning- Limitations and Scope -An extended example – History of Reinforcement Learning - Applications - Ethics in RL- Applying RL for real-world problems- Meta-learning- Multi-Agent Reinforcement Learning

Book 1- Chapter 1</td></tr>
<tr><td colspan="6">UNIT-II: TABULAR METHODS

Finite Markov Decision Processes - Dynamic Programming - Monte Carlo Methods

Book 1- Chapter 3,4,5</td></tr>
</table>

	UNIT-III: Q-NETWORKS AND LEARNING Temporal difference learning – n-step Bootstrapping- Planning and learning with tabular methods, Deep Q-networks- DQN, DDQN, Dueling DQN, Prioritised Experience Replay **Book 1- Chapter 6,7,8**
	UNIT-IV: APPROXIMATE SOLUTION METHODS On-policy prediction with approximation – on-policy control with approximation – policy gradient methods **Book 1- Chapter 9,10,13**
	UNIT-V:PSYCHOLOGY AND NEUROSCIENCE Prediction and control - Classical conditioning – neuroscience – basics-reward and prediction -case studies **Book 1- Chapter 14,15,16**
Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper)	Case study on recent developments and presentation
Skills acquired from this course	Apply Reinforcement Learning core principals and tasks for real time problems.
Recommended Text	1. Sutton, Richard S., and Andrew G. Barto. Reinforcement learning: An introduction. MIT press, 2018.

Reference Books	1. Szepesvári, Csaba. "Algorithms for reinforcement learning." Synthesis lectures on artificial intelligence and machine learning 4.1 (2010): 1-103. 2. Winder, Phil. Reinforcement learning. O'Reilly Media, 2020. 3. Bilgin, Enes. Mastering Reinforcement Learning with Python: Build next-generation, self-learning models using reinforcement learning techniques and best practices. Packt Publishing Ltd, 2020.
Website and e-Learning Source	https://developer.ibm.com/learningpaths/get-started-automated-ai-for-decision-making-api/what-is-automated-ai-for-decision-making/ https://towardsdatascience.com/reinforcement-learning-101-e24b50e1d292 https://www.analyticsvidhya.com/blog/2021/02/introduction-to-reinforcement-learning-for-beginners/

Course Outcomes (for Mapping with POs and POs)

Students will be able to

PO1	Understand the fundamentals of Reinforcement Learning tasks and the core principals including policies, value and functions.
PO2	Apply the tabular and approximation methods to solve classical control problems.
PO3	Analyse policy gradient methods to solve more complex cases.
PO4	Evaluate the tools and methods used for prediction and control.
PO5	Investigate the current advanced techniques and applications in Reinforcement Learning.

OUTCOME MAPPING:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	3	2	1	1
CO2	3	3	3	2	1	1
CO3	3	3	3	2	1	1
CO4	3	3	3	2	1	1
CO5	3	3	3	2	1	1

<table>
<tr><td colspan="2">Title of the Course</td><td colspan="8">SOCIAL NETWORK ANALYSIS</td></tr>
<tr><td colspan="2">Paper Number</td><td colspan="8">ELECTIVE V</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">Elective V</td><td>Year</td><td>II</td><td rowspan="2">Credits</td><td rowspan="2">3</td><td rowspan="2">Course Code</td><td rowspan="2">23DSCE305</td></tr>
<tr><td>Semester</td><td>III</td></tr>
<tr><td colspan="2" rowspan="2">Instructional Hours per week</td><td colspan="2">Lecture</td><td colspan="2">Tutorial</td><td colspan="2">Lab Practice</td><td>Total</td></tr>
<tr><td colspan="2">2</td><td colspan="2">1</td><td colspan="2">--</td><td>3</td></tr>
<tr><td colspan="2">Pre-requisite</td><td colspan="8">Basic understanding of social networks</td></tr>
<tr><td colspan="2">Objectives of the Course</td><td colspan="8">To introduce the concepts and fundamentals of social network components and analysis</td></tr>
<tr><td colspan="2">CourseObjectives</td><td colspan="8">1. To learn about Social media, Social networking and Webcasts
2. To understanding and building a Word Press Powered Website
3. To analysis the Social Networking & Micro-Blogging.
4. To learn and analysis the Widgets & Badges.
5. To explore the importance of Website optimization.</td></tr>
<tr><td colspan="2">Course Outline</td><td colspan="8">UNIT-I: INTRODUCTION TO SEMANTIC WEB AND SOCIAL NETWORKS

Introduction to Semantic Web: Limitations of current Web - Development of Semantic Web - Emergence of the Social Web - Social Network analysis: Development of Social Network Analysis - Key concepts and measures in network analysis - Electronic sources for network analysis: Electronic discussion networks, Blogs and online communities - Web-based networks - Applications of Social Network Analysis- Brief history of Social network analysis

Book 1- Chapter 1,2,3 Book 2: Chapter 1</td></tr>
</table>

	UNIT-II: MODELLING, AGGREGATING AND KNOWLEDGE REPRESENTATION Knowledge Representation on the semantic web- Ontology and their role in the Semantic Web - Ontology languages for the Semantic Web- Modelling and aggregating social network data: State-of-the-art in network data representation - Ontological representation of social individuals - Ontological representation of social relationships - Aggregating and reasoning with social network data - Advanced representations **Book 1: Chapter 4,5,6**
	UNIT-III: DATA COLLECTION Boundary specification – Data collection process- Information bias and issue of reliability – Archival data – Understanding SNA data – Managing SNA data **Book2 : Chapter 2**
	UNIT-IV : METHODS IN SOCIAL NETWORK ANALYSIS Descriptive methods – Graph – Density- Centrality – cliques – MDS- structural equivalence – Two mode networks – Inferential methods – QAP- ERGM **Book 2- Chapter 3, 4**
	UNIT-V:CASE STUDIES Case studies – Evaluation of web-based social network extraction – semantic – based social network analysis in the sciences – emergent semantics **Book 1: Chapter 7,8,9**

Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper)	Case study on recent developments and presentation
Skills acquired from this course	Apply social network in real time applications
Recommended Text	1. Peter Mika, "Social Networks and the Semantic Web", Springer 2007. 2. Yang, Song, Franziska B. Keller, and Lu Zheng. Social network analysis: Methods and examples. Sage Publications, 2016.
Reference Books	1. GuandongXu ,Yanchun Zhang and Lin Li, ―Web Mining and Social Networking – Techniques and applications‖, First Edition, Springer, 2011. 2. Dion Goh and Schubert Foo, ―Social information Retrieval Systems: Emerging Technologies and Applications for Searching the Web Effectively‖, IGI Global Snippet, 2008.
Website and e-Learning Source	https://bookdown.org/chen/snaEd/ch4.html https://www.sciencedirect.com/topics/social-sciences/social-network-analysis https://www.publichealth.columbia.edu/research/population-health-methods/social-network-analysis https://www.ibm.com/docs/en/spss-modeler/18.0.0?topic=analysis-about-social-network

Course Outcomes (for Mapping with POs and POs)

Students will be able to

PO1	Understand the fundamentals of social web and elements of social network analysis.
PO2	Apply and visualize the knowledge representation in social network.
PO3	Analyse the various methods in social network analysis.
PO4	Evaluate the tools and methods for analysing the social network data.
PO5	Investigate the recent potential applications and development of social network with real time case studies.

OUTCOME MAPPING :

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	3	2	1	1
CO2	3	3	3	2	1	1
CO3	3	3	3	2	1	1
CO4	3	3	3	2	1	1
CO5	3	3	3	2	1	1
Weightage of course contribute to each PO						

<table>
<tr><td colspan="2">Title of the Course</td><td colspan="7">Artificial Intelligence and Data Science</td></tr>
<tr><td colspan="2">Paper Number</td><td colspan="7">ELECTIVE VI</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">Elective VI</td><td>Year</td><td>II</td><td rowspan="2">Credits</td><td rowspan="2">3</td><td rowspan="2">Course Code</td><td rowspan="2">23DSCE404</td></tr>
<tr><td>Semester</td><td>IV</td></tr>
<tr><td colspan="2" rowspan="2">Instructional Hours per week</td><td>Lecture</td><td colspan="2">Tutorial</td><td>Lab Practice</td><td colspan="2">Total</td></tr>
<tr><td>2</td><td colspan="2">--</td><td>2</td><td colspan="2">4</td></tr>
<tr><td colspan="2">Pre-requisite</td><td colspan="7">knowledge of Computer Science and Mathematics</td></tr>
<tr><td colspan="2">Objectives of the Course</td><td colspan="7">To explore the approaches and principles of Artificial Intelligence (AI) algorithms, and apply them to Data Science</td></tr>
<tr><td colspan="2">CourseObjectives</td><td colspan="7">1. To learn the basic functions of AI, Heuristic Search Techniques.
2. To gain knowledge on concepts of Representations and Mappings and Predicate Logic.
3. To introduce Machine Learning with respect to Data Mining, Big Data and Cloud.
4. To Study about AI Applications & Impact of ML
5. To learn about AI Frameworks.</td></tr>
<tr><td colspan="2">Course Outline</td><td colspan="7">UNIT-I :

1.1 Artificial Intelligence
The AI Problems - The Underlying Assumptions – What is an AI Technique – The
Level of the Model – Criteria for Success.
1.2 Problems, Problem Spaces & Search
Defining the problem as a State Space Search – Production systems – Problem
Characteristics - Production Systems Characteristics – Issues in the Design of Search
Programs.
1.3 Heuristic Search Techniques
Generate and Test – Hill Climbing – Best First Search – Problem Reduction -
Constraint Satisfaction – Means ends Analysis.</td></tr>
</table>

	UNIT-II : **2.1 Knowledge Representation Issues** Representations and Mappings – Approaches to KR – Issues in KR – The Frame Problem. **2.2 Using Predicate Logic** Representing Simple Facts in Logic - Representing Instances and ISA Relationships – Computable Functions and Predicates – Resolutions – Natural Deductions. **2.3 Representing Knowledge using Rules** Procedural versus Declarative Knowledge – Logic Programming – Forward Versus Backward Reasoning – Matching – Control Knowledge. **2.4 Statistical Reasoning** Probability and Bayes Theorem - Certainty Factors and Rule based Systems – Bayesian Networks – Dempsters Shafer Theory - Fuzzy Logic.
	UNIT-III : **3.1 Learning** What is Learning - Rote Learning – Learning by Taking Advice – Learning by Problem Solving – Learning from Examples: Induction – Explanation based Learning – Discovery – Analogy – Formal Learning Theory – Neural Net Learning and Genetic Learning **3.2 Parallel and Distributed AI** Psychological Modelling – Parallelism in Reasoning Systems – Distributed Reasoning Systems
	UNIT-IV : **4.1 Deep Learning Frameworks and AI Methodologies** Working – Framework – programming Languages – applications – optimization – fuzzy inference systems – artificial creativity – additional AI methodologies – glimpse into the future **4.2 Building DL network using MXNet, TensorFlow and Keras** Core components – MXNet, TensorFlow and Keras in action – Summary and Visualization
	UNIT-V: **5.1 Building and optimizer based on PO and GA** Algorithm - implementation - variants - PO and GA in action - Framework and tips **5.2 Building an Advanced DL system** CNN - RNN **5.3 Alternative AI frameworks in DS** ELMs - CapsNets - Fuzzy logic and Fuzzy inference systems

Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper)	Demonstration, Case studies, Real time projects
Skills acquired from this course	AI methodologies & Techniques for data science related problems
Recommended Text	Kevin Night, Elaine Rich, Nair B., "Artificial Intelligence (SIE)", McGraw Hill2008. (Unit- 1, 2, 3)
Reference Books	Russell, Stuart J., and Peter Norvig. Artificial intelligence: a modern approach. Malaysia; Pearson Education Limited, 2016. Prolog Programming for Artificial Intelligence (International Computer Science Series), Addison-Wesley Educational Publishers Inc; 4th edition, 2011 By Ivan Bratko
Website and **e-Learning Source**	http://www.aispace.org/index.html https://www.britannica.com/technology/artificial-intelligence https://www.sas.com/en_in/insights/analytics/what-is-artificial-intelligence.html

Course Outcomes (for Mapping with POs and POs)

Students will be able to

PO1	Understand and identify problems that are amenable to solution by AI methods
PO2	Analyse and apply appropriate AI methods to solve a given problem.
PO3	Analyse and formalize a given problem in the language/framework of different AI and learning methods
PO4	Evaluate the AI methodologies and DL networks
PO5	Develop AI framework to tackle projects in our increasingly complex world

OUTCOME MAPPING :

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	3	2	1	1
CO2	3	3	3	2	1	1
CO3	3	3	3	2	1	1
CO4	3	3	3	2	1	1
CO5	3	3	3	2	1	1
Weightage of course contribute to eachPO						

<table>
<tr><td colspan="2">Title of the Course</td><td colspan="6">Image Recognition</td></tr>
<tr><td colspan="2">Paper Number</td><td colspan="6">ELECTIVE VI</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">Elective VI</td><td>Year</td><td>II</td><td rowspan="2">Credits</td><td rowspan="2">3</td><td rowspan="2">Course Code</td><td rowspan="2">23DSCE404</td></tr>
<tr><td>Semester</td><td>IV</td></tr>
<tr><td colspan="2" rowspan="2">Instructional Hours per week</td><td>Lecture</td><td colspan="2">Tutorial</td><td>Lab Practice</td><td colspan="2">Total</td></tr>
<tr><td>2</td><td colspan="2">--</td><td>2</td><td colspan="2">4</td></tr>
<tr><td colspan="2">Pre-requisite</td><td colspan="6">Knowledge on Mathematics and Programming Language like python</td></tr>
<tr><td colspan="2">Objectives of the Course</td><td colspan="6">To understand the fundamentals of real time images, image transformations, detect edges and recognize objects in the image</td></tr>
<tr><td colspan="2">CourseObjectives</td><td colspan="6">1. To learn basic computer vision techniques.
2. To learn image processing techniques for solving real problems.
3. To Gain knowledge in image transformation and Image enhancement techniques.
4. To learn Image compression and Segmentation procedures.
5. To study about the image recognition techniques.</td></tr>
</table>

Course Outline	**UNIT-I :** **1.1 Introduction** The Human Vision System - Practical Applications of Computer Vision - The Future of Computer Vision **1.2 Images** The Simple Pinhole Camera Model - Images - Sampling- Quantization- Color Images- Noise – Smoothing
	UNIT-II : **2.1 Histograms** 1D Histograms - Histogram/Image Equalization- Histogram Comparison-k-means Clustering **2.2 Binary Vision** Thresholding- Threshold Detection Methods- Mathematical Morphology
	UNIT-III : **3.1 Geometric Transformations** Affine Transformations - Perspective Transformations – Interpolation **3.2 Edges** Edge Detection - Contour Segmentation - Hough Transform
	UNIT-IV : **4.1 Features** Moravec Corner Detection - Harris Corner Detection - FAST Corner Detection- SIFT - Recognition
	UNIT-V: **5.1 Recognition** Template Matching - Chamfer Matching - Statistical Pattern Recognition - Cascade ofHaar Classifiers - Other Recognition Techniques - Performance **5.2 Vision Problems** Abandoned and Removed Object Detection - Traffic Lights - Real Time Face Tracking - Road Sign Recognition - License Plates

Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper)	Demonstration, Case studies, Real time project analysis
Skills acquired from this course	Real time research projects related to Image recognition
Recommended Text	Kenneth Dawson. A Practical Introduction to Computer Vision with OpenCV. John Wiley & Sons Ltd, 2014.
Reference Books	David A. Forsyth, Jean Ponce. Computer Vision: A Modern Approach. Pearson Edition,2015. Jan Erik Solem. Programming Computer Vision with Python: Tools and Algorithms for Analyzing Images. O'Reilly Media, 2012. Richard Szeliski. Computer Vision: Algorithms and Applications. Springer Publications, 2011. Simon J. D. Prince. Computer Vision: Models, Learning, and Inference. Cambridge University Press,2012.
Website and e-Learning Source	https://www.cs.toronto.edu/~urtasun/courses/CV/lecture01.pdf https://www.cl.cam.ac.uk/teaching/0809/CompVision/CompVisNotes.pdf

Course Outcomes (for Mapping with POs and POs)

Students will be able to

PO1	Understand fundamentals of images, Computer Vision and Geometric transformations
PO2	Apply Histograms in real time images and recognize features
PO3	Analyse the edge detection techniques
PO4	Evaluate the vision related problems in further research
PO5	Develop real time projects related image recognition

OUTCOME MAPPING :

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	3	2	1	1
CO2	3	3	3	2	1	1
CO3	3	3	3	2	1	1
CO4	3	3	3	2	1	1
CO5	3	3	3	2	1	1
Weightage of course contribute to eachPO						

<table>
<tr><td colspan="2">Title of the Course</td><td colspan="6">DEEP LEARNING</td></tr>
<tr><td colspan="2">Paper Number</td><td colspan="6">ELECTIVE VI</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">Elective VI</td><td>Year</td><td>II</td><td rowspan="2">Credits</td><td rowspan="2">3</td><td rowspan="2">Course Code</td><td rowspan="2">23DSCE404</td></tr>
<tr><td>Semester</td><td>IV</td></tr>
<tr><td colspan="2" rowspan="2">Instructional Hours per week</td><td>Lecture</td><td colspan="2">Tutorial</td><td>Lab Practice</td><td colspan="2">Total</td></tr>
<tr><td>2</td><td colspan="2">--</td><td>2</td><td colspan="2">4</td></tr>
<tr><td colspan="2">Pre-requisite</td><td colspan="6">Mathematics, Machine Learning and Programming</td></tr>
<tr><td colspan="2">Objectives of the Course</td><td colspan="6">To provide fundamental knowledge of neural networks and deep learning</td></tr>
<tr><td colspan="2">CourseObjectives</td><td colspan="6">1. To present the mathematical, statistical and computational challenges of building neural networks.
2. To study the various concepts of deep learning.
3. To introduce dimensionality reduction techniques.
4. To examine CNN and RNN.
5. To learn about Auto Encoder and Restricted Boltzmann Machine.</td></tr>
</table>

Course Outline	**UNIT-I :** **Introduction to Artificial Neural Networks** Neural Networks-Application Scope of Neural Networks-Fundamental Concept of ANN: The Artificial Neural Network-Biological Neural Network-Comparison between Biological Neuron and Artificial Neuron-Evolution of Neural Network. Basic models of ANN-Learning Methods-Activation Functions-Importance Terminologies of ANN.
	UNIT-II : **Supervised Learning Network** Shallow neural networks- Perceptron Networks-Theory-Perceptron Learning RuleArchitecture-Flowchart for training Process-Perceptron Training Algorithm for Single and Multiple Output Classes. Back Propagation Network- Theory-Architecture-Flowchart for training process -Training Algorithm-Learning Factors for Back-Propagation Network. Radial Basis Function Network RBFN: Theory, Architecture, Flowchart and Algorithm.
	UNIT-III : **Convolutional Neural Network** Introduction - Components of CNN Architecture - Rectified Linear Unit (ReLU) Layer - Exponential Linear Unit (ELU, or SELU) - Unique Properties of CNN -Architectures of CNN -Applications of CNN.
	UNIT-IV : **Recurrent Neural Network** Introduction- The Architecture of Recurrent Neural Network- The Challenges of Training Recurrent Networks- Echo-State Networks-Long Short-Term Memory (LSTM) - Applications of RNN.
	UNIT-V: **Auto Encoder and Restricted Boltzmann Machine** Introduction - Features of Auto encoder Types of Autoencoder Restricted Boltzmann Machine- Boltzmann Machine - RBM Architecture -Example - Types of RBM.

Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper)	Demonstration, case studies, real time projects (To be discussed during the Tutorial hour)
Skills acquired from this course	Knowledge and Skill for real time research problems
Recommended Text	1. S.N.Sivanandam, S. N. Deepa, Principles of Soft Computing, 2. Wiley-India, 3rd Edition, 2018. Dr. S Lovelyn Rose, Dr. L Ashok Kumar, Dr. D Karthika Renuka, Deep Learning using Python, Wiley-India, 1st Edition, 2019.
Reference Books	1. Charu C. Aggarwal, Neural Networks and Deep Learning, Springer, September 2018. 2. Francois Chollet, Deep Learning with Python, Manning Publications; 1st edition,2017 3. John D. Kelleher, Deep Learning (MIT Press Essential Knowledgeseries), The MIT Press, 2019.
Website and **e-Learning Source**	https://onlinecourses.nptel.ac.in/noc22_cs22/preview https://arxiv.org/abs/1506.06579 https://arxiv.org/abs/1605.06211 https://cs230.stanford.edu/lecture/

Course Outcomes (for Mapping with POs and POs)

Students will be able to

PO1	Understand the major technology trends in neural networks and deep learning
PO2	Analyse neural networks and fully connected deep neural networks
PO3	Apply neural networks and fully connected deep neural networks
PO4	Evaluate efficient (vectorized) neural networks and deep learning for real time application
PO5	Build efficient (vectorized) neural networks and deep learning for real time application

OUTCOME MAPPING :

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	3	2	1	1
CO2	3	3	3	2	1	1
CO3	3	3	3	2	1	1
CO4	3	3	3	2	1	1
CO5	3	3	3	2	1	1
Weightage of course contribute to eachPO						

GROUP G

(Skill Enhancement Courses) SEC:

SEC-I, SEC-II, SEC-III to be chosen from Group G:

23DSCS206	**SEC-I - DATA SCIENCE USING EXCEL**	**C 2 P 4**

COURSE OBJECTIVES:

1. To learn the interface in Tableau / MS-Excel for creating visualisations.
2. To understand the methods for drawing charts and graphs.
3. To learn the use of maps and tables in creating visualisation.
4. To prepare dashboard design for data analytics applications.

LIST OF EXERCISES

(The exercises are to be done in Tableau / MS-Excel)

1. Study of interface, screen and visual cues in Tableau / MS-Excel
2. Connecting with various data sources
3. Working with measures and dimensions
4. Working with Colours
5. Working with Expressions, Functions, Date, Time
6. Drawing Charts and Graphs
7. Creating Maps
8. Working with Table Calculations
9. Sorting Data
10. Applying Filters
11. Dashboard design

COURSE OUTCOMES:

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

PO1: Discover the various elements in the interface to load and analyze data.

PO2: Design filters for data visualization.

PO3: Develop dashboard design for typical data analytics applications.

Outcome Mapping:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	1	2	3	1	3	2	2	1	2	2
CO2	2	2	3	2	3	2	2	3	3	3
CO3	3	2	3	2	3	1	3	3	2	2
CO4	2	2	2	3	3	1	3	3	3	3

Title of the Course		**Data Mining using R**					
Category	SEC-I	**Year**	I	**Credits**	2	**Course Code**	23DSCS206
		Semester	II				
Instructional Hours per week		**Lecture**	**Tutorial**	**Lab Practice**	**Total**		
		--	--	4	4		
Pre-requisite		BasicsofDMAlgorithms&R Programming					

CourseObjectives:

Themain objectivesof thiscourseareto:

1. ToenablethestudentstolearntheconceptsofDataMiningalgorithmsnamelyclassification, clustering, regression….
2. Tounderstand&writeprogramsusingtheDM algorithms
3. Toapplystatisticalinterpretationsforthesolutions
4. Abletousevisualizationtechniquesfor interpretations

ExpectedCourseOutcomes:

Onthesuccessfulcompletionofthecourse,studentwillbeableto:

PO1	AbletowriteprogramsusingRforAssociationrules,Clusteringtechniques	K1,K2
PO2	Toimplement dataminingtechniques likeclassification, prediction	K2,K3
PO3	Abletousedifferent visualizationtechniquesusingR	K4,K5
PO4	Toapplydifferentdataminingalgorithmstosolverealworldapplications	K5,K6

K1-Remember;**K2**-Understand;**K3**-Apply;**K4**-Analyze;**K5**-Evaluate; **K6**-Create

LISTOF PROGRAMS	75hours
1. ImplementApriorialgorithmtoextractassociationruleof datamining. 2. Implementk-meansclusteringtechnique. 3. ImplementanyoneHierarchal Clustering. 4. ImplementClassificationalgorithm. 5. ImplementDecisionTree. 6. LinearRegression. 7. DataVisualization.	
TotalLecturehours	**75hours**

Text Books	
1	MargaretH.Dunham,"DataMining:IntroductoryandAdvancedTopics",Pearson education,2003.
2	C.S.R. Prabhu, "Data Warehousing Concepts,Techniques, Productsand Applications", PHI, Second Edition
ReferenceBooks	
1	ArunK.Pujari,"DataMiningTechniques",UniversitiesPress(India)Pvt. Ltd.,2003.
2	AlexBerson,StephenJ.Smith,"DataWarehousing,DataMiningandOLAP",TMCH, 2001.
RelatedOnlineContents[MOOC,SWAYAM,NPTEL,Websitesetc.]	
1	https://www.javatpoint.com/data-warehouse
2	https://nptel.ac.in/noc/courses/noc20/SEM1/noc20-cs12/
3	https://www.btechguru.com/training--it--database-management-systems--file-structures--introduction-to-data-warehousing-and-olap-2-video-lecture--12054--26--151.html

MappingwithProgrammingOutcomes:										
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	3	3	2	3	3	3	2	2	3	3
CO2	3	3	3	2	3	3	3	2	3	2
CO3	3	3	3	2	3	3	3	3	3	3
CO4	3	3	3	2	3	3	3	2	3	3

<table>
<tr><td colspan="2">Title of the Course</td><td colspan="6">Emerging Technologies in Data Science</td></tr>
<tr><td>Category</td><td>SEC-II</td><td>Year</td><td>II</td><td>Credits</td><td>2</td><td>Course Code</td><td>23DSCS306</td></tr>
<tr><td colspan="2"></td><td>Semester</td><td>III</td><td colspan="4"></td></tr>
<tr><td colspan="2">Instructional Hours per week</td><td colspan="2">Lecture
3</td><td colspan="2">Tutorial
--</td><td>Lab Practice
--</td><td>Total
3</td></tr>
<tr><td colspan="2">Pre-requisite</td><td colspan="6">knowledge of Computer Science and Mathematics</td></tr>
<tr><td colspan="2">Objectives of the Course</td><td colspan="6">To explore the approaches and principles of Artificial Intelligence (AI) algorithms, and apply them to Data Science</td></tr>
<tr><td colspan="2">CourseObjectives</td><td colspan="6">1. To solve different AI Problems.
2. To learn different search techniques.
3. To study about knowledge representation issues.
4. To develop Deep Learning Frameworks and AI Methodologies</td></tr>
<tr><td colspan="2">Course Outline</td><td colspan="6">UNIT-I :

1.1 Artificial Intelligence
The AI Problems - The Underlying Assumptions – What is an AI Technique – TheLevel of the Model – Criteria for Success.
1.2 Problems, Problem Spaces & Search
Defining the problem as a State Space Search – Production systems – ProblemCharacteristics - Production Systems Characteristics – Issues in the Design of SearchPrograms.
1.3 Heuristic Search Techniques
Generate and Test – Hill Climbing – Best First Search – Problem Reduction -Constraint Satisfaction – Means ends Analysis.</td></tr>
<tr><td colspan="2"></td><td colspan="6">UNIT-II :

2.1 Knowledge Representation Issues
Representations and Mappings – Approaches to KR – Issues in KR – The FrameProblem.
2.2 Using Predicate Logic
Representing Simple Facts in Logic - Representing Instances and ISA Relationships– Computable Functions and Predicates – Resolutions – Natural Deductions.
2.3 Representing Knowledge using Rules
Procedural versus Declarative Knowledge – Logic Programming – Forward VersusBackward Reasoning – Matching – Control Knowledge.
2.4 Statistical Reasoning
Probability and Bayes Theorem - Certainty Factors and Rule based Systems –Bayesian Networks – Dempsters Shafer Theory - Fuzzy Logic.</td></tr>
</table>

	UNIT-III : **3.1 Learning** What is Learning - Rote Learning – Learning by Taking Advice – Learning by Problem Solving – Learning from Examples: Induction – Explanation based Learning – Discovery – Analogy – Formal Learning Theory – Neural Net Learning and Genetic Learning **3.2 Parallel and Distributed AI** Psychological Modelling – Parallelism in Reasoning Systems – Distributed Reasoning Systems
	UNIT-IV : **4.1 Deep Learning Frameworks and AI Methodologies** Working – Framework – programming Languages – applications – optimization – fuzzy inference systems – artificial creativity – additional AI methodologies – glimpse into the future **4.2 Building DL network using MXNet, TensorFlow and Keras** Core components – MXNet, TensorFlow and Keras in action – Summary and Visualization
	UNIT-V: **5.1 Building and optimizer based on PO and GA** Algorithm - implementation - variants - PO and GA in action - Framework and tips **5.2 Building an Advanced DL system** CNN - RNN **5.3 Alternative AI frameworks in DS** ELMs - CapsNets - Fuzzy logic and Fuzzy inference systems
Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper)	Demonstration, Case studies, Real time projects
Skills acquired from this course	AI methodologies & Techniques for data science related problems
Recommended Text	Kevin Night, Elaine Rich, Nair B., “Artificial Intelligence (SIE)”, McGraw Hill2008. (Unit- 1, 2, 3)

Reference Books	Russell, Stuart J., and Peter Norvig. Artificial intelligence: a modern approach. Malaysia; Pearson Education Limited, 2016. Prolog Programming for Artificial Intelligence (International Computer Science Series), Addison-Wesley Educational Publishers Inc; 4th edition, 2011 By Ivan Bratko
Website and **e-Learning Source**	http://www.aispace.org/index.html https://www.britannica.com/technology/artificial-intelligence https://www.sas.com/en_in/insights/analytics/what-is-artificial-intelligence.html

Course Outcomes (for Mapping with POs and POs) :

Students will be able to

PO1	Understand and identify problems that are amenable to solution by AI methods
PO2	Analyse and apply appropriate AI methods to solve a given problem.
PO3	Analyse and formalize a given problem in the language/framework of different AI and learning methods
PO4	Evaluate the AI methodologies and DL networks
PO5	Develop AI framework to tackle projects in our increasingly complex world

OUTCOME MAPPING:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	3	2	1	1
CO2	3	3	3	2	1	1
CO3	3	3	3	2	1	1
CO4	3	3	3	2	1	1
CO5	3	3	3	2	1	1

23DSCS306	**SEC II – Cyber Security**	C 2 L3

Course Objectives:

1. To understand the basics of Cybercrime and Computer forensics with protecting mechanism
2. To explore the working principles of WLAN, Email and Smartphone along with security mechanism and guidelines
3. To gain the ability to understand the importance of cyber investigations with its functioning role and learn the basics of Wi Fi and its security measures
4. To understand and learn the method of seize the digital evidence
5. To learn and analyze the concepts of digital forensics with cybercrime prevention techniques

Unit – I

Introduction to cybercrime: Classification of cybercrimes – reasons for commission of cybercrime – malware and its type – kinds of cybercrime – authentication – encryption – digital signatures – antivirus – firewall – steganography – computer forensics – why should we report cybercrime – introduction counter cyber security initiatives in India – generating secure password – using password manager-enabling two-step verification – security computer using free antivirus.

Unit – II

Tips for buying online: Clearing cache for browsers – wireless LAN-major issues with WLAN-safe browsing guidelines for social networking sites – email security tips – introduction-smartphone security guidelines – purses, wallets, smart phones – platforms, setup and installation-communicating securely with a smartphone.

Unit – III

Cyber investigation roles**:** Introduction – role as a cybercrime investigator – the role of law enforcement officers – the role of the prosecuting attorney – incident response: introduction-post mortem versus live forensics – computer analysis for the hacker defender program-network analysis – legal issues of intercepting Wi-Fi transmission – Wi-Fi technology – Wi-Fi RF-scanning RF – eavesdropping on Wi-Fi – fourth amendment expectation of privacy in WLAN.

Unit – IV

Seizure of digital information: introduction – defining digital evidence – digital evidence seizure methodology – factors limiting the wholesale seizure of hardware – other options for seizing digital evidence – common threads within digital evidence seizure – determining the most appropriate seizure method– conducting cyber investigations–demystifying computer/cyber crime – IP addresses – the explosion of networking – interpersonal communication.

Unit – V

Digital forensics and analyzing data: introduction – the evolution of computer forensics– phases of digital forensics-collection – examination-analysis – reporting – Cyber crime prevention: Introduction – crime targeted at a government agency.

Text books:

1. Dr.JeetendraPande, **"**Introduction to Cyber Security" Published by Uttarakhand Open University, 2017.(Chapter: 1.2-6.4,9.3-12.2)
2. Anthony reyes, Kevin o'shea, Jim steele, Jon R. Hansen, Captain Benjamin R. Jean Thomas Ralph, "Cyber-crime investigations" - bridging the gaps between security professionals, law enforcement, and prosecutors, 2007.(Chapter: 4, 5, 6, 7, 8, 9,10)

Reference Books:

1. Sebastian Klipper, "Cyber Security" EinEinblickfurWirtschaftswissenschaftlerFachmedien Wiesbaden,2015.
2. John G.Voller Black and Veatch, "Cyber Security" Published by John Wiley & Sons, Inc., Hoboken, New Jersey Published simultaneously in Canada ©2014.

Course Outcomes :

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

PO1:	Understand, describe, analyze and examine the basics of Cyber security concepts and its implementation in India	K1- K6
PO2:	Comprehend and demonstrate the security tips in browsers, WLAN, social networks, Email security and Smart phone. Apply the investigations in post mortem andForensics	K1- K6
PO3:	Understand, apply and evaluate the various investigation roles and Wi Fi protecting mechanisms.	K1- K6
PO4:	Understand, illustrate and evaluate the method of seize the digital information and evidences forensics data and evaluate the forensics reports	K1- K6
PO5:	Comprehend, apply and appraise the methods digital forensics with cybercrime prevention techniques	K1- K6

K1- Remember, K2- Understand, K3- Apply , K4- Analyze, K5- Evaluate, K6- Create

Mapping with Programme Outcomes:

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

23DSCS405	**SEC III - Cloud Computing Lab**	C 2 P 4

COURSE OBJECTIVES:

1. To learn how to create a warehouse application in cloud environment.
2. To learn Apex Programming language for creating cloud applications.
3. To study and implement SOAP web services and para - virtualization.
4. To create, install, configure and manage Hadoop services.

LIST OF EXERCISES

1. Introduction to cloud computing.
2. Creating a Warehouse Application in SalesForce.com.
3. Creating an Application in SalesForce.com using Apex programming Language.
4. Implementation of SOAP Web services in C#/JAVA Applications.
5. Implementation of Para-Virtualization using VM Ware‘s Workstation/ Oracle‘s Virtual Box and Guest O.S.
6. Installation and Configuration of Hadoop.
7. Create an application (Ex: Word Count) using Hadoop Map/Reduce.
8. Case Study: PAAS(Facebook, Google App Engine)
9. Case Study: Amazon Web Services.

COURSE OUTCOMES:

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

1. Design and create warehouse application.
2. Have practical knowledge on SOAP and para virtualisation.
3. Use Paas services Facebook, Google App Engine and AWS.

Mapping of Course Outcomes with Programme Outcomes :												
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	2	1	1	-	-	-	-	-	-	-	-
CO2	1	1	3	1	-	-	-	-	-	-	-	-
CO3	2	2	-	1	-	-	-	-	-	2	-	2

Title of the Course		**Block Chain TechnologyLab**					
Category	SEC-III	**Year**	II	**Credits**	2	**Course Code**	23DSCS306
		Semester	IV				
Instructional Hours per week		**Lecture**	**Tutorial**	**Lab Practice**	**Total**		
		2	--	--	2		
Pre-requisite		BasicsofBlockChain&Crypto Currency					

CourseObjectives:

Themain objectivesof thiscoursearеto:

1. Understandthe fundamentalsofblockchainand cryptocurrency.
2. Understandtheinfluence androleofblock chaininvariousother fields.
3. Learnsecurityfeaturesandits significance.
4. IdentifyproblemsandchallengesposedbyBlockChain.

ExpectedCourseOutcomes:

Onthesuccessfulcompletionofthecourse,studentwillbeableto:

PO1	Demonstrateblockchain technologyandcrypto currency	K1,K2
PO2	Understandtheminingmechanisminblockchain	K2
PO3	Applyandidentifysecuritymeasures,andvarioustypesofservicesthatallow people to trade and transact with bitcoins	K3,K4
PO4	ApplyandanalyzeBlockchaininhealthcareindustry	K4,K5
PO5	Analyzesecurity,privacy,andefficiencyof agivenBlockchainsystem	K5,K6

K1-Remember;**K2**-Understand;**K3**-Apply;**K4**-Analyze;**K5**-Evaluate; **K6**-Create

LISTOF PROGRAMS

1. Create a Public Ledger and Private Ledger with the various attributes like Access, Network Actors, Native token, Security, Speed and examples.
2. Building and Deploying MultiChain private Blockchain
3. Write Hello World smart contract in a higher programming language (Solidity)
4. Construct the Naïve block chain
5. Construct and deploy your contract (Use deploy method)
6. Set up a Regtest environment
7. Build a payment request URI
8. Hashcash implementation
9. Develop a toy application using Blockchain
10. Create simple wallet transaction from one account to another account using Metamask.

Totalhours	**60hours**

Text Books

1	Arvind Narayanan, Joseph Bonneau, Edward Felten, Andrew Miller and Steven Goldfeder, "Bitcoin and Cryptocurrency Technologies: A Comprehensive Introduction", Princeton University Press (July 19, 2016).
2	Antonopoulos,"MasteringBitcoin:UnlockingDigitalCryptocurrencies"

ReferenceBooks

1	SatoshiNakamoto,"Bitcoin:APeer-to-PeerElectronicCashSystem"
2	RodrigodaRosaRighi,AntonioMarcosAlberti,MadhusudanSingh,"Blockchain Technology for Industry 4.0" Springer 2020.

RelatedOnlineContents[MOOC,SWAYAM,NPTEL,Websitesetc.]

1	https://www.javatpoint.com/blockchain-tutorial
2	https://www.tutorialspoint.com/blockchain/index.htm
3	https://nptel.ac.in/noc/courses/noc20/SEM1/noc20-cs01/

MappingwithProgrammingOutcomes:

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

23DSCI307	**Internship/Industrial Activity**	C 2

(Refer in Data Science Regulations 9.5)

23DSCX406	**Extension Activity**	C 1

(Refer in Data Science Regulations 9.6)

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