



SRI RAMACHANDRA
INSTITUTE OF HIGHER EDUCATION AND RESEARCH
(Category - I Deemed to be University) Porur, Chennai.

CATEGORY 1 UNIVERSITY • ENTITLED, ONLINE MODE

Centre for Distance and Online Education (CDOE)

Programme Project Report (PPR), Regulations and Syllabus for

Master of Science (Data Analytics)

**Post Graduate Degree Programme
(Online mode)**

Academic Year 2026-2027



REGULATORY COMPLIANCE



सत्यमेव जयते

प्रो. रजनीश जैन
सचिव

Prof. Rajnish Jain
Secretary



सत्यमेव जयते

विश्वविद्यालय अनुदान आयोग
University Grants Commission

(मानव संसाधन विकास मंत्रालय, भारत सरकार)
(Ministry of Human Resource Development, Govt. of India)

बहादुरशाह ज़फ़र मार्ग, नई दिल्ली-110002
Bahadur Shah Zafar Marg, New Delhi-110002

Ph.: 011-23236288/23239337

Fax : 011-2323 8858

E-mail : secy.ugc@nic.in

By Speed Post

No. F. 1-1/2018(CPP-I/DU)

June, 2018

The Vice-Chancellor
Sri Ramachandra Medical College and Research Institute
1, Ramachandra Nagar,
Porur, Chennai-600 116,
Tamil Nadu.

22 JUN 2018

Subject:- Categorization of the Deemed to be University under UGC [Categorization of Universities (only) for Grant of Graded Autonomy] Regulations, 2018.

Sir,

As you are aware, UGC is mandated to determine, promote and maintain the standards of higher education in the country. UGC is constantly striving to create an enabling environment whereby higher educational institutions in the country can become institution of global excellence. UGC is also aware that global excellence can be achieved by extending autonomy to better performing institutions for promoting and institutionalizing excellence in higher education.

In order to grant autonomy to the better performing institutions, UGC has notified UGC [Categorization of Universities (only) for Grant of Graded Autonomy] Regulations, 2018 on 12th February, 2018 in the Gazette of India.

The proposal received from **Sri Ramachandra Medical College and Research Institute** under the above UGC Regulations has been examined, processed and considered by the Commission in its 532nd meeting held on 24.05.2018. **The Commission has decided to grade the Sri Ramachandra Medical College and Research Institute as Category-I Deemed to be University as per the provisions of the above UGC Regulations.** The Deemed to be University shall now be eligible for all the benefits as stipulated under Clause 4 (Dimensions of Autonomy for Category-I Universities) of the above mentioned UGC Regulations. However, with respect to Clause 4.3 of the Regulations (pertaining to opening of constituent units/off-campus centres), the Commission is in a process of finalizing certain modalities related to its implementation. The same will be communicated separately.

The Deemed to be University shall inform the UGC about the benefits being implemented from the new academic session. In light of this, the Deemed to be University should acknowledge in writing that it shall strictly comply with all the regulations as mentioned in the provisions (Clause 4) of the University Grants Commission (Categorization of Universities (only) for Grant of Graded Autonomy) Regulations, 2018.

It is further informed that the Deemed to be University shall intimate the Commission about its changed status as per Clause 6 of the said regulations.

Yours faithfully,


(Rajnish Jain)
Secretary



राष्ट्रीय मूल्यांकन एवं प्रत्यायन परिषद
विश्वविद्यालय अनुदान आयोग का स्वायत्त संस्थान
NATIONAL ASSESSMENT AND ACCREDITATION COUNCIL
An Autonomous Institution of the University Grants Commission

Certificate of Accreditation

*The Executive Committee of the
National Assessment and Accreditation Council
is pleased to declare the
Sri Ramachandra Institute of Higher Education and Research
(Deemed to be University u/s 3 of the UGC Act, 1956)
Ramachandra Nagar, Porur, Chennai, Tamil Nadu as
Accredited
with CGPA of 3.53 on four point scale
at A⁺⁺ grade
valid up to January 24, 2028*

Date : January 25, 2021



*S.C. Sema
Director*

EC(S)/55/3rd Cycle/TNUNGN10143









**UNIVERSITY GRANTS COMMISSION
DISTANCE EDUCATION BUREAU**

F.No. 1-10/2025(DEB-SR)

03 October, 2025

List of Category-I Higher Educational Institutions entitled to offer Open and Distance Learning (ODL) programmes for academic year 2025-26, academic session beginning July-August, 2025.

- (I) UGC in its 563rd Commission meeting, held on 22nd November 2022, decided that Category-I HEIs (as notified by UGC as per the UGC (Categorization of Universities (only) for Grant of Graded Autonomy) Regulations, 2018 and its amendments) willing to offer programmes under Open and Distance Learning (ODL) mode from the academic session Jan-Feb 2023, shall submit information to the UGC. HEIs are also required to submit an affidavit ensuring compliance with all the provisions of the University Grants Commission (Open and Distance Learning Programmes and Online Programmes) Regulations, 2020 and its amendments.
- (II) In accordance with the Commission's decision, all Category-I HEIs willing to offer Open and Distance Learning programmes for academic year 2025-26, academic session beginning July-August, 2025 and onwards, submitted the requisite information along with prescribed fees, affidavit and supporting documents to the UGC. The information collected from the HEIs is intended to ascertain conformity to the following provisions:
1. Verification of Category-I Higher Educational Institutions (HEIs) entitlement as notified by UGC.
 2. Permissibility of proposed programmes to be offered under ODL mode.
 3. Adherence to UGC Notification of Specification of Degrees, 2014 and its amendments.
 4. Prior approval of Regulatory Authority, wherever applicable.
- (III) As per the 578th Commission decision, Central or State or Private Universities don't require prior approval/recommendation/NOC from AICTE for offering of Undergraduate, Postgraduate and Postgraduate Diploma programmes falling under the disciplines of Management, Computer Applications and Travel and Tourism. However, Deemed to be Universities are required to seek prior approval/recommendation/ NOC from AICTE for offering such programmes in ODL and/or Online mode.
- (IV) The HEIs are entitled to offer the ODL programmes for the period, till they are Category-I HEIs as per the relevant UGC notifications /regulations. If an institution loses its Category-I status, it must discontinue these programmes and notify the UGC accordingly. Learners already enrolled in the entitled programmes shall be allowed to complete the programmes in the manner laid down as per the University Grants Commission (Open and Distance Learning Programmes and Online Programmes) Regulations, 2020, and its amendments.
- (V) The programmes under the purview of other regulatory authorities have been considered on the basis of NOC/ approval/ recommendation received from the respective regulatory authority. The HEI must strictly comply with all the conditions specified in the relevant regulatory authority's letter, including but not limited to those related to the number of seats, approved academic year, and any other stipulated requirements.
- (VI) The Higher Educational Institution shall ensure the compliance of entry level qualification, mode of admission, duration of the programme (minimum & maximum) and number of credits as per UGC Notification on Specification of Degrees 2014 and its amendments, UGC (Open and Distance Learning Programmes and Online Programmes) Regulations, 2020 and other instructions/notices issued by UGC and other statutory/ regulatory bodies from time to time.
- (VII) The Higher Education Institution shall write 'UGC entitled as per University Grants Commission (Categorization of Universities (only) for Grant of Graded Autonomy) Regulations, 2018 and its amendment(s)' instead of 'UGC recognized' at all places.
- (VIII) The Higher Educational Institution shall scrupulously abide by all the terms and conditions as stipulated in the University Grants Commission (Open and Distance Learning Programmes and Online Programmes) Regulations, 2020 and its amendments and shall take steps as stipulated under Annexure-I to Annexure-X of the said regulations.
- (IX) The Higher Educational Institution shall also adhere to the policy of Territorial Jurisdiction and Learner Support Centres (LSC) as specified in Annexure-III and VIII of University Grants Commission (Open and Distance Learning Programmes and Online Programmes) Regulations, 2020 and its amendments respectively.
- (X) UGC has decided **15th October, 2025** as the last date to admit learners by recognized/entitled HEIs in ODL/Online programmes and the date for submission of admission data on DEB Web portal for academic session beginning July-August 2025 via reverse API.
- (XI) The Higher Educational Institutions have submitted an affidavit to the effect that in case any information, documentary evidence submitted/produced by the Higher Educational Institution is found to be false or wrong at a later stage or in case there is any violation of University Grants Commission (Open and Distance Learning Programmes and Online Programmes) Regulations, 2020 and its amendments by the HEI, the Higher Educational Institution shall be solely liable and responsible for any such contravention/violation and for any consequences thereof (including career consequences of Learner). In such events, the HEI may also be subject to the consequences stipulated under regulation 7 of the University Grants Commission (Open and Distance Learning Programmes and Online Programmes) Regulations, 2020 and its amendments.
- (XII) The list of Category- I Higher Educational Institutions that have submitted the affidavit ensuring compliance of UGC (Open and Distance Learning Programmes and Online Programmes) Regulations, 2020 and its amendments and have been found complying with above mentioned provision (as per point II above), for academic year 2025-26, academic session beginning July-August, 2025 is appended herewith.

(Prof. Manish R. Joshi)
Secretary



S.No	STATE	TYPE OF HEI	HEI NAME	NUMBER OF PROGRAMMES	NAME OF PROGRAMMES
93	TAMIL NADU	DEEMED-TO-BE UNIVERSITY	VEL'S INSTITUTE OF SCIENCE, TECHNOLOGY & ADVANCED STUDIES (VISTAS)	02	1) BACHELOR OF BUSINESS ADMINISTRATION- 4 years 2) MASTER OF BUSINESS ADMINISTRATION
93.	TAMIL NADU	DEEMED-TO-BE UNIVERSITY	SRI RAMACHANDRA INSTITUTE OF HIGHER EDUCATION AND RESEARCH	01	1) BACHELOR OF SCIENCE (HONS) (DATA SCIENCE)
95.	TELANGANA	DEEMED-TO-BE UNIVERSITY	ICFAI FOUNDATION FOR HIGHER EDUCATION	02	1) BACHELOR OF BUSINESS ADMINISTRATION 2) MASTER OF BUSINESS ADMINISTRATION (GENERAL)
96.	TELANGANA	DEEMED-TO-BE UNIVERSITY	INTERNATIONAL INSTITUTE OF INFORMATION TECHNOLOGY	01	1) MASTER OF SCIENCE (DATA SCIENCE)
97.	UTTAR PRADESH	CENTRAL UNIVERSITY	ALIGARH MUSLIM UNIVERSITY	11	1) BACHELOR OF COMMERCE 2) BACHELOR OF ARTS (ECONOMICS, HISTORY, POLITICAL SCIENCE, ENGLISH, URDU, HINDI) 3) MASTER OF ARTS (ECONOMICS) 4) MASTER OF ARTS (HISTORY) 5) MASTER OF ARTS (POLITICAL SCIENCE)

Part A - Programme Project Report (PPR)

TABLE OF CONTENTS

S.NO	TITLE	PAGE NO
1	Overview	9
2	Programme Mission	10
3	Programme Objectives	10
4	Relevance of the Programme with HEI's Mission and Goals	11
5	Nature of Prospective Target Group of Learners	11
6	Appropriateness of Programme to be conducted in Online Mode to acquire Specific Skills and Competence	12
7	Instructional Design used for Online Programmes	13
8	Procedure for Admissions, Curriculum Transaction and Evaluation	14
9	Laboratory Support and Library Resources	15
10	Cost Estimate of the Programme and the Provisions	16
11	Quality Assurance Mechanism and Expected Programme Outcomes	16

MASTER OF SCIENCE (DATA ANALYTICS) POST GRADUATE DEGREE PROGRAM (ONLINE MODE)

Programme Project Report (PPR),

1. Overview:

The Programme Project Report (PPR) of the Centre for Distance and Online Education (CDOE), Sri Ramachandra Institute of Higher Education and Research (SRIHER), presents the two-year M.Sc. Data Analytics programme offered in online mode in alignment with UGC guidelines. The programme is designed to address the growing demand for data-driven decision-making at both national and global levels, driven by rapid advancements in digital technologies, artificial intelligence, and big data. In the Indian context, initiatives such as Digital India and e-Governance have led to large-scale data generation, while globally, the increasing adoption of analytics and AI has created significant demand for skilled data professionals.

Further, the programme focuses on the systematic collection, processing, analysis, and interpretation of data to support informed decision-making across domains such as healthcare, finance, and governance. It emphasizes statistical modelling, machine learning, artificial intelligence, and big data analytics, along with the application of analytical techniques to solve real-world problems. The curriculum is structured as per the National Credit Framework (NCrF), with 1200 learning hours per year and 40 credits per year (total 80 credits), ensuring a balanced approach to academic, skill-based, and experiential learning.

The programme also aligns with the objectives of NEP 2020 by promoting interdisciplinary, skill-based, and technology-enabled education. Overall, it prepares graduates for data-centric roles across industries and enhances their employability in the global job market.

2. Programme Mission

The mission of the M.Sc. Data Analytics programme (Online Mode) at Sri Ramachandra Institute of Higher Education and Research (DU), Chennai, is to provide quality postgraduate education through technology-enabled and flexible learning that fosters analytical thinking, technical competence, and professional excellence in data analytics.

The programme aims to develop expertise in statistical modelling, machine learning, artificial intelligence, and big data technologies through a structured, industry-relevant curriculum supported by digital learning platforms.

It further equips learners with the ability to analyze complex data and effectively communicate data-driven insights to diverse stakeholders, while promoting ethical practices, data privacy, and responsible use of data in a global digital environment.

3. Programme Objectives:

The M.Sc. Data Analytics programme (Online Mode) is designed to develop competent professionals equipped with analytical, technical, and problem-solving skills required in a data-driven environment. The programme aims to:

1: Provide a strong foundation in statistics, data structures, and data analytics techniques for effective data analysis and interpretation.

2: Develop programming proficiency in tools such as Python and R for data manipulation, visualisation, and analytical modelling.

3: Enable application of advanced technologies, including machine learning, artificial intelligence, and big data analytics, to solve real-world problems.

4: Enhance the ability to design and implement data-driven solutions, covering the complete lifecycle from data collection to model deployment.

5: Strengthen practical and technical competencies through lab-based learning, skill enhancement courses, and project work.

6: Provide domain-specific knowledge through elective courses aligned with industry requirements and emerging trends.

7: Promote ethical practices and awareness related to data privacy, governance, and responsible use of data.

8: Encourage continuous learning and professional development to adapt to evolving technologies and industry demands.

9: Support flexible and inclusive learning through online mode, enabling access to quality education for diverse learners.

10: Enhance employability and career readiness by preparing graduates for roles such as Data Analyst, Data Scientist, AI Specialist, and Business Analyst.

4. Relevance of the Programme with HEI's Mission and Goals:

The proposed M.Sc. Data Analytics programme offered through the Online Learning (OL) mode is highly aligned with the mission and goals of the Higher Educational Institution (HEI), which emphasize quality education, professional competence, and societal advancement.

- » The programme responds to the increasing demand for skilled data analytics professionals in the context of digital transformation and data-driven industries.
- » The online mode enables the HEI to scale educational opportunities and reach a wider learner base beyond traditional limits, ensuring inclusivity and access for working professionals and learners from remote regions.
- » The programme offers a flexible learning environment, allowing learners to balance academic, professional, and personal commitments.
- » The curriculum is designed as a contemporary and industry-relevant curriculum, aligned with emerging technologies such as machine learning, artificial intelligence, and big data analytics.
- » It incorporates current tools, techniques, and best practices, with provisions for regular updates to maintain relevance.
- » Overall, the programme contributes to academic excellence, employability, and technological advancement, thereby supporting the HEI's mission and strategic goals.

5. Nature of Prospective Target Group of Learners:

The proposed **M.Sc Data Analytics programme** is designed to cater to a diverse group of learners with varying academic and professional backgrounds. The target group includes:

- » **Working professionals** from sectors such as Information Technology, analytics, finance, and healthcare who seek to enhance their analytical and technical expertise.
- » **Graduates** aspiring to build careers in Data Science, Artificial Intelligence, and Business Analytics.
- » **Professionals seeking upskilling or reskilling opportunities** to remain competitive in a rapidly evolving data-driven job market.
- » **Learners from rural and remote areas** who may have limited access to conventional higher education institutions.
- » **Adult learners and lifelong learners** who wish to continue their education and professional development through flexible learning pathways.

The programme, delivered through **online mode**, ensures:

- » **Flexibility**, allowing learners to study at their own pace and balance academic pursuits with personal and professional commitments.
- » **Accessibility**, enabling participation from learners across different geographical locations without the need for physical presence.
- » **Inclusivity**, providing equal learning opportunities to diverse learner groups, including those who may otherwise be unable to access higher education.

6. Appropriateness of Programme to be conducted in Online Mode to acquire Specific Skills and Competence:

The proposed M.Sc. Data Analytics programme is well suited for delivery through online mode due to its strong integration of theoretical concepts, computational tools, and practical applications.

a. Flexible and Inclusive Learning Environment

The online mode enables learners to access course materials at their convenience, supporting working professionals and promoting inclusive education.

b. Multimedia and Experiential Learning Integration

The programme incorporates:

- » Video lectures and self-learning materials (SLMs)
- » Coding demonstrations and analytics workflows
- » Dataset-based assignments and simulations
- » Case studies based on real-world data problems
- » Project work and applied analytics tasks

c. Interactive Learning and Mentorship

The programme includes:

- » Live virtual sessions
- » Discussion forums
- » Peer interactions
- » Academic mentoring

d. Alignment with Modern Educational Practices

The online delivery aligns with NEP 2020, emphasizing digital education, skill development, and interdisciplinary learning.

e. Professional Competence and Workplace Application

The programme facilitates development of competencies such as:

- » Data analysis and visualization
- » Machine learning model development
- » Big data analytics
- » Cloud-based data processing

7. Instructional design used for online programmes

The **M.Sc Data Analytics programme** adopts a scientifically structured instructional design framework to ensure effective teaching–learning processes in the online mode. The design is based on established pedagogical models and outcome–based education principles.

- **ADDIE Model (Analysis, Design, Development, Implementation, Evaluation):**
Ensures systematic planning, development, delivery, and continuous improvement of the programme.
- **Bloom’s Taxonomy:**
Facilitates the design of learning outcomes ranging from basic understanding to higher–order skills such as analysis, evaluation, and creation.
- **Constructive Alignment:**
Aligns learning outcomes, teaching methodologies, and assessment strategies to ensure achievement of programme objectives.
- **ARCS Model (Attention, Relevance, Confidence, Satisfaction):**
Enhances learner motivation and engagement throughout the course.
- **Gagné’s Nine Events of Instruction:**
Provides a structured approach to content delivery, ensuring effective knowledge acquisition and retention.
- **Weekly Learning Plan:**
Provides a structured schedule of topics, activities, and assessments to guide learners.
- **Academic Calendar:**
Clearly defines timelines for course delivery, assignments, and examinations.
- **Activity–Based Learning:**
Encourages active participation through hands–on tasks and practical exercises.
- **Problem–Based Learning:**
Focuses on solving real–world problems to develop analytical and critical thinking skills.

Four Quadrant Approach (UGC Model):

- **e–Tutorial:**
Video lectures, coding demonstrations, and recorded sessions for conceptual clarity.
- **e–Content (Self Learning Material – SLM):**
Structured digital content designed for self–paced learning.
- **Discussion Forums:**
Interactive platforms for peer learning, doubt clarification, and academic discussions.
- **Assessment:**
Continuous evaluation through quizzes, assignments, and project–based assessments.

8. Procedure for Admissions, Curriculum Transaction and Evaluation

The Higher Educational Institution (HEI) has established a comprehensive and transparent framework for admission, curriculum delivery, and evaluation for the **M.Sc. Data Analytics (ONLINE)** programme, in alignment with UGC ONLINE Regulations.

Admission Policy

- The admission policy is designed to ensure inclusivity, transparency, and accessibility. The programme is open to learners with an appropriate academic background in **mathematics, statistics, computer science, engineering, or related disciplines**, in accordance with the prescribed eligibility criteria.
- Admissions are conducted through an online application process, based on merit and fulfilment of eligibility requirements. The HEI follows applicable reservation norms as per Government of India guidelines.
- The fee structure is clearly notified on the institutional website and prospectus. The HEI also provides information regarding financial assistance, including scholarships, fee concessions, and flexible payment options, wherever applicable, to support learners from diverse socio-economic backgrounds.

Curriculum transaction and evaluation

The programme is delivered through the Online mode, supported by a robust Learning Management System (LMS).

The curriculum transaction includes:

- Self-Learning Materials (SLMs) in digital formats
- Multimedia e-content, including recorded lectures, coding demonstrations, and interactive modules
- Live and recorded online sessions, webinars, and virtual classrooms
- Discussion forums and peer learning platforms

The HEI utilizes web-based tools and digital platforms to facilitate **interactive and learner-centric education**. Academic support is provided through academic counselling sessions, faculty interaction, and learner support services, ensuring effective engagement and learning.

Activity Planner

The HEI prepares and notifies a detailed activity planner (academic calendar) at the beginning of each academic session. The planner includes:

- Admission schedule
- Course delivery timeline
- Webinar and live session details
- Assignment submission deadlines
- Project work
- Examination schedule

This ensures structured progression and timely completion of academic activities.

Evaluation policy

The HEI adopts a continuous and comprehensive evaluation system to assess learner progress.

The evaluation framework includes:

- Continuous Internal Assessment (CIA) through assignments, quizzes, programming tasks, and case studies
- End Semester Examination (ESE) for theoretical and practical components

Appropriate weightage is assigned to internal and external assessments as per institutional norms. Evaluation is conducted using LMS-based tools and conventional methods, ensuring reliability and transparency.

Learners are provided with timely feedback, and provisions for re-evaluation and grievance redressal are available as per institutional policy.

9. Laboratory support and Library Resources

The **M.Sc. Data Analytics programme** includes practical-oriented components delivered through alternative modes appropriate for Online.

- » In place of conventional laboratory sessions, the HEI has adopted **virtual labs, coding environments, dataset-based exercises, and research-oriented learning approaches** to ensure the development of practical competencies.
- » The institution is equipped with advanced computational infrastructure and digital resources, which are utilized to develop **high-quality video demonstrations and coding tutorials** covering data analysis techniques, machine learning workflows, and visualization practices.
- » The programme incorporates **case studies based on real-world datasets and industry scenarios** to enhance analytical thinking, problem-solving, and decision-making skills. In addition, research projects and industry-based assignments are supported through collaborations and datasets, enabling learners to apply their knowledge in real-world contexts.
- » Clear guidelines, project manuals, and supporting materials are provided to learners for all practical components.
- » Upon enrollment, learners are provided with an official institutional email ID, through which they gain access to the **digital library resources of SRIHER**, including e-books, e-journals, datasets, repositories, and analytics-related resources.
- » These provisions ensure that learners receive adequate academic, practical, and research support in alignment with programme requirements and UGC Online Regulations.
- » Overall, the integration of **virtual labs, coding demonstrations, case-based learning, industry-supported projects, and digital library resources** ensures effective acquisition of practical skills and competencies in Data Analytics.

10. Cost estimate of the programme and the provisions

The cost estimate for the **M.Sc. Data Analytics programme** has been prepared in accordance with prescribed guidelines, covering programme development, delivery, and maintenance components.

The estimated annual cost per course is as follows:

Programme Development

Content development: ₹3,00,000 per course per year

Programme Delivery

- Delivery (teaching–learning activities): ₹1,00,000 per course per year
- Evaluation (assessments and examinations): ₹50,000 per course per year

Programme Maintenance and Support

- Development of virtual lab resources, coding tutorials, and case–based materials: ₹50,000 per course per year
- Software maintenance and LMS support: ₹20,000 per course per year

These provisions ensure effective design, delivery, continuous updating, and quality assurance of the programme in online mode.

11. Quality assurance mechanism and expected programme outcomes

The Centre for Distance and Online Education, SRIHER (CDOE) follows a high standard of Quality Assurance Mechanism to ensure learner satisfaction and academic excellence. The norms and standards set by regulatory bodies such as UGC, AICTE, NAAC, and NBA are followed strictly.

- The CDOE works in close association with academic departments for curriculum design and evaluation. **Industry experts and data analytics professionals** provide inputs to ensure relevance to current trends.
- Subject matter experts and qualified faculty members deliver online classes and contribute to curriculum development and content delivery.
- Standardized processes including templates, guidelines, peer reviews, and academic committees ensure high–quality content development.
- Learner guidance is provided through orientation programmes, user manuals, and continuous academic support.
- Periodical feedback from students and stakeholders is collected and analyzed for continuous improvement.
- Regular communication through LMS and academic schedules ensures clarity in learning and assessment processes.

- Industry experts conduct webinars on emerging topics such as AI, machine learning, and big data analytics.
- Internal Quality Assurance mechanisms ensure continuous monitoring and improvement.
- Multi-level reviews of learning materials and videos are conducted before release.
- Plagiarism detection tools ensure originality and academic integrity.
- Advanced e-learning technologies are used to enhance engagement and learning outcomes.
- Learning analytics are used to identify slow learners and provide additional support.
- Structured guidance is provided for projects and dissertations, enabling learners to apply their knowledge to real-world data analytics problems, with industry professionals acting as co-guides where applicable.

Expected program outcomes:

PO1: Apply disciplinary knowledge of statistics, mathematics, and data analytics to solve complex problems.

PO2: Analyze and interpret data-driven problems using appropriate analytical techniques.

PO3: Design and develop analytical solutions using statistical and computational approaches.

PO4: Investigate complex data problems using research-oriented analytical methods.

PO5: Use modern analytical tools, software, and technologies effectively.

PO6: Demonstrate ethical responsibility and professional integrity in data analytics practices.

PO7: Function effectively as an individual and as a member of multidisciplinary teams.

PO8: Communicate analytical findings effectively through reports, visualizations, and presentations.

PO9: Apply project management and organizational principles in analytics-based projects.

PO10: Engage in independent and lifelong learning in emerging areas of data analytics.

PO11: Demonstrate research aptitude through data-driven investigation and analysis.

PO12: Apply analytical thinking and innovation to support entrepreneurship and business decision-making.

Part B

Regulations and Syllabus

Table of Contents

S.No	Section Title	Page No
1	Preamble	20
2	Program Mission	20
3	Alignment with National Credit Framework (NCrF)	20
4	Program Educational Objectives (PEOs)	21
5	Program Outcomes	21
6	Program Description and Structure	22
7	Program Specific Outcomes	23
8	Program Structure	24
9	Summary Scheme for Online Mode Semester System	26
10	Regulations	27
11	Short Title and Commencement	27
12	Eligibility for Admission	27
13	Registration	28
14	Duration of the Program	28
15	Commencement of the Program	28
16	Commencement of the Examinations	28
17	Medium of Instruction	28
18	Duration of a Semester	28
19	Mode of Delivery	28
20	Curriculum	32
21	Credits	32
22	Four Quadrant Approach for Courses and Quality Compliance	34
23	Research Project	36
24	Attendance Required for Admission to Examinations	38
25	Examination, Assessment and Evaluation	39
26	End Semester Examinations	40
27	Grading System	41

S.No	Section Title	Page No
28	Grade Qualifying for a Pass	43
29	Reappearance for Arrear Subjects	43
30	Classification of Successful Candidates	43
31	Migration / Transfer of Candidates	44
32	Award of Degree	44
33	Break of Study from a Program	45
34	Discharge of Students from Program	45
35	Scheme of Curriculum and Evaluation	46
36	Credits Distribution Table	52
37	PO–CO Mapping	52

Regulations and Syllabus

MASTER OF SCIENCE (DATA ANALYTICS)

POST GRADUATE DEGREE PROGRAM (ONLINE MODE)

Preamble:

The Master of Science in Data Analytics (M.Sc. Data Analytics) [Online] program focuses on transforming data into actionable insights for informed decision-making. It integrates statistics, programming, machine learning, and data management to analyze structured and unstructured data. The program emphasizes practical analytical skills and real-world problem solving. Graduates are prepared to meet the growing demand for data-driven professionals across diverse industries.

Program Mission:

The mission of the M.Sc. Data Analytics programme (Online Mode) at Sri Ramachandra Institute of Higher Education and Research (DU), Chennai, is to provide quality postgraduate education through technology-enabled and flexible learning that fosters analytical thinking, technical competence, and professional excellence in data analytics.

The programme aims to develop expertise in statistical modelling, machine learning, artificial intelligence, and big data technologies through a structured, industry-relevant curriculum supported by digital learning platforms.

It further equips learners with the ability to analyze complex data and effectively communicate data-driven insights to diverse stakeholders, while promoting ethical practices, data privacy, and responsible use of data in a global digital environment

Alignment with National Credit Framework (NCrF Level 7):

This MSc in Data Analytics is aligned with the **National Credit Framework (NCrF) 2023** (Postgraduate Degree Level).

- **Duration:** 2 Years (4 Semesters)
- **Total Credits:** 80

Academic Bank of Credits (ABC)

This program is compatible with the **Academic Bank of Credits (ABC)** system. Credits earned are eligible for deposit, accumulation, transfer, and redemption as per UGC norms.

HIGHER EDUCATION QUALIFICATIONS	Total Learning hours/ year	Total learning hours (Programme)	Total Credits/ year	NATIONAL CREDIT FRAMEWORK (NCRF) CREDIT LEVELS	CREDITS POINTS
C-1	C-2	C-3	C-4	C-5	C-6= (C-3 x C4)
MASTER OF DATA ANALYTICS (POST GRADUATE DEGREE PROGRAM (ONLINE MODE))	1200	2400	40	7	280

Reference: National Curriculum and Credit Framework 2023

PROGRAM EDUCATIONAL OBJECTIVES (PEO'S)

The Program Educational Objectives describe the career and professional accomplishments that graduates are expected to achieve within a few years after completing the program.

PEO1: Apply advanced knowledge of statistics, programming, machine learning, and data analytics techniques to solve complex real-world data problems.

PEO2: Develop and implement analytical models and computational solutions using modern data analytics tools, programming frameworks, and big data technologies.

PEO3: Apply data analytics methodologies to solve **industry and societal challenges** across domains such as healthcare, finance, business, and technology.

PEO4: Demonstrate professional ethics, responsible data governance practices, and effective communication of analytical insights.

PEO5: Engage in lifelong learning, research, and professional development to adapt to emerging technologies in data analytics and artificial intelligence.

PROGRAM OUTCOMES:

Learning Outcome Framework (Aligned to Level 7)

Upon successful completion of the MSc program, graduates will be able to:

PO1: Apply disciplinary knowledge of statistics, mathematics, and data analytics to solve complex problems.

PO2: Analyze and interpret data-driven problems using appropriate analytical techniques.

PO3: Design and develop analytical solutions using statistical and computational approaches.

PO4: Investigate complex data problems using research-oriented analytical methods.

PO5: Use modern analytical tools, software, and technologies effectively.

PO6: Demonstrate ethical responsibility and professional integrity in data analytics practices.

PO7: Function effectively as an individual and as a member of multidisciplinary teams.

PO8: Communicate analytical findings effectively through reports, visualizations, and presentations.

PO9: Apply project management and organizational principles in analytics-based projects.

PO10: Engage in independent and lifelong learning in emerging areas of data analytics.

PO11: Demonstrate research aptitude through data-driven investigation and analysis.

PO12: Apply analytical thinking and innovation to support entrepreneurship and business decision-making.

PROGRAM DESCRIPTION AND STRUCTURE

Program Description

The curriculum adopts an outcome-based and industry-oriented approach, integrating statistical foundations, computational techniques, and real-world analytical applications through a flexible online learning environment. It is designed to combine theoretical knowledge with practical skills, digital learning platforms, and research exposure to ensure a comprehensive and holistic learning experience:

Core Courses (CT) establish a strong foundation in key areas such as statistics for data science, data structures and algorithms, database management systems, machine learning, artificial intelligence, and big data analytics. These courses provide essential theoretical and computational knowledge required to analyze complex datasets and support data-driven decision-making.

Skill Enhancement Courses (SL) focus on developing practical competencies in tools and technologies such as Python, R, SQL, Tableau, Power BI, and cloud-based analytics platforms. These courses emphasize hands-on learning, real-time data processing, and industry-relevant applications aligned with current technological trends.

Discipline Electives (DE) enable students to specialize in advanced domains such as time series forecasting, natural language processing, computer vision, deep learning, healthcare analytics, and reinforcement learning. This flexibility allows learners to tailor their expertise based on career goals and emerging industry demands.

General Electives (GE) provide opportunities for interdisciplinary learning through online courses from recognized platforms. Credits earned may be transferred as per institutional guidelines, enhancing students' exposure to diverse domains and emerging technologies in analytics and related fields.

Ability Enhancement Courses (AE) are designed to strengthen non-technical competencies such as research methodology, communication skills, professional ethics, teamwork, and analytical thinking. These skills are essential for effective collaboration and professional growth in data-driven environments.

Core Lab (CL) components focus on practical implementation using programming environments and analytical tools. These courses enable students to develop end-to-end data analytics solutions through coding, data visualization, and model building.

The Research Project (RP) is a significant component of the program that facilitates the application of analytical knowledge to real-world problems. Students undertake industry-based or research-oriented projects involving data collection, preprocessing, model development, validation, and interpretation. This enhances their problem-solving abilities, research aptitude, and capability to deliver actionable insights in professional settings.

PROGRAM SPECIFIC OUTCOMES

PSO1: Apply statistical and machine learning techniques to analyze structured and unstructured datasets for meaningful insights.

PSO2: Develop data analytics solutions using programming tools such as Python, R, SQL, and database technologies.

PSO3: Design effective data visualizations, dashboards, and analytical reports to support data-driven decision making.

PSO4: Apply advanced analytical techniques such as artificial intelligence, big data analytics, and natural language processing to solve real-world problems.

PROGRAM STRUCTURE

Semester I (Foundation Level) – 20 Credits

This semester establishes the **fundamental backbone of data science** by integrating statistics, programming, and analytical thinking: **Statistics for Data Science (Core)**

- **Data Structures and Algorithms (Core)**
- **Data Science with R (Core)**
- **Discipline Elective – 1 (Elective)**
- **Advanced Python Programming (Lab) (Core Lab)**
- **Skill Enhancement Course – 1**

Students gain a **strong dual foundation in statistics and programming**, enabling them to clean, analyse, and interpret data effectively—core skills required for advanced analytics and machine learning

Semester II (Core Analytics Level) – 20 Credits

This semester focuses on strengthening students' ability to **manage, process, and analyze complex datasets** through advanced analytical and data engineering concepts **Advanced Statistics (Core)**

- **Advanced Database Management System (Core)**
- **Foundations of Data Analytics & Transformation Techniques (Core)**
- **Discipline Elective – 2**
- **General Elective – 1**
- **Skill Enhancement Course – 2**

Students gain expertise in **data handling, database systems, and data transformation**, enabling them to prepare high-quality, analysis-ready datasets—an essential step for advanced analytics and machine learning.

Semester III (Advanced & AI Level) – 20 Credits

This semester emphasizes **advanced technologies, intelligent systems, and research skills**, preparing students for high-level data science applications: **Natural Language Processing (Core)**

- **Big Data Analytics & Hadoop Ecosystem (Core)**
- **Artificial Intelligence & Machine Learning Techniques (Core)**
- **Discipline Elective – 3**
- **Research Methodology (AE Course)**
- **Skill Enhancement Course – 3**

Students gain expertise in **AI, machine learning, big data technologies, and research**, enabling them to design intelligent systems and conduct impactful data-driven research.

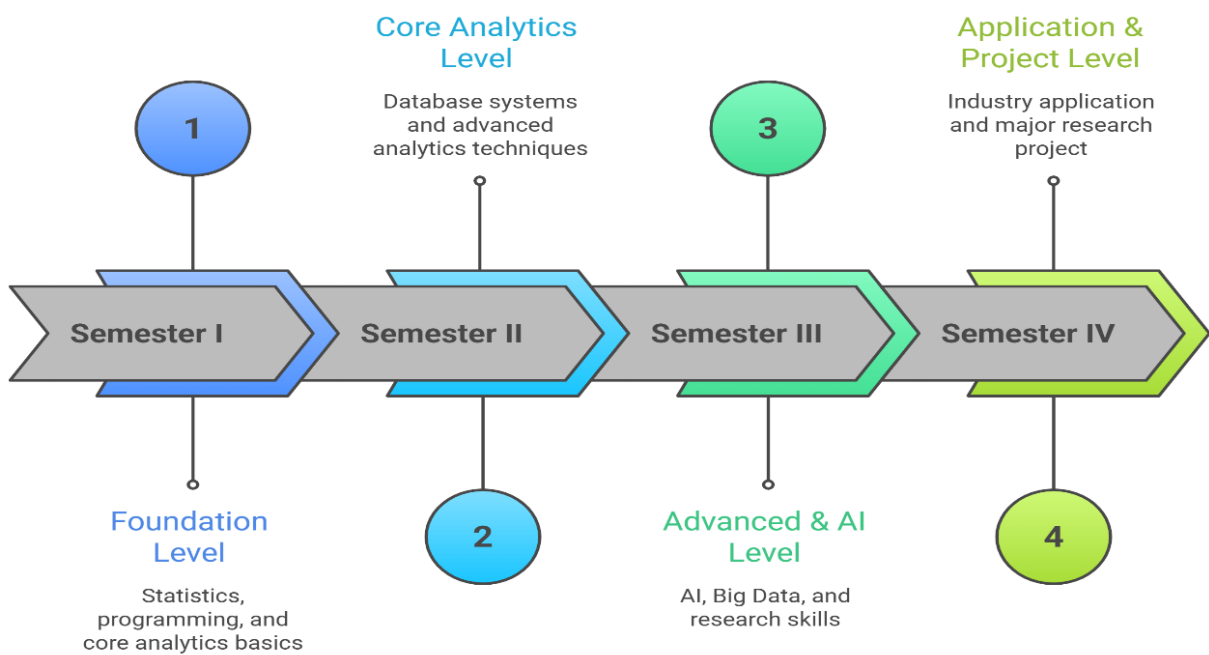
Semester IV (Application & Project Level) – 20 Credits

This semester is the **application and industry-oriented phase**, focusing on real-world implementation and specialization **Advanced Cloud Computing (Core)**

- **Discipline Elective – 4**
- **Research Project / Dissertation (Major Project – 12 Credits)**

Students gain hands-on experience in **cloud-based deployment and real-world problem solving**, making them industry-ready with the ability to design, implement, and deliver complete data science solutions.

M.Sc Data Analytics Semester Structure



SUMMARY SCHEME FOR ONLINE MODE SEMESTER SYSTEM

Semester	Course Code	Core Theory (CT) Credits	Discipline Elective (DE) Credits	Core Lab (CL)	Research Project (RP) Credits	Ability Enhancement (AE) Credits	General Elective (GE) Credits	Skill Enhancement (SE)	Total Credits
1	CT1	3							
	CT2	4							
	CT3	4							
	DE		4						
	CL			3					
	SL							2	
	SEM - 1	11	4	3				2	20
2	CT4	3							
	CT5	4							
	CT6	4							
	DE		4						
	GE						3		
	SL							2	
	SEM - 2	11	4				3	2	20
3	CT7	4							
	CT8	4							
	CT9	4							
	DE		4						
	AE					2			
	SL							2	
	SEM - 3	12	4			2		2	20
4	CT10	4							
	DE		4						
	RP				12				
	SEM - 4	4	4		12				20

Course	CT	RP	DE	CL	SL	GE	AE	Total
Credits	38	12	16	3	6	3	2	
Weightage (%)	62.5		37.5					100%

REGULATIONS

MSC. DATA ANALYTICS POST GRADUATE DEGREE PROGRAM

(Online SEMESTER System)

In exercise of the powers conferred by clause 19 of the Memorandum of Association & Rules and clause 2 (cc) of Bye-Laws of Sri Ramachandra Institute of Higher Education and Research (Deemed to be University), Porur, Chennai-600 116, the Academic Council of the Deemed University hereby makes the following Regulations:

1. SHORT TITLE AND COMMENCEMENT

These regulations may be called "THE REGULATIONS FOR M.Sc. DATA ANALYTICS POST GRADUATE DEGREE PROGRAM (Online mode) OF SRI RAMACHANDRA INSTITUTE OF HIGHER EDUCATION & RESEARCH (DEEMED TO BE UNIVERSITY), PORUR, CHENNAI - 600116.

These regulations shall come into force from the academic year 2026 – 2027 and are subject to such modifications as may be approved by the Academic Council from time to time.

2. ELIGIBILITY FOR ADMISSION

A candidate who seeks admission for M.Sc. Data Analytics Post Graduate Degree (Online) program shall be required to hold a Bachelor or Postgraduate Degree in Engineering / Technology, Life Science/Physical Science/Health Science/Allied Health Sciences from any Institution/University recognized by UGC in regular OR Online mode with minimum of 50% marks in aggregate.

ADMISSION PROCESS

- Admission shall be conducted in accordance with the norms of the University Grants Commission (UGC) and Distance Education Bureau (DEB).
- Applicants shall mandatorily obtain a valid DEB ID and ABC ID prior to enrolment.
- Eligible applicants shall submit the online application along with the prescribed documents.
- Admission shall be granted program to verification of eligibility and submitted credentials.
- The prescribed fee shall be paid through the institution's approved online payment system.
- Admission shall be confirmed upon successful verification and fee payment.
- Admitted learners shall be informed regarding programme commencement and orientation.



3. REGISTRATION

A candidate admitted to the program shall register his/her name with Sri Ramachandra Institute of Higher Education and Research (Deemed to be University) by submitting the prescribed application form for registration, duly filled in along with the prescribed fee, within the stipulated time.

4. DURATION OF THE PROGRAM

The duration of M.Sc. Data Analytics program shall be for two academic years comprising four semesters.

5. COMMENCEMENT OF THE PROGRAM

The first year of the program will commence every year January and July.

6. COMMENCEMENT OF THE EXAMINATIONS

There shall be two sessions of University Examinations in an academic year, viz. and June and December.

7. MEDIUM OF INSTRUCTION

The medium of instruction for all subjects shall be conducted only in English for both study and for examination.

8. DURATION OF A SEMESTER

Each semester shall consists of 15 weeks.

9. MODE OF DELIVERY

The program will be delivered ONLINE through a learning management system (LMS).

Learning Management System (LMS) Compliance and Regulatory Alignment

The Online MSc program shall be delivered through a Learning Management System in compliance with the provisions of the University Grants Commission and the requirements prescribed under the UGC ODL and Online Regulations 2020, as amended from time to time.

Key LMS provisions under the UGC (ODL and Online Programmes) regulations include

- **Content Delivery:** Provides structured e-learning materials such as video lectures, notes, and presentations.
- **Learner Interaction:** Enables communication through discussion forums, live sessions, and messaging.
- **Accessibility:** Offers 24/7 access to course content across multiple devices.
- **Assessment:** Supports online assignments, quizzes, and feedback mechanisms.
- **Monitoring:** Tracks student participation, progress, and performance.
- **Data Security:** Ensures secure storage and maintenance of academic records.
- **Proctoring mechanism:** Ensure the integrity and authenticity of the examinations conducted online by Manual and AI proctoring.

Centre for Distance and Online Education
B.Sc. (Hons) Data Science

Year / Semester : I / 1st Course: B.Sc. Communicative English Date: 22/02/2024

Registration No	Full Name	official email id	Attendance
✓ O0525001	Mr. Jerwin L ✓	o0525001@sriramachandradiglearn.edu.in	Present
✓ O0525002	Dr. Leena Pavitha ✓	o0525002@sriramachandradiglearn.edu.in	Present
AB O0525003	Mr. Koushal Shankar ✓	o0525003@sriramachandradiglearn.edu.in	Discontinued
✓ O0525004	Mr. mohammed afrid azami ✓	o0525004@sriramachandradiglearn.edu.in	Present
✓ O0525005	Mr. Abishek Kumaran Balaji ✓	o0525005@sriramachandradiglearn.edu.in	Present
AB O0525006	Mr. Adhithya N. S. G. ✓	o0525006@sriramachandradiglearn.edu.in	ABSENT
✓ O0525007	Dr. Manimekalai Narayanan ✓	o0525007@sriramachandradiglearn.edu.in	Present
✓ O0525008	Mr. Ramkumar Santhanakrishnan ✓	o0525008@sriramachandradiglearn.edu.in	Present
✓ O0525009	Mr. Aswin T ✓	o0525009@sriramachandradiglearn.edu.in	Present
✓ O0525010	Mr. PRAVEEN M ✓	o0525010@sriramachandradiglearn.edu.in	Present
✓ O0525011	Mr. Ansar Ahammed P V ✓	o0525011@sriramachandradiglearn.edu.in	Present
✓ O0525012	Mr. Prathyush Ayyappan ✓	o0525012@sriramachandradiglearn.edu.in	Present
✓ O0525013	Ms. JANIKSHA M ✓	o0525013@sriramachandradiglearn.edu.in	Present
✓ O0525014	Ms. N. Akshaya ✓	o0525014@sriramachandradiglearn.edu.in	Present
✓ O0525015	Mr. S. Prayag ✓	o0525015@sriramachandradiglearn.edu.in	Present
AB O0525016	Mr. Rhusikesh Omprakash Rai ✓	o0525016@sriramachandradiglearn.edu.in	ABSENT
✓ O0525017	Mr. Jayasrman M ✓	o0525017@sriramachandradiglearn.edu.in	Present
✓ O0525018	Mrs. Safrin A ✓	o0525018@sriramachandradiglearn.edu.in	Present
✓ O0525019	Mr. PAWANKUMAR MOTWANI ✓	o0525019@sriramachandradiglearn.edu.in	Present
✓ O0525020	Ms. Aisha Siddika A ✓	o0525020@sriramachandradiglearn.edu.in	Present
✓ O0525021	Mrs. Murshidha Sheerin ✓	o0525021@sriramachandradiglearn.edu.in	Present
✓ O0525022	Ms. Yeluri hema sindhu ✓	o0525022@sriramachandradiglearn.edu.in	Present
✓ O0525023	Ms. Navneet Sharma ✓	o0525023@sriramachandradiglearn.edu.in	Present
✓ O0525024	Mr. Shaikh owalz ✓	o0525024@sriramachandradiglearn.edu.in	Present

No. of Present: 21 No. of Absent: 2 Total no. of Students: 24
Discontd: 1





Dr. L. SANKARI PRIYA
ASSISTANT PROFESSOR
CDOE.

Manual Proctoring



AI Proctoring

The program shall be delivered through a structured and learner-centric approach using the following components:

Component	Brief Description
Orientation Program	Induction session at the beginning of the program covering objectives, credit structure, assessment pattern, academic regulations, and student support services.
LMS Demonstration	Guided session on accessing course materials, submitting assignments, participating in forums, attending live classes, and tracking progress.
Academic Calendar	Semester-wise schedule outlining course timelines, submission dates, contact sessions, and examination schedules.
Structured Self-Learning Plan	Week-wise learning roadmap with unit outcomes, reading schedule, and milestone activities for systematic self-study.
Online Interactive Classes	Live online sessions for conceptual clarity and discussion; recordings made available for later access.
Webinars & Expert Sessions	Periodic expert lectures to enhance industry exposure and contemporary knowledge.
Continuous internal Assessment	Continuous evaluation through assignments, quizzes, case studies, and discussions.
Review & Remedial Sessions	Scheduled sessions to reinforce learning and address academic gaps before exams.
Feedback & Counselling	Timely academic feedback and mentoring support for learner progression.
End Semester Examination	Summative assessment conducted as per university and regulatory norms.
Archival of Records	Secure digital storage of academic records with audit trails and backup.
Plagiarism Compliance	Mandatory plagiarism screening of research and project submissions as per UGC regulations.

BSc (Hons) Data Science
Fundamentals of Computer Science

Learning Plan

Week	Module	SLM	PPT	Video	Practice Quiz	Discussion Forum	Blogs	
Week 1	Module I- Unit 1	Refer unit-1	2	4	10	4	1	
Week 2	Module I - UNIT-2	Refer unit-2	1	6	10	3	1	
Week 3	Module II- Unit-3	Refer unit-3	1	2	10	3	1	
Week 4	Module II- Unit-4	Refer Unit-4	1	3	10	2	1	
Week 5	Review session unit 1 to 4							
Week 6	Assessment							

ACADEMIC CALENDAR

II - Semester
BSc (Hons) Data Science

Start Date	Day	Week	Activity	Timing
Apr 04 2026	Sunday		Commencement of 2 nd Semester – Orientation	10 am – 12 pm
Apr 10 2026	Friday	Week 1	Live Session	7 pm – 9 pm
Apr 11 2026	Saturday		Live Session	7 pm – 9 pm
Apr 12 2026	Sunday		Live Session	10 am – 12 pm
Apr 17 2026	Friday	Week 2	Live Session	7 pm – 9 pm
Apr 18 2026	Saturday		Live Session	7 pm – 9 pm
Apr 19 2026	Sunday		Live Session	10 am – 12 pm
Apr 24 2026	Friday	Week 3	Live Session	7 pm – 9 pm
Apr 25 2026	Saturday		Live Session	7 pm – 9 pm
Apr 26 2026	Sunday		Live Session	10 am – 12 pm
May 01 2026	Friday		No Live Session – May Day	–
May 02 2026	Saturday	Week 4	Live Session	7 pm – 9 pm
May 03 2026	Sunday		Live Session	10 am – 12 pm
May 03 2026	Sunday		Live Session	1 pm – 2 pm
May 08 2026	Friday		Live Session	7 pm – 9 pm

[Home](#) [Helpdesk](#) Standard view

→ BSc Data Science

[Dashboard](#) [Courses](#) [Events](#) [My Activity](#) [Group Project](#) [Assessment](#)

Select Semester: Semester 1
 Select Course: Mathematics

[Learning Plan](#) [Self-Learning Materials](#) [View PPTs](#) [View Videos](#) [Practice Quiz](#) [Discussion Forum](#) [Blog](#) [Question Bank](#) [Live Sessions](#) [Feedbacks](#)

Week 1

PPTs (2)

Video (3)

Googlemeet (1)

Week 2

PPTs (1)

Video (5)

Googlemeet (1)

Week 3

Googlemeet (1)

PPTs (1)

Video (3)

Week 4

Googlemeet (1)

Video (3)

PPTs (1)

Learning Management System

Table of contents

Unit – 2 Determinants

2.1 Introduction to determinants

Aim
 Instructional Objectives
 Learning outcomes
 Self-Assessment Questions

2.2 Adjoint

Aim
 Instructional Objectives
 Learning outcomes
 Self-Assessment Questions

2.3 Inverse of matrix

Aim
 Instructional Objectives
 Learning outcomes
 Self-Assessment Questions

2.4 Cramer's rule

Aim
 Instructional Objectives
 Learning outcomes
 Self-Assessment Questions

Determinant

Aim:
 The aim of studying to apply it as tool of solving linear equations

Instructional Objectives

The unit is designed to

- > Defining determinants
- > Related to matrix

Learning Outcomes

- > Calculations
- > Problem solving

Introduction to determinants

A square array of numbers that represents the sum of specific products of these numbers is called a determinant. If several complex expressions are expressed as "determinants," they can be handled with ease. Determinant is a scalar defined in terms of elements of a square matrix. Usually, determinants are related to linear equations. Let $ax + b = 0$ and $cx + d = 0$ are satisfied by the same values of x then $ad - bc$. The $ad - bc$ is determinant of second order, and is denoted by

$$\begin{vmatrix} a & b \\ c & d \end{vmatrix} = ad - bc$$

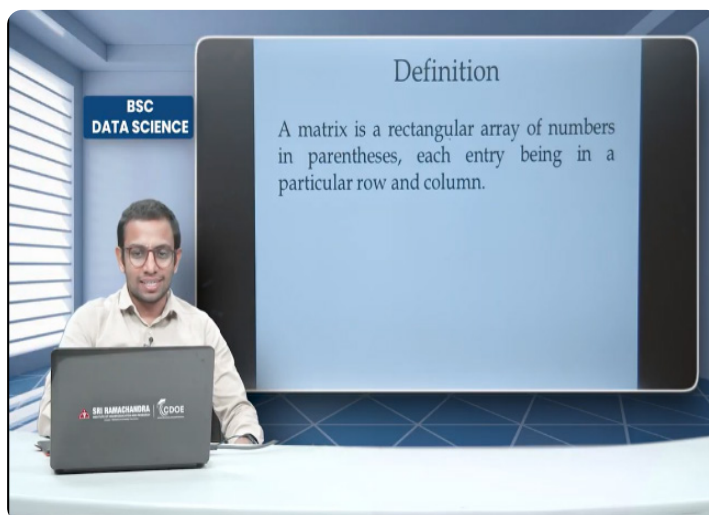
Similarly determinants of order 3

Consider the system of linear equations:

$$\begin{aligned} a_1x + b_1y + c_1z &= d_1 \\ a_2x + b_2y + c_2z &= d_2 \\ a_3x + b_3y + c_3z &= d_3 \end{aligned}$$

Then

Self Learning Material



Lecture Video

10. CURRICULUM

The curriculum and the syllabus for the program of study shall be as prescribed by the Academic Council of the Deemed to be University on the recommendations of the Board of Studies and as may be modified from time to time.

11. CREDITS

The term 'Credit unit' is used to describe the quantum of syllabus for various programs in terms of hours of study. It indicates differential weightage given according to the contents and duration of the courses in the curriculum design. The minimum credits requirement for a M.Sc Data Analytics Post Graduate Degree Program and shall be 80.

11.1 Notional Hours as per UGC – 30 hours per credit

(Notional Learning Hours refer to the total time an average learner is expected to spend to achieve the specified learning outcomes of a course. It represents the overall learner workload and includes all structured and independent learning activities)

As per the UGC guidelines and the National Credit Framework (NCrF):

One academic credit is equivalent to 30 notional learning hours.

Notional learning hours include, but are not limited to:

- Synchronous lectures / live online sessions
- Tutorials and mentoring sessions
- Engagement with e-content and learning materials – include discussion forum
- Assignments, case studies, and project work
- Self-study and preparation
- Assessment and examination time

Thus, the credit value assigned to a course reflects the total expected learner workload required to successfully achieve the course outcomes.

11.2 Table: Norms for Delivery of Courses in Online Mode (as per UGC guidelines Page no. 98)

S. No.	Credit value of the course	No. of Weeks	No of Interactive Sessions		Hours of Study Material		Self-Study hours including Assessment etc. (E)	Total Notional Hours of Study (as per UGC 30 hours per credit)
			Synchronous Online Counselling / Webinars / Interactive Live Lectures (1 hour per week) – (A)	Discussion Forum / Asynchronous Mentoring (2 hours per week) – (B)	e-Tutorial (hours) (C)	e-Content (hours) (D)		
1	2 credits	6 weeks	6 hours	12 hours	10	10	22	60
2	3 credits	9 weeks	9 hours	18 hours	15	15	33	90
3	4 credits	12 weeks	12 hours	24 hours	20	20	44	120

11.3 Multiple Entry–Exit Provision

As per NEP 2020 and NCeF:

- Exit after Year 1 (40 credits): PG Certificate Program in Data Analytics
- Completion of 80 credits: M.Sc (Data Analytics)

Stage	Qualification
40 credits	PG Certificate
80 credits	M.Sc

Multiple Entry–Exit Provision

12. Four Quadrant approach for courses and Quality Compliance

The online courses shall comply with prescribed quality standards and follow the four–quadrant approach as per SWAYAM Guidelines

S. No.	Component	Description
(a)	Quadrant I – e-Tutorial	Includes Video and Audio content in an organized format, Animations, Simulations, Video demonstrations, Virtual Labs, etc., along with transcripts of the videos.
(b)	Quadrant II – e-Content	Includes Self-Instructional Material (Digital Self Learning Material), e-Books, Illustrations, Case Studies, Presentations, Web Resources such as References, Related Links, Open Source Content, Videos, Research Papers, Journals, Articles, Historical development of the subject, Anecdotal information, etc.
(c)	Quadrant III – Discussion Forum	Online discussion forum for raising doubts and clarifying them in real time by the Course Coordinator or the course team.
(d)	Quadrant IV – Assessment	Includes Problems and Solutions in the form of MCQs, Fill in the Blanks, Matching Questions, Short Answer Questions, Long Answer Questions, Quizzes, Question bank (minimum 100 questions), and Assignments with solutions, Discussion forum topics, FAQs, and clarifications on common misconceptions.

Instructional Design principles to support learner engagement and satisfaction:

ADDIE (Analysis, Design, Development, Implementation, and Evaluation) model to identify learner needs and develop high–quality learning content and delivery mechanisms.

Bloom’s Taxonomy is applied in formulating clear instructional objectives and learning outcomes.

Constructive Alignment ensures that learning content, resources, and assessments are aligned with the intended outcomes.

Multiple teaching approaches based on **Richard Mayer’s Multimedia Learning Theory** are used, including videos with animations, visuals, and interactive learning materials.

The **ARCS Model of Motivation (Attention, Relevance, Confidence, and Satisfaction)** by John Keller guides the design of engaging video and visual content.

High-quality learning materials are developed in **professional studios**, and faculty are trained in video delivery techniques to maintain standardization and quality.

Preparation of learning material

1. The **Self-Learning Material (SLM)** for each course is systematically structured to include the Aim, Instructional Objectives, Learning Outcomes, topic-wise explanations, self-assessment questions, summary, terminal questions with answer keys, activities (self-evaluation), glossary, bibliography, external references, image credits, video links, and keywords, ensuring comprehensive learner engagement and alignment with outcome-based education in the online curriculum.
2. The Program incorporates the following **audio-visual (AV) components** to enhance conceptual understanding, learner engagement, and extended self-directed learning within the online curriculum framework.
 - a. Animated Instructional Videos
 - b. Case-Based Explanatory Videos
 - c. Terminology Clarification Videos
 - d. Question Session and Answer Session Recordings
 - e. Curated External Web Links
 - f. Supplementary Learning Resources
 - g. Interactive Learning Support Materials
3. Comprehensive unit-wise **PowerPoint presentations** are provided for all course content, incorporating detailed illustrations, diagrams, charts, and tables to facilitate structured learning, visual reinforcement, and enhanced conceptual clarity in the online curriculum.

Course Content Structure

Credit	No of Units	No of Topics	No of Videos	Discussion forum topics	Self-Learning material Pages	Minimum Word Count (SLM Only)
2	6	18	18	6	120–150 pages	28,000–30,000 words
3	10	30	30	10	180–220 pages	40,000–45,000 words
4	14 (16)	42	42	14	220–280 pages	55,000–60,000 words

13. RESEARCH PROJECT

- a. The Research Project shall be undertaken in the final semester under the supervision of an approved faculty member.
- b. The topic shall be selected in consultation with the supervisor, ensuring relevance to data analytics and industry applications.
- c. Students shall apply the knowledge and analytical skills acquired during the programme, including statistics, programming, and data analytics techniques.
- d. The project shall involve problem identification, data collection/ acquisition, analysis, interpretation of results, and preparation of a dissertation report.
- e. The work shall follow appropriate research methodology and comply with National Credit Framework and UGC Online Programme Regulations.
- f. The dissertation shall be an individual work and may include analytical modelling, case study, experimental study, or review-based research.
- g. The candidates shall submit the dissertation report online through LMS in the prescribed format.
- h. The dissertation work shall be submitted one month prior to the commencement of the University examination.
- i. The project shall undergo plagiarism check as per institutional norms.

PROCESS OF RESEARCH PROJECT IMPLEMENTATION

The Research Project is implemented through a structured and monitored process to ensure academic rigor, transparency, and compliance with UGC Online Learning Regulations, as outlined below:

- **Formation of Research Project Committee (RPC)**

An institutional committee is constituted to ensure academic planning, regulatory compliance, quality assurance, and oversight of the research project in line with UGC OL norms.

- **Appointment of Coordinators / Guides / Mentors**

Faculty members meeting UGC-prescribed qualifications and domain expertise are appointed to supervise and coordinate research activities, ensuring quality and accountability.

- Research Project Orientation by the Committee**
 Structured orientation is conducted through LMS/online mode to familiarize students with research methodology, ethics, timelines, evaluation criteria, and digital submission protocols.
- Allotment of Students as per Guidelines**
 Students are allocated to supervisors based on research domain, faculty expertise, and defined student–mentor ratio, ensuring effective mentoring as per regulatory expectations.
- Execution of Research Project**
 The project is carried out in a phased manner integrating Four–Quadrant learning (Q1–Q4), with emphasis on independent research, guided interaction, and documented progress.
- Continuous Monitoring and Evaluation**
 Progress is assessed through stage–wise reviews, mentor interactions, and LMS–based tracking, ensuring continuous evaluation as mandated by UGC OL regulations.
- Final Evaluation (Dissertation & Viva Voce)**
 The completed dissertation is evaluated, followed by an online viva voce conducted by a Project Evaluation Committee (PEC) to assess research competency and application.
- Student Feedback and Quality Improvement**
 Structured feedback is collected through institutional mechanisms to support continuous quality improvement and alignment with outcome–based education practices.

Credit and Workload Distribution (UGC OL – Four–Quadrant Integration)

The Research Project carries **12 credits equivalent to 360 notional learning hours**, distributed across the UGC Four–Quadrant framework to ensure a balanced mix of guided learning, independent research, interaction, and assessment.

Quadrant	Component	Activities Covered	Notional Hours	Credits
Q1	e–Tutorials	Recorded lectures on research methodology, literature review, data analytics techniques, tools (Python/R), ethics and plagiarism	30	1
Q2	e–Content & Self–Learning	Research survey, problem identification, literature review, proposal development, independent research work, learning resources	150	5

Quadrant	Component	Activities Covered	Notional Hours	Credits
Q3	Interaction / Mentoring	Review-1 & Review-2 discussions, mentor guidance, progress evaluation, feedback sessions, academic interaction	120	4
Q4	Assessment	Final review, dissertation report submission, presentation, viva voce, publication/patent (if applicable)	60	2
Total			360 Hours	12 Credits

14. ATTENDANCE REQUIRED FOR ADMISSION TO EXAMINATIONS

Attendance for online programs shall be calculated based on learner engagement across multiple components, as detailed below:

- **Synchronous Learning (Live Sessions)** – 50%
Attendance shall be recorded based on participation in live online classes, webinars, and interactive sessions.
- **Asynchronous Learning (Recorded Content)** – 20%
Learners shall complete recorded lectures, self-learning materials hosted on the LMS.
- **LMS Activities** – 20%
Attendance shall include participation in practice quizzes, case studies, and discussion forums.
- **Internal Assessments** 10%
Timely submission of assignments and Multiple choice questions.

Minimum Requirement:

- Learners must secure a minimum of **75% overall attendance in each course** to be eligible to appear for end-semester examinations, as per regulatory norms.
- Candidates will not be permitted to appear for the end semester examination without the 75% attendance.
- Where a student is, absent without any prior permission for a semester, he/she shall be treated as **“Reappear (RA)”**. Such candidates shall report to the Director, Online Education, and shall be governed by the disciplinary rules of the Deemed University.

15. EXAMINATION & ASSESSMENT AND EVALUATION

The assessment structure for all courses under the Online Program is designed in accordance with the **UGC (Online Courses or Programs – dated Sep 2020) Regulations** and aligned with the **National Credit Framework (NCrF) dated April 2023**.

- Evaluation follows a balanced system of **Continuous Internal Assessment (CIA)** and **End Semester Examination (ESE)** to ensure both formative and summative assessment. The framework supports Outcome-Based Education (OBE), credit-linked workload (30 hours per credit), and competency-based progression as prescribed under NCrF.
- At the postgraduate level (**NCrF Level 7 equivalent**), assessment methods are structured to evaluate conceptual understanding, analytical ability, application skills, and professional judgement.

Assessment Structure

This evaluation framework ensures academic rigor, transparency, regulatory compliance, and equivalence with conventional mode program as mandated by UGC-DEB and aligned with NCrF provisions.

- Evaluation for a course shall be done on continuous basis with minimum two online continuous internal assessments (CIA) followed by one end semester **online proctored** University End Semester Examination (ESE) for each course.
- For CT/DE/GE category of courses offered, the CIA evaluation weighted at 30% and the ES weighted at 70%
- The Research Project (RP) and AE courses will be assessed internally

Component	Nature of Assessment	Weightage
Continuous Internal Assessment (CIA)	Assignments, quizzes	30%
End Semester Examination (ESE)	Comprehensive examination covering entire syllabus (proctored mode as per UGC norms)	70%
Total		100%

16. END SEMESTER EXAMINATIONS

16.1 THEORY

There shall be End semester examinations for 3 hours duration carrying 100 marks for each course covering the entire syllabus. The end semester exam consists of 70% weightage of the overall assessments.

Theory Question Paper Pattern For University Examinations		
End of Semester Examination (ESE) Theory (CT/DE/GE Courses only)		
Pattern & Choices	Marks	Total Marks
Essay question (either choice)	5x20	100
	Total	100

16.2. Research Project

Evaluation Framework

The Research Project shall be evaluated through **Continuous Internal Assessment (CIA)** and **End Semester Evaluation (ESE)**, in accordance with UGC ODL/Online Learning Regulations (2020), ensuring continuous monitoring, transparency, and outcome-based assessment in data analytics applications.

Part A – Continuous Internal Assessment (50%)

Component	Sub-component	Marks	Weightage (%)
Proposal Evaluation (Review-1)	Problem statement, literature survey, proposed solution, methodology, knowledge of tools, presentation	10	10%
Progress Reviews (Review-2)	Innovation, usage of tools/technology, work progress, data handling, communication and presentation	15	15%
Analytical / Experimental Work	Implementation, model development, real-time testing, results/outcome, learning from resources	15	15%
Pre-Submission (Draft Review)	Draft dissertation, completeness, methodology clarity, documentation quality	10	10%
Total	—	50	50%

Part B: End Semester Evaluation (50 Marks)

Component	Sub-component	Marks	Weightage (%)
Final Dissertation Report	Report quality, methodology, results, documentation, research depth	30	30%
Presentation / Publication	Presentation skills, communication, PPT content, conference/journal publication (if any)	10	10%
Viva Voce Examination	Understanding, methodology explanation, application, comprehension	10	10%
Total	—	50	50%

16.3 Credit Transfer for General Elective (GE) Courses:

Students may opt to earn credits for the **General Elective (GE)** component through **UGC-approved MOOCs platforms such as SWAYAM/NPTEL** in lieu of the electives offered within the program. A maximum of **3 credits** may be earned through such MOOCs, provided that the course corresponds to **NCrF Level 7**.

The transfer of credits through MOOCs shall be subject to the following conditions:

- (i) Prior approval from the Program Coordinator before enrolling in the MOOC course.
- (ii) Verification of equivalence in terms of course outcomes, content, and credit weightage by the **Board of Studies/Academic Council**.
- (iii) Successful completion of the **proctored assessment/examination** conducted by the offering platform, and
- (iv) Compliance with the **maximum credit transfer limits prescribed by the University Grants Commission (UGC)** from time to time.

17. GRADING SYSTEM

Evaluation will be done on a continuous basis. The pattern of evaluation is to assess the “knowing doing and being” of the learners. Student performance in each course is evaluated in terms of percentage of marks (%) which will be converted into letter grades based on a 10-point scale of evaluation.

17.1 Letter Grades and Grade Points:

- a) Sri Ramachandra Institute of Higher Education and Research institute (Deemed to be University) would be following the absolute grading system, where the marks are compounded to grades based on pre-determined class intervals.
- b) The UGC recommended 10-point grading system with the following letter grades are given below:

Letter Grade	Grade Point	Range of Marks
O (Outstanding)	10	86-100
A+ (Excellent)	9	70-85
A (Very Good)	8	60 -69
B+ (Good)	7	55 -59
B (Above Average)	6	50- 54
RA (Reappear)	0	49 and below
Ab (Absent)	0	Reappear
NC - Not Eligible (detained)	0	Detained

17.2 Computation of SGPA and CGPA

The UGC recommends the following procedure to compute the Semester Grade Point

Average (SGPA) and Cumulative Grade Point Average (CGPA):

- (i) The SGPA is the ratio of sum of the product of the number of credits with the grade points scored by a student in all the courses taken by a student and the sum of the number of credits of all the courses undergone by a student, i.e.,

$$\text{SGPA (Si)} = \frac{\sum(C_i \times G_i)}{\sum C_i}$$

Where, C_i is the number of credits of the i^{th} course and G_i is the grade point scored by the student in the i^{th} course.

- (ii) The CGPA is also calculated in the same manner taking into account all the courses undergone by a student over all the semesters of a program, i.e.,

$$\text{CGPA} = \frac{\sum(C_i \times S_i)}{\sum C_i}$$

Where, S_i is the SGPA of the i^{th} semester and C_i is the total number of credits in that semester.

- (iii) The SGPA and CGPA shall be rounded off to 2 decimal points and reported in the transcripts.

17.3 Illustration of Computation of SGPA and CGPA and Format for Transcripts

- (i) Computation of CGPA
- (ii) Grade Card (Format): Based on the above recommendations on letter grades, grade points, SGPA and CGPA, The HEIs may issue the grade card for each semester and a consolidated grade card indicating the performance in all semesters.

C.No	Course Code	Course Title	Credits (C)	Grade Letter	Grade Point (GP)	Credit Points (Credit × Grade)
1	CDA25OCT01	Statistics for Data Science	3	A	8	3 × 8=24
2	CDA25OCT02	Data Structures and Algorithms	4	A+	9	4 × 9=36
3	CDA25OCT03	Data Science with R	4	B+	7	4 × 7=28
4	O0825ODE01	Discipline Elective Course – I	4	A	8	4 × 8=32
5	CDA25OCL01	Advanced Python Programming	3	A+	9	3 × 9=27
6	O0825OSE01	Skill Enhancement Course	2	O	10	2 × 10=20
			20			167
Illustration for SGPA Thus = 167/20=8.35						

Semester 1	Semester 2	Semester 3	Semester 4
Credit: 20 SGPA: 8.6	Credit: 20 SGPA: 8.5	Credit: 20 SGPA: 8.5	Credit: 20 SGPA: 9.4
Illustration for CGPA $\text{CGPA} = \frac{(20 \times 8.60) + (20 \times 8.50) + (20 \times 8.50) + (20 \times 9.40)}{80} = 8.75$			

18. GRADE QUALIFYING A PASS

A candidate shall be declared to have **passed** the examination if he/she secures a minimum of **50% of the marks/grade in each course**.

19. REAPPEARANCE FOR ARREAR SUBJECTS

Students reappearing for a course shall do so along with the subsequent regular end of semester examinations.

20. CLASSIFICATION OF SUCCESSFUL CANDIDATES

Overall Performance in a Program and Ranking of a candidate is in accordance with the University regulations.

Cumulative Grades and Grade Point Average

Consolidated Grade Card		
Letter Grade	Grade Point	CGPA
O (Outstanding)	10	9.01 – 10
A+ (Excellent)	9	8.01 – 9.00
A (Very Good)	8	7.01 – 8.00
B+ (Good)	7	6.01 – 7.00
B (Above Average)	6	5.01 – 6.00

A successful candidate

- (i) Who secures not less than O grade with a CGPA of 9.01 – 10.00 shall be declared to have secured '**OUTSTANDING**' provided he/she passes the whole examination in the FIRST ATTEMPT;
- (ii) Who secures not less than A+ grade with a CGPA of 8.01 – 9.00 shall be declared to have secured '**EXCELLENT**' provided he/she passes the whole examination in the FIRST ATTEMPT;
- (iii) Who secures not less than A grade with a CGPA of 7.01 – 8.00 and completes the course within the stipulated course period shall be declared to have passed the examinations with "**Very Good**"
- (iv) All other candidates shall be declared to have passed the examinations.

21. MIGRATION/TRANSFER OF CANDIDATES

Application seeking Migration/Transfer of a candidate from any recognized institution to the University shall be considered subject to the condition that:

- a) There must be vacancy in the particular year of study;
- b) transfer shall be effective only at the beginning of an academic year; and
- c) Approval of the Vice-Chancellor shall be obtained.
- d) Students shall be allowed to take credits earned from other institutions and vice-versa as per university norms.

22. AWARD OF DEGREE

The university will award the Post Graduate degree after a candidate successfully completes the required University examinations and earns all the prescribed 80 credits for the M.Sc Data Analytics (Online Mode).

23. BREAK OF STUDY FROM A PROGRAM

The University regulations for readmission are applicable for a candidate seeking re-entry to a program

- a) Students admitted to a program and absenting for ≥ 3 months must seek readmission into the appropriate semester as per University norms
- b) The candidates having a break of study of 6 months and above but less than one year shall apply for re-admission in the prescribed form to the Director, Centre for Distance and Online Education of the University and remitting the stipulated fee for condonation. The candidates may be re-admitted in corresponding program of study at the commencement of the semester and shall undergo a minimum period of study of 3 months. After the fulfillment of the regulations of this University, he/she shall be admitted for the examination. The candidate shall be granted exemption in the subjects they have already passed.
- c) The candidates having a break of study of \geq one year shall apply for re-admission in the prescribed form to the Director, Centre for Distance and Online Education of the University and remitting the stipulated fee for condonation. The candidates may be permitted to re-join the program in the beginning of the session/semester of a program as the case may be and will not be granted any exemption in any subject they may have already passed. They shall subscribe to the regulations of this University.
- d) Candidates having a break of study of two years and above from date of admission and more than two spells of break will not be considered for re-admission.
- e) The two years period of break of study shall be calculated from the date of first admission of the candidate to the program inclusive of all the subsequent spells of break of studies.
- f) Candidates having break of study shall be considered for re-admission provided that they are not subjected to any disciplinary action and no charges are pending or contemplated against them.
- g) The students permitted to rejoin a program after break of study/prevention (detained) due to lack of attendance, shall be governed by the Curriculum and Regulations in force at the time of joining
- h) The maximum period of study permissible to complete the program is four years
- i) All re-admission of candidates are subject to the approval of the Vice-Chancellor.

24. DISCHARGE OF STUDENTS FROM PROGRAM

If a student admitted to a course of study in this Deemed University is for any reason not able to complete the course or qualify for the Post Graduate degree by passing the examinations prescribed within a period comprising twice the duration prescribed in the Regulations for the concerned program, he/she will be discharged from the said course, his/her name will be taken off the rolls of the Deemed University and he/she will not be permitted to attend classes or appear for any examination conducted by the Deemed University thereafter

SCHEME OF CURRICULUM AND EVALUATION

M.SC. DATA ANALYTICS POST GRADUATE DEGREE PROGRAM (ONLINE) 2026-27 FIRST YEAR

C.No.	Course Code	Cat	Course Titles	Credit value of the course	No of Weeks	No of Interactive Sessions (hours)			Hours of Study Material		Self-Study hours including Assessment	Total Notional Hours of Study (as per UGC 30 hours per credit)
						A Synchronous Online Counseling / Webinars / Interactive Live Lectures	B Discussion Forum / Asynchronous Mentoring	C e-Tutorial	D e-Content	E		
			Semester - I									
1	CDA25OCT01	CT	Statistics for Data Science	3	9	18	15	15	33	90		
2	CDA25OCT02	CT	Data Structures and Algorithms	4	12	24	20	20	44	120		
3	CDA25OCT03	CT	Data Science with R	4	12	24	20	20	44	120		
4	O0825ODE01#	DE	Discipline Elective Course 1	4	12	24	20	20	44	120		
5	CDA25OCL01	CL	Advanced Python Programming	3	9	18	15	15	33	90		
6	O0825OSE01*	SL	To be Chosen	2	6	12	10	10	22	60		
				20	60	120	100	100	220	600		
			Semester - II									
6	CDA25OCT04	CT	Advanced Statistics	3	9	18	15	15	33	90		
7	CDA25OCT05	CT	Advanced Database Management System	4	12	24	20	20	44	120		
8	CDA25OCT06	CT	Foundations of Data Analytics and Transformation Techniques	4	12	24	20	20	44	120		
9	O0825ODE02#	DE	Discipline Elective Course 2	4	12	24	20	20	44	120		
10	O0825OGE01\$	GE	General Elective Course 1	3	9	18	15	15	33	90		
11	O0825OSE02*	SL	To be Chosen	2	6	12	10	10	22	60		
				20	60	120	100	100	220	600		

SCHEME OF CURRICULUM AND EVALUATION

M.SC. DATA ANALYTICS POST GRADUATE DEGREE PROGRAM (ONLINE) 2026--27 SECOND YEAR

C.No.	Course Code	Cat	Course Titles	Credit value of the course	No of Weeks	No of Interactive Sessions (hours)				Hours of Study Material		Self-Study hours including Assessment	Total Notional Hours of Study (as per UGC 30 hours per credit)
						Synchronous		Discussion Forum / Asynchronous Mentoring	e-Tutorial	e-Content			
						Online Counselling / Webinars / Interactive Live Lectures	A				B		
			Semester – III										
1	CDA25OCT07	CT	Natural Language Processing	4	12	12		24	20	20	44	120	
2	CDA25OCT08	CT	Big Data Analytics and Hadoop Ecosystem	4	12	12		24	20	20	44	120	
3	CDA25OCT09	CT	Artificial Intelligence and Machine Learning Techniques	4	12	12		24	20	20	44	120	
4	O0825ODE03#	DE	Discipline Elective Course 3	4	12	12		24	20	20	44	120	
5	CDA25OAE01	AE	Research Methodology	2	6	6		12	10	10	22	60	
6	O0825OSE03*	SL	To be Chosen	2	6	6		12	10	10	22	60	
				20	60	60		120	100	100	220	600	
			Semester -IV										
7	CDA25OCT10	CT	Advanced Cloud Computing	4	12	12		24	20	20	44	120	
8	O0825ODE04#	DE	Discipline Elective Course 4	4	12	12		24	20	20	44	120	
9	CDA25ORP01	RP	Research Project1	12	12	12		24	60	60	204	360	
				20	60	60		120	100	100	220	600	

- Skill enhancement courses represented by asterisk Symbol * choose by students list of course available below
- Discipline Specialisation Elective Courses by Hash Symbol # choose by students list of course available below
- General elective Courses by \$ Dollar Symbol \$ choose by students list of course available below



C.No.	Course Code	Cat	Course Titles	Credit value of the course	No of Weeks	No of Interactive Sessions (hours)		Hours of Study Material		Self-Study hours including Assessment	Total Notional Hours of Study (as per UGC 30 hours per credit)		
						Synchronous Online Counseling / Webinars / Interactive Live Lectures	Discussion Forum / Asynchronous Mentoring	e-Tutorial	e-Content				
						A	B	C	D	E	Sum A-E		
			DISCIPLINE SPECIALISATION ELECTIVE COURSES										
1	CDA25ODE01	DE	Ensemble Learning for Predictive Analytics	4	12								
2	CDA25ODE02	DE	Time Series Analytics and Forecasting										
3	CDA25ODE03	DE	Computer Vision and Image Analytics										
4	CDA25ODE04	DE	Generative AI and Deep Learning Models										
5	CDA25ODE05	DE	Clinical Decision Support and Healthcare Analytics										
6	CDA25ODE06	DE	Text Analytics					12	24	20	20	44	120
7	CDA25ODE07	DE	Reinforcement Learning for Artificial Intelligence										
8	CDA25ODE08	DE	Fundamentals of Cryptography and Network Security										
9	CDA25ODE09	DE	Internet of Things and Arduino Programming										
10	CDA25ODE10	DE	Artificial Neural Network and Deep Learning										



C.No.	Course Code	Cat	Course Titles	Credit value of the course	No of Weeks	No of Interactive Sessions (hours)		Hours of Study Material		Self-Study hours including Assessment	Total Notional Hours of Study (as per UGC 30 hours per credit)
						Synchronous Online Counseling / Webinars / Interactive Live Lectures	Discussion Forum / Asynchronous Mentoring	e-Tutorial	e-Content		
			SKILL ENHANCEMENT COURSES			A	B	C	D	E	Sum A-E
1	CDA25OSLO1	SL	Advanced Excel for Data Analytics	2	6	6	12	10	10	22	60
2	CDA25OSLO2	SL	Tableau for Data Analysis								
3	CDA25OSLO3	SL	Unix Shell Programming								
4	CDA25OSLO4	SL	Agile Methodologies for Project Management								
5	CDA25OSLO5	SL	SQL: Advanced Concepts and Applications								
6	CDA25OSLO6	SL	Statistical Analysis using Jamovi								
7	CDA25OSLO7	SL	Web Scraping with Python								
8	CDA25OSLO8	SL	Pyspark for Big Data and Analytics								
9	CDA25OSLO9	SL	Microsoft Azure AI platform for AI based application development								
10	CDA25OSLO10	SL	Business Intelligence and Visualization with Power BI								

C.No.	Course Code	Cat	Course Titles	Credit value of the course	No of Weeks	No of Interactive Sessions (hours)		Hours of Study Material		Self-Study hours including Assessment	Total Notional Hours of Study (as per UGC 30 hours per credit)
						Synchronous Online Counseling / Webinars / Interactive Live Lectures	Discussion Forum / Asynchronous Mentoring	e-Tutorial	e-Content		
			GENERAL ELECTIVE COURSES			A	B	C	D	E	Sum A-E
1	CDA25OGE01	GE	Responsible AI and Data Ethics	3	9	9	18	15	15	33	90
2	CDA25OGE02	GE	AI Tools for Everyday Productivity			9	18	15	15	33	90
3	CDA25OGE03	GE	Digital Marketing Analytics			9	18	15	15	33	90

PROGRAM OUTCOMES:

PO1: Apply disciplinary knowledge of statistics, mathematics, and data analytics to solve complex problems.

PO2: Analyze and interpret data-driven problems using appropriate analytical techniques.

PO3: Design and develop analytical solutions using statistical and computational approaches.

PO4: Investigate complex data problems using research-oriented analytical methods.

PO5: Use modern analytical tools, software, and technologies effectively.

PO6: Demonstrate ethical responsibility and professional integrity in data analytics practices.

PO7: Function effectively as an individual and as a member of multidisciplinary teams.

PO8: Communicate analytical findings effectively through reports, visualizations, and presentations.

PO9: Apply project management and organizational principles in analytics-based projects.

PO10: Engage in independent and lifelong learning in emerging areas of data analytics.

PO11: Demonstrate research aptitude through data-driven investigation and analysis.

PO12: Apply analytical thinking and innovation to support entrepreneurship and business decision-making.

PO-CO MAPPING

- **3 – High Correlation:** The Course Outcome strongly contributes to the achievement of the Program Outcome. The learning activities, assessments, and content are directly aligned and significantly support the PO.
- **2 – Moderate Correlation:** The Course Outcome has a reasonable level of contribution to the Program Outcome. The relationship is partial or indirect but still meaningful.
- **1 – Low Correlation:** The Course Outcome has a minimal or limited contribution to the Program Outcome. The linkage exists but is not strong or direct.
- **Blank (-):** Indicates that there is no significant correlation between the Course Outcome and the Program Outcome.

CT1- STATISTICS FOR DATA SCIENCE												
Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1: Analyze statistical fundamentals and experimental designs	3	3	-	2	-	-	-	-	-	1	2	-
CO2: Evaluate data visualization techniques for exploratory analysis	2	2	2	-	3	-	-	2	-	-	-	-
CO3: Analyze and interpret datasets using statistical measures	3	3	-	2	2	-	-	-	-	-	-	-
CO4: Evaluate probabilistic models for data-driven problems	2	3	-	3	-	-	-	-	-	-	2	-
CO5: Design and justify statistical inference and regression models	3	3	3	3	2	-	-	1	-	2	3	-

CT2: DATA STRUCTURES AND ALGORITHMS

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1: Analyze algorithmic principles and data structures for computational efficiency	3	3	-	2	-	-	-	-	-	1	2	-
CO2: Design and implement optimized linear data structures for problem solving	2	3	3	-	3	-	-	-	-	-	-	-
CO3: Analyze and evaluate tree and graph structures for real-world applications	3	3	-	3	2	-	-	-	-	-	2	-
CO4: Evaluate and optimize searching and sorting algorithms based on complexity	2	3	-	2	3	-	-	-	-	-	2	-
CO5: Design and analyze combinatorial optimization solutions using advanced techniques	3	3	3	3	2	-	-	1	-	2	3	-

CT 3 – DATA SCIENCE WITH R

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1: Analyze R programming constructs for statistical and analytical workflows	3	2	-	-	3	-	-	-	-	1	-	-
CO2: Evaluate statistical and analytical techniques implemented using R	3	3	-	2	2	-	-	-	-	-	2	-
CO3: Analyze and interpret datasets using advanced visualization and EDA	2	3	-	2	3	-	-	2	-	-	-	-
CO4: Develop and evaluate predictive models using suitable performance metrics	3	3	3	3	2	-	-	-	-	-	3	-
CO5: Design and implement data-driven solutions using real-world datasets in R	3	3	3	2	3	-	-	1	-	2	2	-

CL1 : ADVANCED PYTHON PROGRAMMING

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1: Analyze data science environments and preprocessing techniques using Python	3	2	-	-	3	-	-	-	-	1	-	-
CO2: Evaluate and manage structured data using NumPy and Pandas	3	3	-	2	3	-	-	-	-	-	-	-
CO3: Design effective static and interactive visualizations	2	3	2	-	3	-	-	2	-	-	-	-
CO4: Develop and evaluate machine learning models using Python	3	3	3	3	2	-	-	-	-	-	3	-
CO5: Design and implement end-to-end ML / data science projects	3	3	3	2	3	-	-	1	-	2	3	-

CT 4 : ADVANCED STATISTICS

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1: Analyze and evaluate regression models for prediction and inference	3	3	2	3	2	-	-	-	-	-	3	-
CO2: Develop and validate logistic regression models for classification	3	3	3	3	2	-	-	-	-	-	3	-
CO3: Analyze and assess clustering techniques for segmentation quality	3	3	-	3	2	-	-	-	-	-	2	-
CO4: Evaluate association and correlation patterns for decision-making	3	3	-	2	2	-	-	1	-	-	-	-
CO5: Apply and interpret survival analysis models for time-dependent data	3	3	-	3	-	-	-	-	-	-	3	-

CT5 : Advanced Database Management System

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1: Analyze relational database architectures and data models	3	3	-	2	-	-	-	-	-	-	2	-
CO2: Design normalized database schemas ensuring integrity and minimal redundancy	3	3	3	-	-	-	-	-	-	-	-	-
CO3: Develop and optimize advanced SQL/PLSQL programs for complex data operations	3	3	3	2	3	-	-	-	-	-	2	-
CO4: Evaluate transaction processing, concurrency control, and security mechanisms	3	3	-	3	2	2	-	-	-	-	2	-
CO5: Implement and assess database solutions for real-time analytical application	3	3	3	2	3	-	-	1	-	2	2	-

CT6 : FOUNDATIONS OF DATA ANALYTICS AND TRANSFORMATION TECHNIQUES

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1: Analyze challenges associated with missing and inconsistent data in real-world datasets	3	3	-	3	-	-	-	-	-	-	2	-
CO2: Evaluate data storage and transformation strategies for structured and unstructured data	3	3	2	2	3	-	-	-	-	-	2	-
CO3: Analyze datasets using descriptive analytics and visualization techniques	2	3	-	2	3	-	-	2	-	-	-	-
CO4: Develop and evaluate predictive models using regression-based techniques	3	3	3	3	2	-	-	-	-	-	3	-
CO5: Assess high-dimensional data issues and apply dimensionality reduction techniques	3	3	-	3	2	-	-	-	-	-	3	-

CT7 : Natural Language Processing												
Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1: Analyze computational challenges in natural language processing tasks	3	3	-	3	-	-	-	-	-	-	2	-
CO2: Develop NLP algorithms using mathematical and engineering principles	3	3	3	2	2	-	-	-	-	-	2	-
CO3: Evaluate NLP techniques using existing libraries for real-world applications	2	3	-	2	3	-	-	-	-	-	-	-
CO4: Design and develop NLP-based systems to solve complex problems	3	3	3	3	2	-	-	-	-	-	3	-
CO5: Design and implement NLP solutions collaboratively for real-world applications	2	2	3	2	3	-	3	1	-	2	2	-

CT8 : Big Data Analytics and Hadoop Ecosystem												
Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1: Analyze Big Data characteristics, architectures, and processing paradigms	3	3	-	2	-	-	-	-	-	-	2	-
CO2: Evaluate statistical and probabilistic techniques for Big Data analytics	3	3	-	3	-	-	-	-	-	-	3	-
CO3: Analyze Hadoop ecosystem components for scalable data processing	3	3	-	2	3	-	-	-	-	-	2	-
CO4: Design and optimize MapReduce workflows for large-scale analytics	3	3	3	3	3	-	-	-	-	-	2	-
CO5: Evaluate and implement domain-specific Big Data solutions across industries	3	3	3	2	3	-	-	1	-	2	2	-

CT9 : Artificial Intelligence and Machine Learning Techniques												
Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1: Analyze AI concepts, intelligent systems, and emerging trends	3	3	-	2	-	-	-	-	-	2	2	-
CO2: Evaluate problem-solving strategies using search and reasoning techniques	3	3	2	3	-	-	-	-	-	-	2	-
CO3: Analyze neural architectures and learning mechanisms in AI systems	3	3	-	3	2	-	-	-	-	-	3	-
CO4: Develop supervised and unsupervised learning models for classification and pattern recognition	3	3	3	3	2	-	-	-	-	-	3	-
CO5: Design hybrid intelligent systems using fuzzy logic and genetic algorithms	3	3	3	3	2	-	-	1	-	2	3	-

CT10 : Advanced Cloud Computing												
Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1: Analyze cloud computing architectures and deployment models	3	3	-	2	-	-	-	-	-	-	2	-
CO2: Evaluate virtualization techniques for efficient cloud resource management	3	3	-	2	3	-	-	-	-	-	2	-
CO3: Design, deploy, and evaluate cloud-based applications using commercial platforms	3	3	3	3	3	-	-	-	-	-	2	-
CO4: Analyze cloud-based data storage architectures and file systems	3	3	-	2	2	-	-	-	-	-	2	-
CO5: Evaluate cloud service models, operational practices, and ethical considerations	3	2	-	2	2	3	-	1	-	2	-	-

AE1: Research Methodology												
Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1: Analyze research concepts, objectives, and processes	3	3	-	2	-	-	-	-	-	2	3	-
CO2: Design research problems and methodologies with sampling strategies	3	3	3	3	-	-	-	-	-	-	3	-
CO3: Evaluate ethical data collection methods for research studies	2	2	-	-	-	3	-	-	-	-	2	-
CO4: Analyze and interpret quantitative and qualitative research data	3	3	-	3	2	-	-	-	-	-	3	-
CO5: Design research reports and evaluate emerging research methodologies	3	3	2	3	-	-	-	2	-	2	3	-

DE: Ensemble Learning for Predictive Analytics												
Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1: Analyze principles and assumptions of ensemble learning methods	3	3	-	2	-	-	-	-	-	-	2	-
CO2: Evaluate bagging, boosting, and stacking across data scenarios	3	3	-	3	2	-	-	-	-	-	3	-
CO3: Analyze bias-variance trade-offs in ensemble models	3	3	-	3	-	-	-	-	-	-	3	-
CO4: Develop and optimize ensemble models for high-accuracy prediction	3	3	3	3	2	-	-	-	-	-	3	-
CO5: Design ensemble-based solutions for real-world predictive analytics	3	3	3	2	3	-	-	1	-	2	2	-

DE: TIME SERIES ANALYTICS AND FORECASTING

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1: Analyze time series characteristics such as trend, seasonality, and autocorrelation	3	3	-	2	-	-	-	-	-	-	2	-
CO2: Evaluate statistical and ML models for time series forecasting	3	3	-	3	2	-	-	-	-	-	3	-
CO3: Analyze stationarity and transformation techniques for temporal data	3	3	-	3	-	-	-	-	-	-	3	-
CO4: Develop and validate forecasting models for real-world datasets	3	3	3	3	2	-	-	-	-	-	3	-
CO5: Design end-to-end forecasting solutions for business and industry	3	3	3	2	3	-	-	1	-	2	2	-

DE: Computer Vision and Image Analytics Program

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1: Analyze image representation, enhancement, and feature extraction techniques	3	3	-	2	-	-	-	-	-	-	2	-
CO2: Evaluate classical and deep learning-based computer vision algorithms	3	3	-	3	2	-	-	-	-	-	3	-
CO3: Analyze object detection and image classification models for accuracy and robustness	3	3	-	3	2	-	-	-	-	-	3	-
CO4: Develop computer vision solutions using convolutional neural networks	3	3	3	3	2	-	-	-	-	-	3	-
CO5: Design image analytics systems for real-world applications (healthcare, surveillance)	3	3	3	2	3	-	-	1	-	2	2	-

DE : GENERATIVE AI AND DEEP LEARNING MODELS												
Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1: Analyze generative modeling principles and deep learning architectures	3	3	-	2	-	-	-	-	-	-	2	-
CO2: Evaluate GANs, VAEs, and transformer-based generative models	3	3	-	3	2	-	-	-	-	-	3	-
CO3: Analyze ethical, social, and technical challenges of generative AI	2	2	-	2	-	3	-	-	-	-	2	-
CO4: Develop generative deep learning models for synthetic data and content	3	3	3	3	2	-	-	-	-	-	3	-
CO5: Design innovative generative AI solutions for real-world applications	3	3	3	2	3	-	-	1	-	2	2	-

DE: CLINICAL DECISION SUPPORT AND HEALTHCARE ANALYTICS												
Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1: Analyze healthcare data sources and clinical workflows for decision support	3	3	-	2	-	-	-	-	-	-	2	-
CO2: Evaluate predictive and prescriptive analytics for clinical decision-making	3	3	-	3	2	-	-	-	-	-	3	-
CO3: Analyze patient outcomes using healthcare analytics models	3	3	-	3	-	-	-	-	-	-	3	-
CO4: Develop data-driven clinical decision support systems	3	3	3	3	2	-	-	-	-	-	3	-
CO5: Design ethical and interpretable healthcare analytics solutions	3	2	3	2	2	3	-	1	-	2	2	-

DE – TEXT ANALYTICS												
Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1: Analyze textual data using linguistic and statistical techniques	3	3	-	2	-	-	-	-	-	-	2	-
CO2: Evaluate text representation models and feature extraction methods	3	3	-	3	2	-	-	-	-	-	3	-
CO3: Analyze sentiment, topic, and semantic patterns in large corpora	3	3	-	3	2	-	-	-	-	-	3	-
CO4: Develop text analytics models for classification and information extraction	3	3	3	3	2	-	-	-	-	-	3	-
CO5: Design scalable text analytics solutions for real-world applications	3	3	3	2	3	-	-	1	-	2	2	-

DE : REINFORCEMENT LEARNING FOR ARTIFICIAL INTELLIGENCE												
Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1: Analyze reinforcement learning frameworks and Markov decision processes	3	3	-	2	-	-	-	-	-	-	2	-
CO2: Evaluate value-based and policy-based reinforcement learning algorithms	3	3	-	3	2	-	-	-	-	-	3	-
CO3: Analyze exploration-exploitation strategies in RL systems	3	3	-	3	-	-	-	-	-	-	3	-
CO4: Develop reinforcement learning agents for sequential decision-making problems	3	3	3	3	2	-	-	-	-	-	3	-
CO5: Design intelligent systems using reinforcement learning for real-world environments	3	3	3	2	3	-	-	1	-	2	2	-

DE : FUNDAMENTALS OF CRYPTOGRAPHY AND NETWORK SECURITY												
Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1: Analyze cryptographic principles and security threats in networked systems	3	3	-	2	-	2	-	-	-	-	2	-
CO2: Evaluate symmetric, asymmetric, and hashing algorithms for security applications	3	3	-	3	2	-	-	-	-	-	3	-
CO3: Analyze network vulnerabilities and attack mechanisms	3	3	-	3	-	2	-	-	-	-	3	-
CO4: Develop secure communication mechanisms using cryptographic protocols	3	3	3	3	2	2	-	-	-	-	2	-
CO5: Design secure network architectures to protect data and communication systems	3	3	3	2	3	2	-	1	-	2	2	-

DE : INTERNET OF THINGS AND ARDUINO PROGRAMMING												
Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1: Analyze IoT architectures, communication protocols, and sensor networks	3	3	-	2	-	-	-	-	-	-	2	-
CO2: Evaluate embedded systems and microcontroller platforms for IoT applications	3	3	-	2	3	-	-	-	-	-	2	-
CO3: Analyze real-time data acquisition and processing in IoT systems	3	3	-	3	2	-	-	-	-	-	3	-
CO4: Develop IoT applications using Arduino and connected sensors	3	3	3	3	3	-	-	-	-	-	2	-
CO5: Design end-to-end IoT solutions for smart and industrial environments	3	3	3	2	3	-	-	1	-	2	2	-

DE : ARTIFICIAL NEURAL NETWORKS AND DEEP LEARNING

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1: Analyze neural network architectures and learning mechanisms	3	3	-	2	-	-	-	-	-	-	2	-
CO2: Evaluate deep learning models for classification, regression, and pattern recognition	3	3	-	3	2	-	-	-	-	-	3	-
CO3: Analyze optimization techniques and regularization strategies in deep learning	3	3	-	3	-	-	-	-	-	-	3	-
CO4: Develop deep neural network models for real-world applications	3	3	3	3	2	-	-	-	-	-	3	-
CO5: Design scalable and efficient deep learning systems using modern frameworks	3	3	3	2	3	-	-	1	-	2	2	-

SL : ADVANCED EXCEL FOR DATA ANALYTICS

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1: Analyze datasets using advanced Excel functions and data analysis tools	3	3	-	2	3	-	-	-	-	-	-	-
CO2: Evaluate data quality and trends using pivot tables, charts, and dashboards	2	3	-	2	3	-	-	2	-	-	-	-
CO3: Analyze business problems using Excel-based statistical techniques	3	3	2	2	2	-	-	-	-	-	-	-
CO4: Develop automated analytical workflows using formulas, macros, and Power Query	2	3	3	2	3	-	-	-	-	-	-	-
CO5: Design Excel-based decision-support dashboards for real-world applications	3	3	3	2	3	-	-	2	-	2	-	-

SL : TABLEAU FOR DATA ANALYSIS												
Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1: Analyze datasets to identify patterns and insights for visual analytics	3	3	-	2	3	-	-	-	-	-	-	-
CO2: Evaluate visualization techniques for effective data storytelling	2	3	-	2	3	-	-	3	-	-	-	-
CO3: Analyze dashboard performance and usability for decision-making	2	3	-	2	2	-	-	2	-	-	-	-
CO4: Develop interactive dashboards using Tableau for business analytics	3	3	3	2	3	-	-	-	-	-	-	-
CO5: Design end-to-end visual analytics solutions for real-world datasets	3	3	3	2	3	-	-	2	-	2	-	-

SL : UNIX SHELL PROGRAMMING												
Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1: Analyze Unix file systems and command-line utilities for data handling	3	3	-	2	3	-	-	-	-	-	-	-
CO2: Evaluate shell commands and utilities for text processing and automation	2	3	-	2	3	-	-	-	-	-	-	-
CO3: Analyze system-level tasks using pipes, filters, and redirection	3	3	-	2	3	-	-	-	-	-	-	-
CO4: Develop shell scripts to automate data processing and system operations	2	3	3	2	3	-	-	-	-	-	-	-
CO5: Design robust shell-based solutions for real-world data and system management	3	3	3	2	3	-	-	1	-	2	-	-

SL : AGILE METHODOLOGIES FOR PROJECT MANAGEMENT												
Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1: Analyze Agile principles, frameworks, and roles	3	3	-	2	-	-	-	-	2	-	-	-
CO2: Evaluate Scrum, Kanban, and XP for project suitability	3	3	-	2	-	-	-	-	3	-	-	-
CO3: Analyze project risks, stakeholders, and sprint outcomes	3	3	-	3	-	-	2	-	3	-	-	-
CO4: Develop Agile project plans and sprint backlogs	2	3	3	2	-	-	-	-	3	-	-	-
CO5: Design Agile-based project management strategies	3	3	3	2	-	-	2	1	3	2	-	2

SL : SQL: ADVANCED CONCEPTS AND APPLICATIONS												
Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1: Analyze complex database schemas and relational structures	3	3	-	2	-	-	-	-	-	-	2	-
CO2: Evaluate query performance and optimization techniques	3	3	-	3	2	-	-	-	-	-	3	-
CO3: Analyze transactional data using advanced SQL constructs	3	3	-	2	3	-	-	-	-	-	2	-
CO4: Develop optimized SQL solutions for large-scale data processing	3	3	3	3	3	-	-	-	-	-	2	-
CO5: Design secure and efficient database queries for enterprise applications	3	3	3	2	3	2	-	1	-	2	2	-

SL : STATISTICAL ANALYSIS USING JAMOVI

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1: Analyze datasets using statistical methods through Jamovi software	3	3	-	2	3	-	-	-	-	-	2	-
CO2: Evaluate statistical test results for hypothesis testing and inference	3	3	-	3	2	-	-	-	-	-	3	-
CO3: Analyze relationships using correlation and regression techniques	3	3	-	2	2	-	-	-	-	-	2	-
CO4: Develop statistical models and reports using Jamovi outputs	3	3	2	2	3	-	-	2	-	-	2	-
CO5: Design data-driven analytical interpretations for research and business problems	3	3	3	2	2	-	-	1	-	2	3	-

SL : WEB SCRAPING WITH PYTHON

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1: Analyze web structures and data extraction techniques	3	3	-	2	-	-	-	-	-	-	2	-
CO2: Evaluate ethical and legal considerations in web data extraction	2	2	-	-	-	3	-	-	-	-	2	-
CO3: Analyze unstructured web data for preprocessing and storage	3	3	-	2	2	-	-	-	-	-	2	-
CO4: Develop automated web scraping pipelines using Python libraries	3	3	3	2	3	-	-	-	-	-	2	-
CO5: Design scalable data collection systems for analytics applications	3	3	3	2	3	-	-	1	-	2	2	-

SL : PYSPARK FOR BIG DATA AND ANALYTICS

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1: Analyze distributed data processing concepts using PySpark	3	3	-	2	-	-	-	-	-	-	2	-
CO2: Evaluate Spark transformations and actions for large-scale analytics	3	3	-	3	3	-	-	-	-	-	3	-
CO3: Analyze performance and scalability issues in Spark applications	3	3	-	3	2	-	-	-	-	-	3	-
CO4: Develop PySpark programs for real-time and batch processing	3	3	3	3	3	-	-	-	-	-	2	-
CO5: Design scalable analytics pipelines using Spark for Big Data environments	3	3	3	2	3	-	-	1	-	2	2	-

SL: MICROSOFT AZURE AI PLATFORM FOR AI BASED APPLICATION DEVELOPMENT

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1: Analyze Azure AI services and cloud-based AI architectures	3	3	-	2	-	-	-	-	-	-	2	-
CO2: Evaluate Azure ML tools for model development and deployment	3	3	-	3	3	-	-	-	-	-	3	-
CO3: Analyze cloud-based AI workflows for scalability and performance	3	3	-	3	2	-	-	-	-	-	3	-
CO4: Develop AI-enabled applications using Azure AI services	3	3	3	3	3	-	-	-	-	-	2	-
CO5: Design end-to-end cloud-based AI solutions for real-world applications	3	3	3	2	3	-	-	1	-	2	2	-

SL: BUSINESS INTELLIGENCE AND VISUALIZATION WITH POWER BI												
Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1: Analyze business datasets to identify KPIs and trends	3	3	-	2	3	-	-	-	-	-	-	-
CO2: Evaluate data models and transformations for BI reporting	3	3	-	2	3	-	-	-	-	-	-	-
CO3: Analyze interactive reports and dashboards for decision support	2	3	-	2	2	-	-	2	-	-	-	-
CO4: Develop dynamic Power BI dashboards integrating multiple data sources	3	3	3	2	3	-	-	-	-	-	-	-
CO5: Design enterprise-level BI solutions for strategic decision-making	3	3	3	2	3	-	-	2	-	2	-	-

GE1 : RESPONSIBLE AI AND DATA ETHICS												
Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1: Explain the principles and foundations of responsible AI and data ethics	3	2	-	2	-	2	-	-	-	1	1	-
CO2: Examine ethical challenges in data collection, privacy, and governance.	2	3	2	-	2	-	2	-	-	-	-	-
CO3: Analyze bias, fairness, and transparency issues in AI systems	3	3	-	2	2	-	-	-	-	-	-	-
CO4: Evaluate legal and policy frameworks governing AI and data usage	2	2	-	3	-	3	-	-	-	-	2	-
CO5: Design responsible AI solutions incorporating ethical and accountability principles.	3	3	3	3	2	-	2	-	-	2	2	-

GE2 : AI TOOLS FOR EVERYDAY PRODUCTIVITY												
Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1: Explain the role of AI tools in improving everyday productivity.	3	2	-	-	-	-	2	-	-	1	-	-
CO2: Apply AI-powered tools for writing, communication, and content creation	2	3	2	-	3	-	-	-	-	-	-	-
CO3: Analyze AI tools used for data organization and decision support.	2	3	-	2	3	-	-	-	-	-	-	-
CO4: Evaluate the effectiveness of AI tools for workflow automation and productivity improvement.	2	2	2	3	3	-	-	-	-	-	-	-
CO5: Design efficient workflows using multiple AI tools for real-world tasks	3	3	3	3	2	-	-	-	-	2	-	-

GE3 : DIGITAL MARKETING ANALYTICS												
Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1: Explain fundamental concepts of digital marketing and analytics.	3	2	-	-	-	-	2	-	-	1	-	-
CO2: Examine digital marketing metrics and performance indicators.	2	3	2	-	2	-	-	-	-	-	-	-
CO3: Analyze customer behavior using web and social media analytics.	3	3	-	2	3	-	-	-	-	-	-	-
CO4: Evaluate marketing campaign effectiveness using data-driven insights.	2	2	2	3	3	-	-	-	-	-	-	-
CO5: Design data-driven strategies to optimize digital marketing performance.	3	3	3	3	2	-	-	-	-	2	-	-

M.SC. DATA ANALYTICS POST GRADUATE DEGREE PROGRAM SYLLABUS

FIRST YEAR – SEMESTER I

CT1 : STATISTICS FOR DATA SCIENCE

C. No.	Course Code	Course category	Course Title	L	P/ RP	Total Credits	Total Hours
1	CDA25OCT01	CT	Statistics for Data Science	3	-	3	90

Particulars	Details (as per NCrF, 2023)	Four-Quadrant Component (as per UGC, 2020)
Course Number	1	
Course Code	CDA25OCT01	
Course Category	CT	
Course Title	Statistics for Data Science	
Course Credits	3	
Number of Units	12	
Number of Topics	36	
Number of Videos	36	Q1 – e-Tutorials (Video Lectures)
Self-Learning Material	200 Pages	Q2 – e-Content (Self-Learning Material)
Number of Discussion Forums	12	Q3 – Discussion Forum / Interactive Activities
Question Bank (MCQs, Short, Long answers)	1	Q4 – Assessment
Number of Assignments	2	Q4 – Assessment

Course Description:

This course introduces the fundamental concepts of Statistics for Data Science, focusing on statistical methods used for data analysis and interpretation. It covers descriptive statistics, probability, statistical inference, regression analysis, and data visualization techniques essential for analyzing real-world datasets. The course enables learners to apply statistical reasoning and analytical tools to support data-driven decision making in various application domains.

Learning Outcomes

At the end of the course, the student should be able to:

CO1: Analyze statistical fundamentals and experimental designs to interpret real-world datasets.

CO2: Evaluate data visualization techniques for effective exploratory data analysis and decision support.

CO3: Analyze and interpret datasets using appropriate statistical measures.

CO4: Evaluate probabilistic models to solve complex data-driven problems.

CO5: Design and justify statistical inference and regression models for analytical decision-making.

Unit	Topics	Specific Learning Objectives
Unit 1: Foundations of Statistics and Data Concepts	Introduction to statistics; Individuals and variables; Population and parameter; Types of variables: Quantitative, Categorical	Define statistical terminology, classify variable types, summarize distinctions between population and sample, analyze real-world datasets to identify appropriate statistical representations, and justify selection of variable types for analytical contexts.
Unit 2: Sampling Techniques and Errors	Sampling methods: Random, Stratified, Systematic, Cluster; Sampling errors	Describe probability and non-probability sampling structures, categorize sampling methods, compute sampling errors in practical scenarios, compare sampling strategies for bias control, and evaluate suitability of sampling designs for empirical studies.
Unit 3: Experimental Design and Bias Control	Experimental design; Avoiding bias in survey design; Randomization; Placebo effect; Blocked randomization; Blinding	Explain experimental design principles, outline randomization techniques, examine placebo and blinding mechanisms, construct unbiased experimental frameworks, and assess internal validity of survey-based investigations.
Unit 4: Tabular and Graphical Data Representation	Frequency tables, relative frequency tables, histograms, stem-and-leaf plots	Illustrate frequency distributions, prepare tabular summaries, construct graphical displays, interpret distributional shapes, and critique graphical effectiveness for exploratory data analysis.
Unit 5: Advanced Graphical Methods and Distribution Patterns	Time series graphs, bar graphs, Pareto charts, pie charts; Clusters, peaks, gaps, outliers	Identify graphical structures for categorical and time-based data, differentiate distributional patterns, detect anomalies, evaluate graphical appropriateness for decision support, and defend visualization choices analytically.

Unit	Topics	Specific Learning Objectives
Unit 6: Measures of Central Tendency	Mean, Median, Mode, Trimmed mean, Weighted average	Define measures of central tendency, compute appropriate averages for varied datasets, compare robustness across measures, analyze sensitivity to extreme values, and justify measure selection in applied contexts.
Unit 7: Measures of Dispersion and Relative Variation	Variance, Standard deviation, Coefficient of variation; Chebyshev's Theorem	Summarize dispersion metrics, calculate variance and standard deviation, apply Chebyshev's theorem to distribution bounds, interpret variability across datasets, and assess relative consistency using coefficient of variation.
Unit 8: Positional Measures and Bivariate Visualization	Percentiles, Interquartile Range (IQR), Box-and-Whisker plots, Scatter diagrams	Define positional statistics, construct box plots and scatter diagrams, examine spread and skewness, investigate relationships between variables, and interpret outliers in multivariate contexts.
Unit 9: Fundamental Probability Concepts	Theoretical probability; Sample spaces; Set operations; Experimental probability; Randomness and simulation	Describe probability foundations, formulate sample spaces, compute probabilities using set operations, simulate random experiments, and interpret probabilistic outcomes in applied decision scenarios.
Unit 10: Conditional Probability and Independence	Addition rule, Multiplication rule, Conditional probability, Independence	Explain conditional probability concepts, derive joint probabilities, assess independence between events, solve applied uncertainty problems, and validate probabilistic reasoning in data-driven models.
Unit 11: Statistical Inference and Sampling Distributions	Normal distribution; Empirical rule; Z-scores; Sampling distributions; Central Limit Theorem; t-test; ANOVA	Define normal distribution properties, compute Z-scores, interpret sampling distributions, apply Central Limit Theorem in estimation, conduct hypothesis testing using t-test and ANOVA, and evaluate statistical significance rigorously.
Unit 12: Correlation and Regression Modeling	Linear correlation; Linear regression; Least squares criterion; Coefficient of determination	Describe correlation measures, formulate regression equations, estimate parameters using least squares, interpret coefficient of determination, construct predictive models, and defend regression-based decisions analytically.

TEXTBOOK REFERENCES:

- Freedman, D., Pisani, R., Purves, R. – Statistics, 4th Edition, W.W. Norton & Company, 2007.
- Anderson, D.R., Sweeney, D.J., Williams, T.A. – Statistics for Business and Economics, 13th Edition, Cengage, 2019.
- Montgomery, D.C., Runger, G.C. – Applied Statistics and Probability for Engineers, 7th Edition, Wiley, 2021.
- Mann, P.S. – Introductory Statistics, 9th Edition, Wiley, 2017.
- Devore, J.L. – Probability and Statistics for Engineering and the Sciences, 9th Edition, Cengage, 2020.

CT2: DATA STRUCTURES AND ALGORITHMS

C. No.	Course Code	Course category	Course Title	L	P/RP	Total Credits	Total Hours
2	CDA25OCT02	CT	Data Structures and Algorithms	3	1	4	120

Particulars	Details (as per NCrF, 2023)	Four-Quadrant Component (as per UGC, 2020)
Course Number	2	
Course Code	CDA25OCT02	
Course Category	CT	
Course Title	Data Structures and Algorithms	
Course Credits	4	
Number of Units	16	
Number of Topics	42	
Number of Videos	42	Q1 – e-Tutorials (Video Lectures)
Self-Learning Material	250 Pages	Q2 – e-Content (Self-Learning Material)
Number of Discussion Forums	14	Q3 – Discussion Forum / Interactive Activities
Question Bank (MCQs, Short, Long answers)	1	Q4 – Assessment
Number of Assignments	2	Q4 – Assessment

COURSE DESCRIPTIONS:

This course introduces the fundamental concepts of **Data Structures and Algorithms**, focusing on efficient data organization and algorithm design for computational problem solving. It covers linear and non-linear data structures, algorithm analysis, searching and sorting techniques, and optimization strategies. The course enables learners to analyze algorithmic efficiency and implement suitable data structures for solving real-world computing problems.

Learning Outcomes

At the end of the course, the student should be able to:

CO1: Analyze algorithmic principles and data structures for computational efficiency.

CO2: Design and implement optimized linear data structures for problem solving.

CO3: Analyze and evaluate tree and graph structures for real-world computational applications.

CO4: Evaluate and optimize searching and sorting algorithms based on time and space complexity.

CO5: Design and analyze combinatorial optimization solutions using advanced algorithmic techniques.

Unit	Topics	Specific Learning Objectives
Unit 1: Algorithm Fundamentals and Characteristics	Algorithm definition, characteristics, types	Define algorithm properties, classify algorithm types, illustrate real-world examples, analyze structural components of algorithms, and justify characteristics required for correctness and efficiency.
Unit 2: Complexity Analysis and Asymptotic Notation	Time and space complexity; Big-O notation	Explain complexity measures, interpret asymptotic notation, compute time and space complexity of algorithms, compare growth rates analytically, and evaluate computational feasibility for large-scale problems.
Unit 3: Classification of Data Structures	Linear and Non-linear data structures	Differentiate linear and non-linear structures, categorize storage representations, examine operational characteristics, and assess suitability of structures for varied computational requirements.
Unit 4: Arrays and Multi-Dimensional Arrays	Array representation, operations, applications; multi-dimensional arrays	Describe array memory representation, perform insertion and deletion operations, construct multi-dimensional arrays, analyze computational efficiency, and apply arrays to structured data problems.
Unit 5: Singly Linked Lists	Representation, operations, applications	Outline singly linked list structure, implement traversal and update operations, compare with arrays, analyze pointer manipulation, and evaluate efficiency in dynamic memory contexts.
Unit 6: Doubly and Circular Linked Lists	Doubly and circular linked lists; operations and applications	Distinguish doubly and circular linked lists, execute insertion and deletion operations, examine bidirectional traversal, and appraise advantages in specific computational scenarios.

Unit	Topics	Specific Learning Objectives
Unit 7: Stacks and Applications	Push, pop; expression evaluation	Describe stack operations, demonstrate expression evaluation, construct stack-based solutions for recursive problems, and assess LIFO structures in algorithm design.
Unit 8: Queues and Variants	Simple queue, circular queue, priority queue, deque	Explain queue operations, differentiate queue variants, implement enqueue/ dequeue mechanisms, analyze scheduling applications, and justify queue selection for process management systems.
Unit 9: Tree Structures and Binary Trees	Binary tree representation; traversals (Inorder, Preorder, Postorder)	Define tree terminology, construct binary trees, perform traversal algorithms, analyze hierarchical data representation, and compare traversal strategies for data retrieval efficiency.
Unit 10: Binary Search Trees (BST)	BST operations and applications	Explain BST properties, execute insertion and deletion operations, analyze search efficiency, evaluate ordered data retrieval mechanisms, and justify BST usage in database indexing contexts.
Unit 11: Graph Representation and Traversal	Adjacency matrix, adjacency list; BFS and DFS	Describe graph representations, construct adjacency structures, perform BFS and DFS traversals, analyze connectivity properties, and compare traversal techniques for problem-solving tasks.
Unit 12: Graph Algorithms for Optimization	Minimum spanning tree (Prim's, Kruskal's); Shortest path (Dijkstra's)	Summarize MST and shortest path principles, implement Prim's and Kruskal's algorithms, apply Dijkstra's algorithm for path optimization, evaluate computational complexity, and defend algorithm selection for network optimization.
Unit 13: Searching and Sorting Techniques	Linear search, Binary search; Selection, Insertion, Merge, Quick sort	Describe searching and sorting methods, compute algorithmic complexity, implement divide-and-conquer techniques, compare algorithm stability and performance, and optimize sorting for practical datasets.
Unit 14: Hashing Techniques	Hash functions; collision resolution (chaining, open addressing)	Define hashing concepts, design hash functions, resolve collisions using chaining and open addressing, analyze load factor impact, and evaluate hashing efficiency in retrieval systems.

Unit	Topics	Specific Learning Objectives
Unit 15: Dynamic Programming and Greedy Methods	Fibonacci, 0/1 Knapsack; Huffman coding; Fractional knapsack	Explain dynamic programming principles, construct optimal substructure solutions, apply greedy strategies, compare optimality conditions, and assess performance trade-offs in combinatorial problems.
Unit 16: Backtracking and Branch & Bound	N-Queens; Hamiltonian circuit; Travelling Salesman Problem	Describe backtracking mechanisms, construct state-space trees, implement branch and bound strategies, analyze pruning techniques, and formulate optimized solutions for NP-hard problems.

TEXTBOOK REFERENCES:

- Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, Clifford Stein (2020). Introduction to Algorithms, 4rd Edition, The MIT Press
- Anany Levitin (2011). Introduction to the Design and Analysis of Algorithms, 3rd Edition, Addison Wesley.

OTHER REFERENCES:

- Ellis Horowitz, Sartaj Sahni and S. Rajasekharan, "Fundamentals of Computer Algorithms".
- Jon Kleinberg and Eva Tardos, "Algorithm Design", Pearson Education, 2006.
- Steven S Skiena, 'The Algorithm Design Manual', 2nd Edition, Springer, 2008.

CT 3 – Data Science with R

Course Number	Course Code	Course Category	Course Title	L	P	C	Total Hours
3	CDA25OCT03	CT	Data Science with R	3	1	4	120

Particulars	Details (as per NCrF, 2023)	Four-Quadrant Component (as per UGC, 2020)
Course Number	3	
Course Code	CDA25OCT03	
Course Category	CT	
Course Title	Data Science with R	
Course Credits	4	
Number of Units	16	
Number of Topics	48	
Number of Videos	48	Q1 – e-Tutorials (Video Lectures)
Self-Learning Material	275 Pages	Q2 – e-Content (Self-Learning Material)
Number of Discussion Forums	16	Q3 – Discussion Forum / Interactive Activities
Question Bank (MCQs, Short, Long answers)	1	Q4 – Assessment
Number of Assignments	2	Q4 – Assessment

Course Description

This course introduces the fundamentals of **Data Science using R**, focusing on statistical computing, data manipulation, and analytical workflows. It covers data structures in R, data preprocessing, exploratory data analysis, and visualization techniques using relevant R libraries. The course enables learners to develop predictive models and apply data-driven analytical methods to solve real-world data science problems.

Learning Outcomes

At the end of the course, the student should be able to:

CO1: Analyze R programming constructs for statistical and analytical workflows.

CO2: Evaluate statistical and analytical techniques implemented using R.

CO3: Analyze and interpret datasets through advanced visualization and exploratory analysis

CO4: Develop and evaluate predictive models using suitable performance metrics.

CO5: Design and implement data-driven solutions using real-world datasets in R.

UNIT	TOPICS	SPECIFIC LEARNING OBJECTIVES
Unit 1: R Environment and Basic Syntax	Overview of R and RStudio; Basic syntax; Operators; Data types	Identify components of the R environment, describe syntax rules and operators, classify data types, execute basic R scripts, and examine program flow for analytical tasks.
Unit 2: Core Data Structures in R	Vectors, Lists, Matrices, Data Frames, Factors	Define R data structures, differentiate their properties, construct structured datasets, manipulate elements programmatically, and assess suitability for statistical workflows.
Unit 3: Functions, Control Structures, and File Handling	User-defined functions; Conditional statements; Loops; Reading and writing data (CSV, Excel, text files)	Outline function components, implement control structures, import and export datasets, debug script logic, and develop modular R programs for reproducible analysis.
Unit 4: Data Importing and Wrangling	Importing data from multiple sources; dplyr, tidyr, readr	Describe data wrangling libraries, transform raw datasets using tidy principles, restructure variables programmatically, and optimize workflows for structured data preparation.
Unit 5: Data Cleaning and Transformation	Handling missing values and outliers; Data transformation and reshaping	Explain missing data mechanisms, implement imputation strategies, reshape datasets for analysis, evaluate transformation techniques, and justify preprocessing decisions analytically.
Unit 6: Data Integration Techniques	Merging, joining, filtering datasets	Define join types, perform dataset integration operations, analyze relational consistency, validate merged outputs, and construct unified analytical datasets.
Unit 7: Descriptive Statistics and Data Exploration	Summary statistics; Exploratory data analysis techniques	Compute descriptive measures, interpret distributional summaries, explore variable relationships, assess data quality, and synthesize preliminary analytical insights.

Unit 8: Visualization with ggplot2	Histogram, boxplot, scatterplot, bar plot, heatmaps	Describe grammar of graphics principles, construct layered visualizations, evaluate graphical clarity, interpret multivariate patterns, and refine plots for analytical communication.
Unit 9: Interactive and Dashboard Visualization	Interactive visualization; Dashboard creation	Illustrate interactive visualization concepts, design analytical dashboards, integrate visual components, assess user interaction effectiveness, and justify visualization design choices.
Unit 10: Probability Distributions and Sampling	Probability distributions; Sampling and resampling techniques	Summarize properties of probability distributions, simulate sampling processes, compare parametric and resampling approaches, and evaluate sampling variability in applied contexts.
Unit 11: Hypothesis Testing and Inferential Methods	t-test; Chi-square; ANOVA	Describe inferential test assumptions, conduct hypothesis tests in R, interpret p-values and confidence intervals, compare parametric procedures, and validate statistical conclusions.
Unit 12: Correlation and Regression Analysis	Correlation analysis; Linear regression	Compute correlation coefficients, construct regression models, assess model assumptions, interpret coefficients, and evaluate predictive validity statistically.
Unit 13: Time Series Fundamentals	Time series basics	Define time series components, visualize temporal trends, analyze seasonality and patterns, and formulate preliminary forecasting structures.
Unit 14: Introduction to Machine Learning in R	Overview of ML in R; Linear and logistic regression	Explain supervised learning concepts, implement regression-based models, compare classification and regression tasks, and assess predictive performance metrics.

Unit 15: Tree-Based Models and Ensemble Methods	Decision trees; Random forest	Describe tree construction principles, implement classification trees, evaluate ensemble performance, compare model interpretability, and optimize predictive accuracy.
Unit 16: Model Evaluation and Case Study Implementation	Confusion matrix; ROC; AUC; RMSE; Mini-project using real dataset	Define evaluation metrics, compute model performance indicators, compare predictive models empirically, construct data-driven solutions for real datasets, and defend model selection through evidence-based reasoning.

TEXTBOOK REFERENCES:

- Garrett Grolemund and Hadley Wickham, *R for Data Science*, O'Reilly Media, 2017.
- Norman Matloff, *The Art of R Programming*, No Starch Press, 2011.
- Jared P. Lander, *R for Everyone: Advanced Analytics and Graphics*, Addison-Wesley, 2014

OTHER REFERENCES:

- Robert Kabacoff, *R in Action*, Manning Publications, 2015.
- W. N. Venables and B. D. Ripley, *Modern Applied Statistics with S*, Springer, 2002.
- Prabhanjan Narayanachar Tattar et al., *Practical Data Science with R*, Packt Publishing, 2017.

CL1: ADVANCED PYTHON PROGRAMMING

C. No.	Course Code	Course category	Course Title	L	P/ RP	Total Credits	Total Hours/ Marks
5	CDA25OCL01	CL	Advanced Python Programming	-	3	3	90

Particulars	Details (as per NCrF, 2023)	Four-Quadrant Component (as per UGC, 2020)
Course Number	5	
Course Code	CDA25OCL01	
Course Category	CL	
Course Title	Advanced Python Programming	
Course Credits	3	
Number of Units	12	
Number of Topics	36	
Number of Videos	36	Q1 – e-Tutorials (Video Lectures)
Self-Learning Material	200 Pages	Q2 – e-Content (Self-Learning Material)
Number of Discussion Forums	12	Q3 – Discussion Forum / Interactive Activities
Question Bank (MCQs, Short, Long answers)	1	Q4 – Assessment
Number of Assignments	2	Q4 – Assessment

Course Description

This course focuses on advanced programming concepts in **Python for data science and machine learning applications**. It covers data preprocessing, numerical computing using NumPy, data manipulation with Pandas, and data visualization techniques. The course also introduces machine learning algorithms and practical implementation using Python libraries to develop end-to-end data analytics solutions.

Learning Outcomes

At the end of the course, the student should be able to:

CO1: Analyze data science environments and preprocessing techniques using Python.

CO2: Evaluate and manage structured data using NumPy and Pandas for analytical tasks.

CO3: Design effective static and interactive visualizations for communicating data insights.

CO4: Develop and evaluate machine learning models using Python-based algorithms.

CO5: Design and implement end-to-end data science or machine learning projects using Python.

Unit	Topics	Specific Learning Objectives
Unit 1: Python Distributions and Data Science Environments	Python distributions; Data science tools and environments; Jupyter Notebook; Spyder	Identify Python distributions and development environments, describe features of Jupyter and Spyder, configure analytical environments, examine tool compatibility, and justify environment selection for data science workflows.
Unit 2: Data Preparation, Normalization and Standardization	Data preparation and cleaning; Data normalization; Data standardization	Explain preprocessing techniques, implement normalization and standardization procedures, compare scaling approaches, evaluate data quality improvements, and validate preprocessing effectiveness for modeling tasks.
Unit 3: NumPy Fundamentals	NumPy arrays; Indexing; Array operations	Describe NumPy array structures, perform indexing and slicing operations, compute vectorized transformations, analyze computational efficiency, and optimize numerical processing tasks.
Unit 4: Pandas Data Structures and Operations	Pandas Series and DataFrame; Data operations; GroupBy	Define Pandas structures, manipulate structured datasets, perform aggregation using GroupBy, analyze tabular data programmatically, and assess performance in large datasets.
Unit 5: Quantitative and Qualitative Data Analysis	Structured data analysis using Pandas and NumPy	Classify quantitative and qualitative data, execute exploratory computations, interpret summary outputs, integrate analytical functions, and construct structured analytical pipelines.
Unit 6: Visualization using Matplotlib	Plotting curves; Scatter plots; Bar charts; Histograms; Box plots; Pie charts	Describe plotting principles, generate graphical representations, interpret distributional characteristics, compare visualization types, and refine graphical clarity for reporting purposes.

Unit 7: Advanced Visualization Tools	Seaborn visualizations; Built-in tools; Plotly; Cufflinks	Differentiate static and interactive visualization libraries, implement advanced plotting techniques, analyze multivariate visual outputs, evaluate visualization effectiveness, and justify tool selection for interactive dashboards.
Unit 8: Supervised Learning Models	Linear regression; Logistic regression; Support Vector Machine (SVM); Iris dataset	Explain regression and classification concepts, implement supervised models using Python libraries, assess classification boundaries, compare algorithm performance, and interpret predictive outputs using real datasets.
Unit 9: Model Evaluation Techniques	Accuracy prediction; Performance metrics	Define evaluation metrics, compute accuracy and related indicators, analyze model reliability, compare predictive results empirically, and validate classification performance statistically.
Unit 10: Unsupervised Learning Techniques	K-Means clustering; K-Nearest Neighbors (KNN)	Describe clustering and instance-based learning principles, implement K-Means and KNN algorithms, analyze distance-based classifications, compare clustering outcomes, and evaluate segmentation effectiveness.
Unit 11: TensorFlow and Computational Graphs	Basics of TensorFlow; Tensors; Computational graphs	Identify TensorFlow components, describe tensor operations, construct computational graphs, analyze model architecture workflows, and optimize deep learning computations using framework capabilities.
Unit 12: End-to-End Data Science Projects	Mini-projects using real-world datasets; Capstone project implementation	Plan project workflows, integrate preprocessing and modeling techniques, construct end-to-end machine learning solutions, evaluate project outcomes using performance metrics, and defend analytical decisions through systematic validation.

Textbooks

- Dr. R. Nageswara Rao, *Core Python Programming*, Dreamtech Press, 2nd Edition, 2021.
- Sebastian Raschka and Vahid Mirjalili, *Python Machine Learning*, Packt Publishing, 3rd Edition, 2020.
- Guido van Rossum et al., *Python Programming Manual*, Python Software Foundation Documentation, Latest Version.

Reference Books

- Jake VanderPlas, *Python Data Science Handbook: Essential Tools for Working with Data*, O'Reilly Media, 2nd Edition, 2022.
- Aurélien Géron, *Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow*, O'Reilly Media, 3rd Edition, 2023.

FIRST YEAR – SEMESTER II

CT 4: ADVANCED STATISTICS

C. No.	Course Code	Course category	Course Title	L	P/R P	Total Credits	Total Hours
7	CDA25OCT04	CT	Advanced Statistics	3	-	3	90

Particulars	Details (as per NCrF, 2023)	Four-Quadrant Component (as per UGC, 2020)
Course Number	7	
Course Code	CDA25OCT04	
Course Category	CT	
Course Title	Advanced Statistics	
Course Credits	3	
Number of Units	12	
Number of Topics	36	
Number of Videos	36	Q1 – e-Tutorials (Video Lectures)
Self-Learning Material	200 Pages	Q2 – e-Content (Self-Learning Material)
Number of Discussion Forums	12	Q3 – Discussion Forum / Interactive Activities
Question Bank (MCQs, Short, Long answers)	1	Q4 – Assessment
Number of Assignments	2	Q4 – Assessment

COURSE DESCRIPTION

This course provides advanced statistical methods for data analysis and predictive modeling. It covers regression models, logistic regression, clustering techniques, association analysis, and survival analysis for time-dependent data. The course enables learners to apply advanced statistical tools for inference, classification, segmentation, and decision-making in real-world analytical applications.

Learning Outcomes

At the end of the course, the student should be able to:

CO1: Analyze and evaluate regression models for prediction and inference.

CO2: Develop and validate logistic regression models for classification problems.

CO3: Analyze and assess clustering techniques to evaluate segmentation quality.

CO4: Evaluate association and correlation patterns to support analytical decision-making.

CO5: Apply and interpret survival analysis models for time-dependent data.

Unit	Topics	Specific Learning Objectives
Unit 1: Simple Regression Model	Simple regression model; Method of Least Squares	Define simple regression structure, explain least squares estimation, compute regression coefficients, analyze goodness-of-fit, and justify model suitability for linear relationships.
Unit 2: Multiple Regression Model	Multiple regression model; Estimation and prediction	Describe multiple regression framework, estimate parameters using least squares, construct prediction equations, evaluate multicollinearity issues, and assess predictive accuracy using statistical diagnostics.
Unit 3: Regression Model Evaluation	Analysis of variance; Testing usefulness of the model	Explain ANOVA in regression context, compute F-statistics, analyze model significance, evaluate hypothesis tests for coefficients, and validate overall model adequacy.
Unit 4: Advanced Regression Models	Polynomial regression model; Multivariate analysis of variance (MANOVA)	Define polynomial regression structure, construct higher-order models, analyze MANOVA framework, compare multivariate group effects, and justify model extensions for complex datasets.
Unit 5: Logistic Regression Fundamentals	The logistic model; Odds and odds ratios	Describe logistic function properties, compute odds and odds ratios, interpret categorical outcome modeling, analyze probability transformations, and evaluate classification capability.
Unit 6: Logistic Regression Model Development	Developing logistic regression model; Logistic regression using analytical tool	Construct logistic regression equations, estimate parameters using analytical tools, assess model fit statistics, interpret output results, and defend classification decisions statistically.

Unit	Topics	Specific Learning Objectives
Unit 7: Cluster Analysis Basics	Basics of cluster analysis; When to use cluster analysis; Key issues in clustering	Define clustering principles, classify clustering objectives, analyze assumptions and limitations, evaluate distance measures, and justify clustering applicability for segmentation tasks.
Unit 8: K-Means and Two-Step Cluster Analysis	K-Means clustering; Assumptions; Two-Step clustering; Assumptions	Explain K-Means algorithm steps, implement clustering using analytical tools, analyze cluster validity measures, compare Two-Step clustering framework, and evaluate assumption compliance critically.
Unit 9: Cluster Output and Interpretation	Outputs of cluster analysis; Cluster analysis using analytical tool	Interpret cluster outputs, examine centroids and cluster profiles, assess cluster stability, validate segmentation quality statistically, and formulate data-driven grouping strategies.
Unit 10: Association Rule Mining	Mining frequent patterns; Frequent itemset mining methods; Association rules	Define frequent itemsets and association rules, compute support and confidence, analyze rule strength, evaluate pattern significance, and justify rule relevance for decision-making.
Unit 11: Correlation and Pattern Evaluation	Correlation analysis using lift; Correlation using chi-square; Pattern evaluation methods; Mining using analytical tool	Explain lift and chi-square measures, compute correlation metrics, analyze statistical dependence, evaluate rule validity, and defend pattern usefulness through analytical interpretation.
Unit 12: Survival Analysis Models	Survival analysis basics; Kaplan-Meier analysis; Cox regression; Assumptions	Define survival analysis concepts, construct Kaplan-Meier survival curves, analyze hazard functions using Cox regression, evaluate proportional hazards assumptions, and design time-to-event models for longitudinal data.

TEXTBOOK REFERENCES:

- Statistical Inference by George Casella and Roger L. Berger
- Mathematical Statistics and Data Analysis by John A. Rice

REFERENCE BOOKS:

- All of Statistics: A Concise Course in Statistical Inference by Larry Wasserman.
- Kendall's Advanced Theory of Statistics series by Alan Stuart.

CT5: Advanced Database Management System

Course Number	Course Code	Course Category	Course Title	L	P	C	Total Hours
8	CDA25OCT05	CT	Advanced Database Management System	3	1	4	120

Particulars	Details (as per NCrF, 2023)	Four-Quadrant Component (as per UGC, 2020)
Course Number	8	
Course Code	CDA25OCT05	
Course Category	CT	
Course Title	Advanced Database Management System	
Course Credits	4	
Number of Units	12	
Number of Topics	36	
Number of Videos	36	Q1 – e-Tutorials (Video Lectures)
Self-Learning Material	275 Pages	Q2 – e-Content (Self-Learning Material)
Number of Discussion Forums	16	Q3 – Discussion Forum / Interactive Activities
Question Bank	1	Q4 – Assessment
Number of Assignments	2	Q4 – Assessment

COURSE DESCRIPTION

This course provides advanced concepts of database management systems with emphasis on database design, optimization, and management of large-scale data. It covers relational database architecture, SQL programming, query processing, transaction management, and data warehousing concepts. The course enables learners to design efficient database solutions and manage structured data for analytical and enterprise applications.

Learning Outcomes

At the end of the course, the student should be able to:

CO1: Analyze relational database architectures and data models.

CO2: Design normalized database schemas ensuring integrity and minimal redundancy.

CO3: Develop and optimize advanced SQL/PLSQL programs for complex data operations.

CO4: Evaluate transaction processing, concurrency control, and security mechanisms.

CO5: Implement and assess database solutions for real-time analytical applications.

UNIT	TOPICS	SPECIFIC LEARNING OBJECTIVES
Unit 1: Database Systems and Relational Model Concepts	File systems vs Database systems; Relational model concepts; Database schema; Keys	Define database system components, differentiate file and database systems, classify schema and key types, analyze relational model structure, and justify advantages of DBMS architecture.
Unit 2: Relational Operations and Query Languages	Relational operations; Formal relational query languages; Relational algebra; Relational calculus (Tuple & Domain)	Describe relational operations, formulate queries using relational algebra, construct tuple and domain relational calculus expressions, compare procedural and non-procedural query methods, and evaluate query correctness analytically.
Unit 3: Database Design and ER Modeling	Database design; ER diagram; Overview of commercial RDBMS packages	Identify ER components, construct ER diagrams, transform ER models into relational schemas, analyze design constraints, and justify database design decisions for enterprise applications.
Unit 4: Normalization Techniques	1NF, 2NF, 3NF, BCNF, 4NF, 5NF	Define normal forms, identify functional dependencies, decompose schemas systematically, evaluate redundancy elimination, and optimize relational structure for data integrity.
Unit 5: ACID Properties and Concurrency Fundamentals	ACID properties; Concurrency control fundamentals	Explain ACID components, analyze transaction behavior, examine concurrency challenges, evaluate consistency maintenance strategies, and justify transactional reliability mechanisms.
Unit 6: Structured Query Language (SQL) Fundamentals	SQL Commands: DDL, DML, DCL; Table fundamentals; Data constraints; Operators	Describe SQL command categories, construct DDL and DML statements, apply constraints for integrity enforcement, compute table-based operations, and validate query execution correctness.

UNIT	TOPICS	SPECIFIC LEARNING OBJECTIVES
Unit 7: Advanced SQL Queries	Functions; Grouping data; Subqueries; Joins; Dynamic SQL	Implement aggregate functions, construct complex joins and subqueries, analyze query nesting behavior, evaluate dynamic SQL execution, and optimize multi-table data retrieval strategies.
Unit 8: Database Objects and Optimization	Index; Views; Clusters; Sequence; Security management	Define database objects, construct indexes and views, analyze indexing impact on performance, evaluate security mechanisms, and optimize schema for efficient query processing.
Unit 9: PL/SQL Programming Concepts	OOPs in SQL; PL/SQL block structure; PL/SQL tables; Database objects	Describe PL/SQL architecture, construct procedural blocks, implement structured programming logic, integrate database objects, and develop modular database programs.
Unit 10: Cursor and Transaction Management in PL/SQL	Cursor management; PL/SQL transactions; PL/SQL security	Explain cursor types, implement explicit and implicit cursors, manage transaction control statements, analyze rollback and commit operations, and secure procedural database operations.
Unit 11: Transaction Processing and Recovery Mechanisms	Locking techniques; Time stamp ordering; Validation techniques; Recovery concepts; Shadow paging; Log-based recovery	Describe transaction processing models, compare concurrency control techniques, analyze recovery strategies, evaluate log-based mechanisms, and defend system reliability for ACID compliance.
Unit 12: MySQL Implementation and Administration	Introduction to MySQL; Installation; Data types; Server management; Database creation; Table operations; Query writing	Identify MySQL components, install and configure MySQL server, create and manage databases, construct tables and queries, analyze query execution results, and implement database solutions for real-time applications.

TEXTBOOK REFERENCES:

- Abraham Silberschatz, Henry Korth, S. Sudarshan, "Database Systems Concepts", 7th Edition, McGraw Hill
- Ramakrishnan and Gherke, "Database Management Systems", TMH

OTHER REFERENCES:

- Rajesh Narang "Database management System" PHI.
- R. Elmarsri and SB Navathe, "Fundamentals of Database Systems", Pearson
- Bipin Desai, "An Introduction to database Systems", Galgotia Publications

CT 6: Foundations of Data Analytics and Transformation Techniques

C. No.	Course Code	Course Category	Course Title	L	T	P/RP	Total Credits	Total Hours
9	CDA25OCT06	CT	Foundations of Data Analytics and Transformation Techniques	3	-	1	4	120

Particulars	Details	Four-Quadrant Component
Course Number	9	
Course Code	CDA25OCT06	
Course Category	CT	
Course Title	Foundations of Data Analytics and Transformation Techniques	
Course Credits	4	
Number of Units	12	
Number of Topics	36	
Number of Videos	36	Q1 – e-Tutorials (Video Lectures)
Self-Learning Material	250 Pages	Q2 – e-Content (SLM, PPT, Case Studies)
Number of Discussion Forums	16	Q3 – Discussion Forum
Question Bank	1	Q4 – Assessment
Number of Assignments	2	Q4 – Assessment

COURSE DESCRIPTION

This course introduces the fundamental concepts of data analytics, focusing on data preprocessing, transformation, and analytical techniques for structured and unstructured data. It covers data cleaning, data storage, descriptive analytics, predictive modeling, and dimensionality reduction methods. The course enables learners to transform raw data into meaningful insights for effective decision-making in real-world applications.

Learning Outcomes

At the end of the course, the student should be able to:

CO1: Analyze challenges associated with missing and inconsistent data in real-world datasets.

CO2: Evaluate data storage and transformation strategies for structured and unstructured data.

CO3: Analyze datasets using descriptive analytics and visualization techniques.

CO4: Develop and evaluate predictive models using regression-based techniques.

CO5: Assess high-dimensional data issues and apply dimensionality reduction techniques.

Unit	Topics	Specific Learning Objectives
Unit 1: Types of Data	Quantitative data; Qualitative data	Define quantitative and qualitative data, classify data types based on measurement scales, distinguish structured characteristics, analyze dataset composition, and justify data-type selection for analytical tasks.
Unit 2: Time Series Data and Real-World Challenges	Time series data; Challenges of real-world data	Describe characteristics of time series data, identify practical data challenges, examine irregularities in real-world datasets, evaluate impact on analytics, and propose corrective strategies.
Unit 3: Missing and Corrupted Data Handling	Missing data; Corrupted data	Define types of missing and corrupted data, detect inconsistencies in datasets, analyze causes of data loss, evaluate impact on analysis outcomes, and design corrective data handling procedures.
Unit 4: Data Cleaning and Imputation Techniques	Techniques of data cleaning; Data imputation	Explain cleaning methodologies, implement imputation techniques, compare imputation strategies, assess data integrity improvements, and validate preprocessing effectiveness statistically.
Unit 5: Data Storage Concepts	Data storage; Structured and unstructured data	Define storage models, differentiate structured and unstructured formats, analyze storage architecture requirements, evaluate scalability considerations, and justify appropriate storage solutions for analytics systems.

Unit	Topics	Specific Learning Objectives
Unit 6: Database Design for Analytics	Database design for structured and unstructured data	Describe database design principles, construct schemas for analytical systems, examine design constraints, evaluate integration challenges, and optimize database structures for transformation workflows.
Unit 7: ETL and Data Transformation Pipelines	Need for ETL; Examples of data transformations in real-world applications	Define ETL processes, construct transformation pipelines, analyze extraction and loading mechanisms, evaluate transformation logic, and implement real-world data transformation workflows.
Unit 8: Descriptive Analytics Foundations	Need for descriptive analytics; Applications of statistical techniques	Describe objectives of descriptive analytics, compute summary measures, interpret statistical outputs, analyze distributional characteristics, and justify analytical choices for business insights.
Unit 9: Data Visualization Techniques	Data visualization techniques	Identify visualization methods, construct graphical representations, analyze trends and patterns, evaluate clarity and interpretability of visuals, and refine visual communication strategies.
Unit 10: Predictive Analytics using Regression	Application of regression in predictive analytics	Define regression-based prediction models, construct regression equations, analyze predictive relationships, evaluate model performance, and defend predictive decisions using statistical evidence.
Unit 11: Regression Diagnostics	Multicollinearity; Variable influence; Heteroscedasticity in Linear Regression	Describe regression assumption violations, detect multicollinearity and heteroscedasticity, analyze variable influence, evaluate diagnostic statistics, and implement corrective measures to improve model validity.
Unit 12: High-Dimensional Data and Dimensionality Reduction	Problems of high dimensionality; Basics of dimensionality reduction	Define high-dimensional data challenges, examine curse of dimensionality effects, analyze feature redundancy, design dimensionality reduction approaches, and implement reduction strategies for improved model efficiency.



TEXTBOOK REFERENCES:

- Thomas S. D. and Andrew B. H. Fundamentals of Data Analytics, John Wiley & Sons, 1st edition (2020), ISBN-13: 978-1119462803, ISBN-10: 1119462803.
- Rafael A. Irizarry, Introduction to Data Science, CRC Press, 1st edition (2019), ISBN-13: 978-1138447567, ISBN-10: 113844756X.
- Wes McKinney, Python for Data Analysis: Data Wrangling with Pandas, NumPy, and IPython, O'Reilly Media, 2nd edition (2017), ISBN-13: 978-1491957660, ISBN-10: 1491957662.
- Nathan Hunter, Data Analytics: A Comprehensive Beginner's Guide to Learn Data Analysis, Data Science and Data Analytics, Wiley Global Education, 1st edition (2019), ISBN-13: 978-1119643051, ISBN-10: 1119643050.

Second Year – Semester III

CT 7 Natural Language Processing

C. No.	Course Code	Course category	Course Title	L	T	P/ RP	Total Credits	Total Hours
13	CDA25OCT07	CT	Natural Language Processing	3	-	1	4	120

Particulars	Details (as per NCrF, 2023)	Four-Quadrant Component (as per UGC, 2020)
Course Code	CDA25OCT07	
Course Title	Natural Language Processing	
Course Category	CT	
Course Credits	4	
Number of Units	14	
Number of Topics	40	
Number of Videos	40	Q1 – e-Tutorials (Video Lectures)
Self-Learning Material	250 Pages	Q2 – e-Content (SLM, PPT, Case Studies)
Number of Discussion Forums	16	Q3 – Discussion Forum
Question Bank	1 (MCQ + Short + Long)	Q4 – Assessment
Number of Assignments	2	Q4 – Assessment

COURSE DESCRIPTION:

This course introduces computational techniques for processing and analyzing human language data. It covers text preprocessing, word and document representations, deep learning models for NLP, and text classification methods. The course equips learners with skills to develop intelligent systems for applications such as text analytics, chatbots, and language translation.

Learning Outcomes

At the end of the course, the student should be able to:

- CO1:** Analyze computational challenges in natural language processing tasks.
- CO2:** Develop NLP algorithms using mathematical and engineering principles.
- CO3:** Evaluate NLP techniques using existing libraries for real-world applications.
- CO4:** Design and develop NLP-based systems to solve complex problems.
- CO5:** Design and implement NLP solutions collaboratively for real-world applications.



Unit	Topics	Specific Learning Objectives
Unit 1: Foundations of NLP and Text Corpus	Introduction to NLP; Text corpus (paragraphs, sentences, phrases)	Define Natural Language Processing concepts, classify text corpus structures, examine linguistic components, analyze corpus characteristics, and justify preprocessing requirements for NLP pipelines.
Unit 2: Text Preprocessing Techniques	Tokenization; Stop word removal	Describe tokenization strategies, identify stop words, implement text cleaning procedures, analyze preprocessing impact on model performance, and refine textual datasets for computational processing.
Unit 3: Morphological Processing and POS Tagging	Stemming; Lemmatization; Part-of-Speech (POS) tagging	Differentiate stemming and lemmatization, apply POS tagging methods, evaluate linguistic normalization techniques, analyze syntactic patterns, and optimize preprocessing workflows for structured feature extraction.
Unit 4: Word Embeddings	Word2Vec (CBOW, Skip-gram)	Define distributed word representations, compare CBOW and Skip-gram architectures, generate word embeddings, analyze semantic similarity, and evaluate embedding quality for downstream tasks.
Unit 5: Sentence and Document Embeddings	Sentence2Vec; Doc2Vec	Describe sentence and document embedding frameworks, construct embedding models, examine contextual representation differences, analyze document similarity, and justify embedding choice for large-scale text modeling.
Unit 6: Feature Engineering for NLP	Feature engineering techniques for NLP	Identify textual feature extraction methods, construct numerical feature sets, analyze dimensional representation, evaluate feature relevance, and design optimized feature pipelines for modeling.
Unit 7: Neural Network Foundations for NLP	Neural network basics; Activation functions	Explain neural network architecture, describe activation functions, construct feedforward models, analyze gradient behavior, and justify architectural choices for textual data processing.
Unit 8: CNN for Text Processing	Convolutional Neural Networks (CNN) for text	Describe CNN and RNN architectures, implement sequential modeling frameworks, analyze feature extraction in CNN, compare sequential learning mechanisms, and evaluate performance for text classification tasks.
Unit 9: RNN for Text Processing	Recurrent Neural Networks (RNN)	Describe CNN and RNN architectures, implement sequential modeling frameworks, analyze feature extraction in CNN, compare sequential learning mechanisms, and evaluate performance for text classification tasks.

Unit	Topics	Specific Learning Objectives
Unit 10: LSTM and Bidirectional LSTM	Long Short-Term Memory (LSTM); Bidirectional LSTM (Bi- LSTM)	Define LSTM cell structure, construct Bi-LSTM architectures, analyze long-term dependency modeling, evaluate sequence learning efficiency, and optimize deep learning models for contextual understanding.
Unit 11: Topic Modeling	Topic modeling (LDA, NMF)	Describe probabilistic topic modeling techniques, implement LDA and NMF models, analyze topic coherence, evaluate spam detection systems, and validate classification outcomes using empirical metrics.
Unit 12: Text Classification Applications	Spam detection; Comment filtering	Describe probabilistic topic modeling techniques, implement LDA and NMF models, analyze topic coherence, evaluate spam detection systems, and validate classification outcomes using empirical metrics.
Unit 13: Search, Deduplication and Text Summarization	Search systems; Deduplication; Text summarization	Identify search and deduplication strategies, construct summarization workflows, analyze redundancy detection mechanisms, evaluate summarization quality, and design NLP solutions for information retrieval systems.
Unit 14: Advanced NLP and Recent Research Trends	Neural Machine Translation; Chatbot evaluation; Detection of spam/offensive content; Transformers (BERT, GPT); Pretrained language models	Describe neural machine translation architecture, implement translation and chatbot evaluation methods, analyze offensive content detection frameworks, evaluate transformer-based models (BERT, GPT), and design advanced NLP solutions using pretrained language models for real-world datasets.

TEXTBOOK REFERENCES:

- Daniel Jurafsky and James H Martin, Speech and Language Processing: An Introduction to Natural Language Processing, Computational Linguistics, and Speech Recognition with language models.
- Steven Bird, Ewan Klein and Edward Loper, Natural language processing with python: Analyzing text with the natural language toolkit .

CT 8 – Big Data Analytics and Hadoop Ecosystem

Course Number	Course Code	Course Category	Course Title	L	T	P	C	Total Hours
14	CDA25OCT08	CT	Big Data Analytics and Hadoop Ecosystem	3	-	1	4	120

Particulars	Details	Four-Quadrant Component
Course Code	CDA25OCT08	
Course Title	Big Data Analytics & Hadoop Ecosystem	
Course Category	CT	
Course Credits	4	
Number of Units	16	
Number of Topics	48	
Number of Videos	48	Q1 – e-Tutorials
Self-Learning Material	250 Pages	Q2 – e-Content
Number of Discussion Forums	16	Q3 – Interactive Discussion
Question Bank	1	Q4 – Assessment
Number of Assignments	2	Q4 – Assessment

COURSE DESCRIPTION

This course introduces the principles and technologies used for processing and analyzing large-scale datasets. It focuses on Big Data characteristics, distributed computing frameworks, and the Hadoop ecosystem including HDFS, YARN, and MapReduce. The course enables learners to design scalable data processing solutions for data-intensive applications across various domains.

Learning Outcomes

At the end of the course, the student should be able to:

CO1: Analyze Big Data characteristics, architectures, and processing paradigms.

CO2: Evaluate statistical and probabilistic techniques for Big Data analytics.

CO3: Analyze Hadoop ecosystem components for scalable data processing.

CO4: Design and optimize MapReduce workflows for large-scale data analytics.

CO5: Evaluate and implement domain-specific Big Data solutions across industries.

Unit	Topics	Specific Learning Objectives
Unit 1: Foundations of Big Data	Big Data – Introduction; Characteristics; Types; Elements	Define Big Data concepts, classify data types and elements, describe core characteristics, analyze scalability challenges, and justify the need for distributed analytics frameworks.
Unit 2: Traditional vs Big Data Systems	Traditional vs Big Data; Business approach; Advantages; Applications	Differentiate traditional data systems from Big Data platforms, examine business-driven analytics strategies, evaluate benefits of Big Data technologies, and assess sector-specific applications analytically.
Unit 3: Distributed and Parallel Computing	Distributed computing; Parallel computing for Big Data	Describe distributed and parallel processing principles, analyze task partitioning strategies, evaluate computational efficiency, and design scalable processing workflows for large datasets.
Unit 4: Big Data Architecture and Virtualization	Components in Big Data architecture; Virtualization approaches	Identify architectural components, describe virtualization techniques, analyze infrastructure requirements, evaluate system reliability, and construct virtualized Big Data environments.
Unit 5: Statistical Foundations for Big Data	Sampling techniques; Data classification; Tabulation; Frequency representation	Explain sampling methodologies, classify datasets, construct tabular summaries, analyze distribution patterns, and interpret large-scale data characteristics statistically.
Unit 6: Probability and Central Tendency	Mean, Mode, Median; Random variables; Probability theory	Define measures of central value, compute summary statistics, describe random variables, apply probability principles, analyze uncertainty in datasets, and evaluate probabilistic modeling approaches.
Unit 7: Hadoop Fundamentals	Hadoop – Introduction; Features; Advantages; Versions; Key considerations	Describe Hadoop framework components, compare versions and features, analyze scalability factors, evaluate deployment considerations, and justify Hadoop adoption for Big Data management.
Unit 8: RDBMS vs Hadoop and Hadoop Ecosystem	RDBMS vs Hadoop; Hadoop ecosystem overview	Differentiate relational and distributed storage models, examine ecosystem tools, analyze storage and processing differences, and evaluate suitability for varied analytical workloads.
Unit 9: HDFS Architecture and Commands	HDFS architecture; Features; HDFS commands	Identify HDFS components, explain block storage mechanism, execute HDFS commands, analyze fault tolerance features, and evaluate distributed storage performance.

Unit	Topics	Specific Learning Objectives
Unit 10: Hadoop YARN and Data Processing	Processing data with Hadoop; Hadoop YARN	Describe YARN architecture, analyze resource management mechanisms, evaluate job scheduling processes, and implement distributed data processing tasks efficiently.
Unit 11: MapReduce Framework Fundamentals	MapReduce features; Uses; Working principle	Define MapReduce architecture, describe data flow between map and reduce phases, analyze task execution sequence, and evaluate its scalability for massive datasets.
Unit 12: MapReduce Input, Output and Functions	MapReduce input/output operations; Map and Reduce functions	Construct Map and Reduce functions, analyze intermediate key-value processing, evaluate data flow mechanisms, and optimize input-output configurations for performance improvement.
Unit 13: MapReduce Optimization Techniques	MapReduce optimization techniques	Identify performance bottlenecks, analyze task parallelism strategies, evaluate combiner and partitioner roles, and design optimized workflows for enhanced throughput.
Unit 14: HBase Architecture and Applications	HBase – Introduction; Architecture; HBase in Hadoop; Applications	Describe HBase data model, analyze integration with Hadoop, evaluate column-oriented storage advantages, and design scalable NoSQL solutions for high-volume applications.
Unit 15: MapReduce Task Execution and Environment	Task execution; Execution environment	Explain MapReduce task lifecycle, analyze execution environment components, evaluate distributed runtime behavior, and optimize deployment configurations for stability and efficiency.
Unit 16: Big Data Applications in Real-World Domains	Applications in retail, healthcare, finance, social media, IoT; Distributed architectures	Identify domain-specific Big Data use cases, implement distributed processing solutions, analyze virtualization-enabled architectures, evaluate performance across sectors, and design scalable solutions for enterprise-level deployment.

TEXTBOOK REFERENCES:

- Rob Kitchin The Data Revolution: Big Data Open Data Data Infrastructures And Their Consequences SAGE Publications Ltd
- Croll and B. Yoskovitz Lean Analytics: Use Data to Build a Better Startup Faster o’reilly
- Mayer-Schönberger and K. Cukier Big Data: A Revolution That Will Transform How We Live Work and Think

OTHER REFERENCES:

- E. Siegel-Predictive Analytics: The Power to Predict Who Will Click Buy Lie or Die
- Bernard Marr-Big Data in Practice Wiley publication.

CT 9 – Artificial Intelligence and Machine Learning Techniques

Course Number	Course Code	Course Category	Course Title	L	T	P	C	Total Hours
15	CDA25OCT09	CT	Artificial Intelligence and Machine Learning Techniques	3	-	1	4	120

Particulars	Details	Four-Quadrant Component
Course Code	CDA25OCT09	
Course Title	Artificial Intelligence & Machine Learning Techniques	
Course Category	CT	
Course Credits	4	
Number of Units	16	
Number of Topics	48	
Number of Videos	48	Q1 – e-Tutorials
Self-Learning Material	250 Pages	Q2 – e-Content
Number of Discussion Forums	16	Q3 – Discussion Forum
Question Bank	1	Q4 – Assessment
Number of Assignments	2	Q4 – Assessment

COURSE DESCRIPTION:

This course provides an overview of artificial intelligence concepts and machine learning methodologies used for intelligent data-driven systems. It covers problem-solving strategies, search algorithms, neural networks, supervised and unsupervised learning models, and soft computing techniques. The course enables learners to develop predictive models and intelligent systems for real-world applications.

Learning Outcomes

At the end of the course, the student should be able to:

CO1: Analyze AI concepts, intelligent systems, and emerging trends.

CO2: Evaluate problem-solving strategies using search and reasoning techniques.

CO3: Analyze neural architectures and learning mechanisms in AI systems.

CO4: Develop supervised and unsupervised learning models for classification and pattern recognition.

CO5: Design hybrid intelligent systems using fuzzy logic and genetic algorithms.

Unit	Topics	Specific Learning Objectives
Unit 1: Foundations of Artificial Intelligence	AI Introduction; AI problems; AI techniques	Define Artificial Intelligence concepts, classify AI problem categories, describe AI techniques, analyze intelligent agent characteristics, and justify AI approaches for real-world problem domains.
Unit 2: AI Applications and Trends	Characteristics of AI applications; Current trends in AI	Identify features of AI applications, describe emerging AI trends, examine deployment challenges, evaluate technological advancements, and assess their impact on intelligent systems.
Unit 3: Machine Learning Fundamentals	Machine learning overview; Design of a learning system	Explain components of a learning system, describe training and testing processes, analyze model development workflows, and evaluate learning system performance systematically.
Unit 4: Types and Applications of Machine Learning	Types of machine learning; Applications of machine learning	Classify supervised and unsupervised learning types, examine application domains, analyze use-case suitability, and justify algorithm selection for domain-specific solutions.
Unit 5: Probability Theory in AI	Variables and probabilities; Probability theory; Probability distributions	Define random variables, describe probability distributions, compute probabilistic measures, analyze uncertainty modeling, and apply probability principles in intelligent decision-making systems.
Unit 6: Problem Solving and Production Systems	General problem solving; Production systems; Control strategies	Describe production system components, differentiate control strategies, analyze state-space representation, evaluate rule-based reasoning models, and construct structured problem-solving frameworks.
Unit 7: Forward and Backward Chaining	Forward chaining; Backward chaining	Explain inference mechanisms, implement chaining algorithms, analyze reasoning efficiency, compare goal-driven and data-driven approaches, and optimize rule-based agent performance.
Unit 8: Uninformed Search Strategies	Breadth First Search (BFS); Depth First Search (DFS)	Define uninformed search methods, implement BFS and DFS algorithms, analyze search tree expansion, evaluate completeness and optimality, and compare algorithm efficiency.
Unit 9: Heuristic Search Techniques	Heuristic search; Greedy best-first search	Describe heuristic evaluation functions, construct greedy search algorithms, analyze search optimization strategies, evaluate heuristic accuracy, and design efficient solution search processes.

Unit 10: Knowledge Representation	Knowledge representation; Mapping; Issues in knowledge representation	Identify representation techniques, describe symbolic mapping approaches, analyze representation challenges, evaluate consistency and completeness, and design structured knowledge bases.
Unit 11: Soft Computing Foundations	Soft computing vs hard computing; Types of soft computing; Applications	Define soft computing paradigms, differentiate hard and soft computing approaches, classify soft computing techniques, analyze approximate reasoning mechanisms, and evaluate applications for complex problem-solving.
Unit 12: Neural Network Fundamentals	Human brain; Biological neural network; Evolution of ANN; Structure and function of neuron; ANN vs human brain	Describe biological neuron structure, explain artificial neuron models, differentiate ANN and biological networks, analyze learning mechanisms, and evaluate neural network capabilities.
Unit 13: Neural Network Architecture and Learning	Learning methods; Activation functions; Neural network architecture; Characteristics and applications of ANN	Classify network architectures, implement learning rules, analyze activation function behavior, evaluate network performance metrics, and design ANN models for predictive tasks.
Unit 14: Supervised and Unsupervised Neural Networks	Perceptron learning; Single-layer and multilayer networks; Backpropagation; Competitive learning; Kohonen Self-Organizing Networks	Construct perceptron models, implement backpropagation algorithms, analyze multilayer learning processes, evaluate competitive learning networks, and design classification systems using supervised and unsupervised methods.
Unit 15: Expert Systems and Fuzzy Logic	Expert systems; MYCIN case study; Fuzzy set theory; Operations on fuzzy sets; Properties of fuzzy sets	Describe expert system architecture, analyze MYCIN workflow, define fuzzy set operations, evaluate fuzzy inference mechanisms, and construct rule-based fuzzy reasoning systems.
Unit 16: Genetic Algorithms and Hybrid Systems	Genetic algorithm fundamentals; Encoding; Fitness function; Reproduction; Working principle	Define genetic algorithm components, implement encoding schemes, analyze fitness evaluation and reproduction strategies, evaluate convergence behavior, and design hybrid intelligent systems integrating fuzzy logic and genetic algorithms for optimization.

TEXTBOOK REFERENCES:

- Elaine Rich and Kevin Knight “Artificial Intelligence” – Tata McGraw Hill.
- Dan W. Patterson “Introduction to Artificial Intelligence and Expert Systems” Prentice India.
- Nils J. Nilson “Principles of Artificial Intelligence” Narosa Publishing House
- Christopher Bishop “Pattern Recognition and Machine Learning” Springer 5. Kevin P. Murphy “Machine Learning: A Probabilistic Perspective” MIT Press

OTHER REFERENCES:

- EthemAlpaydin “Introduction to Machine Learning” MIT Press
- Tom Mitchell “Machine Learning” McGraw–Hill
- Stephen Marsland “Machine Learning – An Algorithmic Perspective” Chapman and Hall/CRC Press 4. S Rajasekaran & G.A. VijayalakshmiPai Neural Networks Fuzzy Logic & Genetic Algorithms Synthesis & Applications PHI publication.

SECOND YEAR - SEMESTER IV

CT 10 – Advanced Cloud Computing

Course Number	Course Code	Course Category	Course Title	L	T	P	C	Total Hours
19	CDA25OCT10	CT 9	Advanced Cloud Computing	3	-	1	4	120

Particulars	Details (as per NCrF, 2023)	Four-Quadrant Component (as per UGC, 2020)
Course Code	CDA25OCT10	
Course Title	Advanced Cloud Computing	
Course Category	CT	
Course Credits	4	
Number of Units	16	
Number of Topics	48	
Number of Videos	48	Q1 – e-Tutorials (Video Lectures)
Self-Learning Material	250 Pages	Q2 – e-Content (SLM, PPT, Case Studies)
Number of Discussion Forums	16	Q3 – Discussion Forum / Interactive Activities
Question Bank	1 (MCQ + Short + Long)	Q4 – Assessment
Number of Assignments	2	Q4 – Assessment

COURSE DESCRIPTION:

This course introduces advanced concepts in cloud computing, including cloud architectures, virtualization, and service deployment models. It explores cloud platforms, data storage systems, and application development in cloud environments. The course prepares learners to design and manage scalable cloud-based solutions for modern data analytics applications.

Learning Outcomes

At the end of the course, the student should be able to:

- CO1:** Analyze cloud computing architectures and deployment models.
- CO2:** Evaluate virtualization techniques for efficient cloud resource management.
- CO3:** Design, deploy, and evaluate cloud-based applications using commercial platforms.
- CO4:** Analyze cloud-based data storage architectures and file systems.
- CO5:** Evaluate cloud service models, operational practices, and ethical considerations.

Unit	Topics	Specific Learning Objectives
Unit 1: Foundations of Cloud Computing	Definition; History; Importance; Characteristics; Pros & Cons	Define cloud computing concepts, describe historical evolution, classify key characteristics, analyze advantages and limitations, and justify cloud adoption for enterprise environments.
Unit 2: Cloud Technologies and Infrastructure	Cloud computing technologies; Cloud infrastructure	Identify core cloud technologies, describe infrastructure components, analyze resource provisioning mechanisms, evaluate scalability features, and design foundational cloud environments.
Unit 3: Types of Cloud and Deployment Models	Public, Private, Community, Hybrid Clouds; Deployment models	Classify cloud types and deployment models, compare architectural differences, analyze use-case suitability, evaluate security implications, and recommend appropriate deployment strategies.
Unit 4: Cloud Service Models	Cloud service models (Infrastructure, Platform, Software)	Define service models, differentiate IaaS, PaaS, and SaaS, analyze service-level responsibilities, evaluate cost-performance trade-offs, and justify service model selection for applications.
Unit 5: Virtualization Fundamentals	Virtualization characteristics; Benefits; Virtualization in cloud computing	Describe virtualization principles, explain resource abstraction mechanisms, analyze benefits in cloud environments, evaluate performance implications, and design virtualized resource pools.
Unit 6: Hypervisors and Multitenancy	Hypervisors; Multitenancy; Types of tenancy; Virtualization architecture	Define hypervisor types, describe multitenancy concepts, classify tenancy models, analyze virtualization architecture, and assess tenant isolation strategies for secure operations.
Unit 7: Virtual Infrastructure and Resource Virtualization	CPU virtualization; Network virtualization; Storage virtualization	Explain CPU, network, and storage virtualization, analyze resource allocation mechanisms, evaluate efficiency improvements, and implement virtual infrastructure configurations.
Unit 8: Advanced Virtualization Environments	Clustering; Grid computing; Virtualization tools (VMware, Eucalyptus, CloudSim, OpenNebula)	Describe clustering and grid computing concepts, implement virtualization tools, analyze tool capabilities, evaluate simulation environments, and optimize cloud resource management using appropriate platforms.
Unit 9: Cloud Application Platforms	Application platforms; Tools for building cloud applications	Identify cloud development platforms, describe application building tools, analyze deployment pipelines, evaluate platform capabilities, and design scalable cloud-native applications.

Unit	Topics	Specific Learning Objectives
Unit 10: Programming and Migration in the Cloud	Programming in the cloud; Moving applications to cloud	Explain cloud programming models, implement migration strategies, analyze compatibility challenges, evaluate performance after migration, and optimize application deployment in cloud environments.
Unit 11: Commercial Cloud Platforms	Microsoft Azure; Google Cloud applications (Gmail, Calendar, Docs, Video)	Describe features of major commercial cloud platforms, analyze service integration mechanisms, evaluate productivity tools, and deploy applications using enterprise cloud services.
Unit 12: Enterprise Data Storage Systems	DAS; SAN; NAS; Enterprise data storage management	Define enterprise storage models, differentiate DAS, SAN, and NAS, analyze storage architecture suitability, evaluate performance characteristics, and design enterprise storage solutions.
Unit 13: Cloud Storage and File Systems	Cloud file systems; FAT; NTFS; Data storage management	Describe file system structures, compare FAT and NTFS, analyze cloud file system integration, evaluate storage management practices, and implement secure data storage strategies.
Unit 14: Cloud Computing Services Overview	Cloud computing elements; Understanding services and applications by types	Identify cloud service elements, classify web-based and infrastructure services, analyze service orchestration models, evaluate operational efficiency, and design service-oriented cloud solutions.
Unit 15: On-Demand and Web-Based Services	On-demand computing; Web-based services; Other cloud services	Describe on-demand computing principles, implement web-based service deployment, analyze service scalability, evaluate cost models, and optimize cloud-based service delivery.
Unit 16: Cloud Governance and Operational Practices	Cloud Do's and Don'ts; Operational practices; Ethical considerations	Define best practices in cloud operations, analyze governance policies, evaluate ethical and security implications, and develop secure, compliant, and efficient cloud management strategies.

TEXTBOOK REFERENCES:

- Raj Kumar Buyya James Broberg andrezei M.Goscinski –Cloud Computing: Principles and Paradigms–Wiley 2011.
- Srinivasan J.Suresh–Cloud Computing – a Practical Approach for Learning and Implementation Pearson India [ISBN–978131776513]



REFERENCE BOOKS:

- Toby Velte Anthony Velte Robert Elsenpeter–Cloud Computing a Practical Approach – McGraw Hill 2010 [ISBN: 0071626948]
- Greg Schulz –Cloud and Virtual Data Storage Networking Auerbach Publications [ISBN: 978- 1439851739].
- Marty Poniatowski–Foundations of Green IT- [ISBN: 978-0137043750].
- Ravi Kant Soni Learning Spring Application Development Packt Publishing.
- Michael Miller Cloud Computing 2008.

AE1: Research Methodology

C. No.	Course Code	Course category	Course Title	L	T	P/ RP	Total Credits	Total Hours
17	CDA25OAE01	AE	Research Methodology	2	-	-	2	60

Particulars	Details	Four-Quadrant Component
Course Code	CDA25OAE01	
Course Title	Research Methodology	
Course Category	AE	
Course Credits	2	
Number of Units	8	
Number of Topics	24	
Number of Videos	24	Q1 – e-Tutorials
Self-Learning Material	120 Pages	Q2 – e-Content
Number of Discussion Forums	8	Q3 – Interactive Sessions
Question Bank	1	Q4 – Assessment
Number of Assignments	1	Q4 – Assessment

COURSE DESCRIPTION:

This course provides an introduction to research principles, methods, and techniques used in scientific investigations. It covers research design, data collection methods, hypothesis formulation, statistical analysis, and research ethics. The course enables learners to conduct systematic research and prepare scholarly reports and research publications

Learning Outcomes

At the end of the course, the student should be able to:

CO1: Analyze research concepts, objectives, and processes.

CO2: Design research problems and methodologies with appropriate sampling strategies.

CO3: Evaluate ethical data collection methods for research studies.

CO4: Analyze and interpret quantitative and qualitative research data.

CO5: Design research reports and evaluate emerging research methodologies.

Unit	Topics	Specific Learning Objectives
Unit 1: Fundamentals of Research	Meaning and objectives of research; Types of research: Basic, Applied, Descriptive, Analytical, Qualitative, Quantitative	Define research terminology, classify major types of research, illustrate objectives of scientific inquiry, analyze characteristics of qualitative and quantitative approaches, and evaluate appropriate research types for academic investigations.
Unit 2: Research Process and Problem Formulation	Research process; Problem identification and formulation; Literature review; Identifying research gaps	Describe stages of the research process, formulate research problems from literature sources, analyze scholarly studies to identify research gaps, and justify research directions for investigation.
Unit 3: Research Design	Exploratory, Descriptive, and Experimental research design	Classify research design types, compare exploratory, descriptive, and experimental designs, construct suitable research frameworks, and evaluate design choices for empirical studies.
Unit 4: Hypothesis Formulation and Sampling	Research objectives and hypothesis; Sampling techniques: Probability and Non-probability sampling	Formulate research objectives and hypotheses, distinguish probability and non-probability sampling techniques, select appropriate sampling strategies, and evaluate sampling adequacy for reliable research outcomes.
Unit 5: Data Collection Methods	Primary and secondary data; Surveys, interviews, questionnaires, observation	Differentiate primary and secondary data sources, implement appropriate data collection methods, design structured instruments such as questionnaires, and analyze methodological suitability for research problems.
Unit 6: Measurement, Reliability, and Ethics	Measurement scales; Reliability and validity; Ethical considerations in research	Classify measurement scales used in research, evaluate reliability and validity of research instruments, implement ethical guidelines in data collection, and justify responsible research practices.
Unit 7: Data Analysis and Interpretation	Descriptive statistics: Mean, Median, Mode, SD; Inferential statistics: t-test, Chi-square, ANOVA, Correlation, Regression; Use of software (R, SPSS, Python)	Apply statistical techniques for research analysis, interpret descriptive and inferential statistical results, analyze relationships among variables, and evaluate analytical outputs using statistical software tools.

Unit	Topics	Specific Learning Objectives
Unit 8: Research Reporting and Emerging Trends	Structure of research report; Referencing styles (APA, MLA, Chicago); Tables, graphs, charts; Qualitative research, case studies, mixed-method research; Current research trends	Construct structured research reports, apply standardized referencing styles, present analytical findings using tables and charts, critique qualitative and mixed-method research approaches, and evaluate emerging trends in research methodology.

TEXTBOOK REFERENCES:

- Kothari, C.R. – Research Methodology: Methods and Techniques, 3rd Edition, New Age International, 2021.
- Creswell, J.W. – Research Design: Qualitative, Quantitative, and Mixed Methods Approaches, 5th Edition, Sage Publications, 2018.
- Nachmias, D., Nachmias, C. – Research Methods in the Social Sciences, 9th Edition, Routledge, 2020.
- Sekaran, U., Bougie, R. – Research Methods for Business: A Skill-Building Approach, 8th Edition, Wiley, 2020.

RP1: Research Project 1

C. No.	Course Code	Course category	Course Title	L	T	P/ RP	Total Credits	Total Hours
21	CDA25ORPO1	RP1	Research Project	-	-	12	12	360

During the fourth semester, students work on their individual research, with a duration of fifteen weeks. These projects focus on topics within their specific disciplinary program or on interdisciplinary subjects. The outcomes of their work are aimed at publications in peer-reviewed journals and presentations at conferences, or potential patents.

Research work serves as an opportunity for students to implement computer science concepts through software or hardware applications, addressing real-time problems or exploring innovative solutions. The project / research work is undertaken under the guidance of experienced experts from various organizations, including research laboratories, renowned academic institutions, or industries in India or abroad. Students may also opt to work under the guidance of internal faculty members, ensuring flexibility and accessibility in mentoring while maintaining high academic standards.

The evaluation of the research work is conducted by a panel constituted by the parent department. This panel comprises two internal faculty members, ensuring a balanced and thorough review. One faculty member is selected from the student's parent department to provide subject-specific insights, while the other represents a different specialization within Sri Ramachandra Faculty of Engineering and Technology. This diverse evaluation process ensures a comprehensive assessment of the project, considering both technical depth and interdisciplinary perspectives.

The performance evaluation in continuous internal assessment (CIA) comprises of three components, first component is review 1 for 20 marks, and the second component is review 2 for 20 marks. A student is not allowed to appear for the final review and considered as fail if he/she has not secured minimum of 20 marks.

First two components are assessed for 20 marks each, and the final review assessed for 60 marks. The evaluation pattern for project courses (PR) is as follows:

- Continuous evaluation of project /research course is assessed for 40 marks.
- Report submission is assessed for 10 marks.
- Conference presentation /publication for 10 marks
- The project assessment is evaluated for 40 marks.

Scheme for continuous internal assessments			
For Major Project Course			
Component 1	Component 2	Component 3	Total weightage
Review -1 Basic Research Survey, Problem Statement and Proposed Solution, Knowledge Needed for the project on tools and techniques, Clarity of Workflow/Proposed Methodology, and	Review -2 Innovation Usage of modern tools/ technology Presentation: Communication and PPT content Learning from resources	Final Review Objective/Task and Approach Formulation / Design Methodology Learning from resources Usage of modern tool / technology Implementation Real time Testing	W: 100
Presentation (conducted for 4 marks each)	Work Progress and Quality of Project Work	Result / Outcome Future scope	
(W: 20)	(conducted for 4 marks each) (W: 20)	Broader Impact of the work Comprehension Communication Presentation & content (W:40) Project Report (10 marks) (W: 10) Reputed National/ International Conference Or Journal publication Or Patent Publication (W: 10)	

PROJECT ASSESSMENT

Each major project is for a period of fifteen weeks.

The major project is assessed as mentioned in previous table based on project report, publication and oral presentation and of the student.

The project course (RP) is evaluated for 100 marks as follows:

- Objective/Task and Approach (10 marks) Formulation / Design (5 marks)
- Methodology (5 marks)
- Learning from resources (10 marks)
- Usage of modern tool / technology (10 marks) Implementation (10 marks)
- Real time Testing (10 marks) Result / Outcome (10 marks) Future scope (5 marks)
- Broader Impact of the work (5 marks) Comprehension (5 marks)
- Communication (5 marks) Presentation & content (10 marks)

The total of 100 marks is converted to 40 marks (weightage 40). The minimum requirement for passing an project course is 50 marks that has to be secured in CIA as mentioned in previous table.

Scheme for continuous internal assessments			
For Research Work			
Component 1	Component 2	Component 3	Total weightage
Review -1 Basic Research Survey, Problem Statement and Proposed Solution , Knowledge Needed for the research techniques, Clarity of Workflow/ Proposed Methodology, and Presentation (conducted for 4 marks each) (W: 20)	Review -2 Innovativeness Usage of modern tool/ technology Presentation : Communication and PPT content Learning from resources Work Progress and Quality of Research Work (conducted for 4 marks each) (W: 20)	Final Viva-voce Aim and Objectives Introduction Review of Literature Methodology Results / Outcome Discussion Future Scope Presentation & content (W:40) Dissertation (W: 10) Reputed National/ International Conference Or Journal publication Or Patent Publication (W: 10)	W: 100

The research work is assessed as mentioned in previous table based on Dissertation, publication and oral presentation and of the student.

If a student fails in the major project / research work course, he/she may complete it in the subsequent semesters within the stipulated maximum duration for the award of degree.

SPECIALIZATION ELECTIVE COURSES

DE: Ensemble Learning for Predictive Analytics

Specialization Elective								
C. No.	Course Code	Course category	Course Title	L	T	P/ RP	Total Credits	Total Hours
1	CDA25ODE01	DE	Ensemble Learning for Predictive Analytics	3	-	1	4	120

Particulars	Details (as per NCrf, 2023)	Four-Quadrant Component (as per UGC, 2020)
Course Code	CDA25ODE01	
Course Title	Ensemble Learning for Predictive Analytics	
Course Category	DE (Specialization Elective)	
Course Credits	4	
Number of Units	16	
Number of Topics	48	
Number of Videos	48	Q1 – e-Tutorials (Recorded Video Lectures)
Self-Learning Material	250 Pages	Q2 – e-Content (SLM, Case Studies, Research Papers, Code Examples)
Number of Discussion Forums	16	Q3 – Discussion Forum / Case-based Interactive Sessions
Question Bank	1 (MCQ + Short + Analytical Questions)	Q4 – Assessment
Number of Assignments	2 (Model Implementation + Case Study)	Q4 – Assessment

COURSE DESCRIPTION:

This course introduces ensemble learning techniques used to improve predictive performance in machine learning models. It covers methods such as bagging, boosting, random forests, and stacking for classification and regression problems. The course enables learners to build robust predictive models by combining multiple algorithms to enhance accuracy and reduce model variance.

Learning Outcomes

At the end of the course, the student should be able to:

CO1: Analyze the principles and assumptions of ensemble learning methods for predictive modeling.

CO2: Evaluate the performance of bagging, boosting, and stacking techniques for different data scenarios.

CO3: Analyze bias–variance trade–offs in ensemble–based predictive models.

CO4: Develop and optimize ensemble models for high–accuracy prediction tasks.

CO5: Design ensemble–based solutions for real–world predictive analytics applications.

Unit	Topics	Specific Learning Objectives
Unit 1: Supervised Learning Foundations	Overview of supervised learning; Linear regression (Simple & Multiple); Least squares	Define supervised learning framework, derive least squares estimation, implement simple and multiple regression models, analyze model assumptions, and evaluate predictive performance.
Unit 2: Regularized Linear Models	Ridge regression; Lasso regression; Elastic Net; Regularization and feature selection	Compare regularization techniques, analyze shrinkage effects, implement Ridge, Lasso, and Elastic Net models, evaluate feature selection behavior, and justify model selection under multicollinearity.
Unit 3: Linear Classification Methods	Logistic regression and extensions; Perceptron learning algorithm	Formulate logistic regression models, implement perceptron learning, analyze decision boundaries, evaluate classification metrics, and compare linear classifiers for predictive accuracy.
Unit 4: Model Assessment and Selection	Bias, variance, model complexity; Bias–variance tradeoff; Training vs. test error; Generalization error	Analyze bias–variance tradeoff, evaluate generalization performance, compare training and testing errors, assess model complexity, and optimize predictive reliability.
Unit 5: Cross–Validation and Hyperparameter Optimization	K–fold; LOOCV; Bootstrap; Grid search; Random search	Implement cross–validation strategies, compare error estimation methods, conduct hyperparameter tuning using grid and random search, evaluate robustness, and optimize model parameters.
Unit 6: Information Criteria and Bayesian Selection	AIC; BIC; Bayesian model selection	Compute information criteria, compare model selection metrics, analyze likelihood–based evaluation, evaluate Bayesian selection principles, and select optimal predictive models.

Unit	Topics	Specific Learning Objectives
Unit 7: Additive Models and Tree-Based Methods	Generalized Additive Models (GAM); Regression and classification trees	Construct GAM models, implement regression and classification trees, analyze splitting criteria, evaluate interpretability, and assess predictive stability.
Unit 8: Bagging and Random Forests	Bagging; Random forests; Feature importance	Implement bagging algorithms, construct random forest models, analyze variance reduction, evaluate feature importance measures, and assess ensemble robustness.
Unit 9: Boosting Techniques	AdaBoost; Gradient Boosting; XGBoost; LightGBM; CatBoost; Model interpretation	Compare boosting frameworks, implement gradient boosting variants, analyze sequential learning strategies, evaluate overfitting control, and interpret ensemble model outputs.
Unit 10: Neural Networks for Prediction	Architecture; Activation functions; Optimization; Backpropagation; Stochastic gradient descent	Describe neural network architecture, implement backpropagation algorithm, analyze activation functions, evaluate optimization techniques, and assess predictive performance.
Unit 11: Training Challenges in Neural Networks	Overfitting; Vanishing gradients; Regularization (Dropout, BatchNorm)	Analyze training issues in deep learning, evaluate gradient instability problems, implement regularization strategies, and optimize network generalization.
Unit 12: Support Vector Machines and KNN	SVM for classification and regression; Kernel trick; RKHS; K-Nearest Neighbor	Formulate SVM optimization problems, apply kernel functions, analyze RKHS concepts, implement KNN algorithms, and compare distance-based and margin-based classifiers.
Unit 13: Unsupervised Learning and Association Mining	Association rule mining (Apriori, FP-Growth); Cluster analysis (K-Means, Hierarchical, DBSCAN, GMM)	Implement association rule algorithms, evaluate support and confidence metrics, construct clustering models, analyze cluster validity, and interpret unsupervised learning outcomes.
Unit 14: Dimensionality Reduction Techniques	PCA; t-SNE; UMAP	Derive principal component transformations, implement nonlinear embedding methods, analyze variance preservation, evaluate visualization quality, and optimize dimensionality reduction workflows.
Unit 15: Time Series Forecasting	ARIMA; SARIMA; Prophet; LSTMs	Develop ARIMA and SARIMA models, implement forecasting frameworks, analyze seasonality and trends, evaluate deep learning approaches (LSTM), and compare forecasting accuracy.



TEXTBOOK REFERENCES:

- Fundamentals of Machine Learning for Predictive Data Analytics, second edition: Algorithms, Worked Examples, and Case Studies 2nd Edition by John D. Kelleher , Brian Mac Namee , Aoife D’Arcy.
- Trevor Hastie, Robert Tibshirani, Jerome Friedman, The Elements of Statistical Learning–Data Mining, Inference, and Prediction, Second Edition, Springer Verlag, 2009.
- Müller, A. C., & Guido, S. (2016). “Introduction to Machine Learning with Python: A Guide for Data Scientists”

DE: TIME SERIES ANALYTICS AND FORECASTING

Specialization Elective								
C. No.	Course Code	Course category	Course Title	L	T	P/ RP	Total Credits	Total Hours
2	CDA25ODE02	DE	Time Series Analytics and Forecasting	3	-	1	4	120

Particulars	Details (as per NCeF, 2023)	Four-Quadrant Component (as per UGC, 2020)
Course Code	CDA25ODE02	
Course Title	Time Series Analytics and Forecasting	
Course Category	DE (Specialization Elective)	
Course Credits	4	
Number of Units	16	
Number of Topics	48	
Number of Videos	48	Q1 – e-Tutorials (Recorded Video Lectures)
Self-Learning Material	250 Pages	Q2 – e-Content (SLM, Case Studies, Python/R Implementation, Research Articles)
Number of Discussion Forums	16	Q3 – Discussion Forum / Data Analysis Activities
Question Bank	1 (MCQ + Short + Analytical Questions)	Q4 – Assessment
Number of Assignments	2 (Forecasting Model Implementation + Case Study)	Q4 – Assessment

COURSE DESCRIPTION:

This course focuses on the analysis and forecasting of time-dependent data using statistical and machine learning methods. Topics include time series components, smoothing techniques, ARIMA models, and forecasting evaluation methods. The course equips learners with analytical skills to model temporal patterns and generate accurate forecasts for real-world applications.



Learning Outcomes

At the end of the course, the student should be able to:

CO1: Analyze time series characteristics such as trend, seasonality, and autocorrelation.

CO2: Evaluate statistical and machine learning models for time series forecasting.

CO3: Analyze stationarity and transformation techniques for temporal data modeling.

CO4: Develop and validate forecasting models for real-world temporal datasets.

CO5: Design end-to-end forecasting solutions for business and industrial applications.

Unit	Topics	Specific Learning Objectives
Unit 1: Foundations of Time Series Analysis	Definition and importance; Applications (finance, energy, traffic, healthcare); Challenges (non-stationarity, seasonality, irregular data)	Define time series concepts, classify application domains, analyze temporal data characteristics, evaluate forecasting challenges, and justify preprocessing requirements for structured time-dependent data.
Unit 2: Types of Time Series and Data Preprocessing	Univariate vs. multivariate time series; Handling missing values (resampling, interpolation, imputation)	Differentiate univariate and multivariate series, analyze missing data patterns, implement resampling and interpolation methods, evaluate imputation techniques, and prepare clean datasets for modeling.
Unit 3: Time Series Visualization and Pattern Recognition	Line plots, scatter plots, bar plots, area plots, heatmaps; Identifying seasonality, trend, cycles	Construct visual representations of temporal data, interpret graphical patterns, analyze seasonal and cyclical components, evaluate variability, and extract actionable insights from visual analysis.
Unit 4: Seasonal-Trend Decomposition and Advanced Visualization	STL decomposition; Interactive visualization (Matplotlib, Seaborn, Plotly)	Apply STL decomposition techniques, interpret trend and seasonal components, implement interactive visualization tools, evaluate decomposition accuracy, and optimize exploratory time series analysis.
Unit 5: Introduction to ARIMA and SARIMA Models	ARIMA; SARIMA; Model structure	Explain autoregressive and moving average components, formulate ARIMA/SARIMA models, analyze stationarity conditions, and justify seasonal modeling extensions.
Unit 6: Model Identification and Diagnostics	ACF; PACF; Order selection; Model fitting; Residual diagnostics	Interpret ACF and PACF plots, determine optimal model orders, perform parameter estimation, evaluate residual assumptions, and validate forecasting models statistically.

Unit	Topics	Specific Learning Objectives
Unit 7: Exponential Smoothing and State Space Models	Simple Exponential Smoothing; Holt; Holt-Winters; State space models	Implement smoothing techniques, analyze trend and seasonality adjustments, evaluate state space representation, and compare smoothing models for forecasting performance.
Unit 8: Prophet and Model Evaluation Criteria	Prophet for business forecasting; Model comparison (AIC, BIC, RMSE, MAPE)	Apply Prophet forecasting framework, compute performance metrics, compare competing models, evaluate predictive accuracy, and select optimal forecasting solutions.
Unit 9: Recurrent Neural Networks (RNNs)	RNN architecture; Sequential modeling	Describe RNN structure, analyze sequence learning mechanisms, implement recurrent models, evaluate temporal dependency capture, and compare with classical models.
Unit 10: LSTM and Variants	LSTM; Bi-LSTM; GRU	Explain gating mechanisms in LSTM, implement Bi-LSTM and GRU networks, analyze long-term dependency handling, evaluate vanishing gradient mitigation, and optimize deep temporal architectures.
Unit 11: Sequence-to-Sequence Modeling	Seq2Seq forecasting models; Practical LSTM implementation	Construct sequence-to-sequence architectures, implement multi-step forecasting, evaluate prediction stability, and optimize model training for complex datasets.
Unit 12: Classical vs. Deep Learning Approaches	Comparison of statistical and deep learning methods	Analyze strengths and limitations of classical and deep models, compare forecasting accuracy, evaluate computational complexity, and justify model choice based on data characteristics.
Unit 13: Financial and Energy Forecasting Case Studies	Stock price forecasting; Electricity consumption forecasting	Design forecasting pipelines for financial and energy datasets, evaluate predictive accuracy, analyze volatility patterns, and interpret domain-specific results.
Unit 14: Transportation and Weather Forecasting	Traffic flow prediction; Weather forecasting	Implement forecasting models for transportation and meteorological data, evaluate real-time prediction challenges, and optimize forecasting frameworks for dynamic environments.



Unit	Topics	Specific Learning Objectives
Unit 15: Demand Forecasting and Real-Time Applications	Demand forecasting; Real-time time series applications	Analyze demand variability, implement forecasting strategies for operational planning, evaluate real-time deployment considerations, and design scalable prediction systems.
Unit 16: Model Evaluation and Performance Assessment	Performance metrics; Forecast validation techniques	Compute RMSE, MAE, MAPE and other metrics, perform backtesting procedures, analyze forecast errors, evaluate robustness, and develop comprehensive model evaluation reports.

TEXTBOOK REFERENCES:

- Hyndman, R. J., & Athanasopoulos, G. (2018). "Forecasting: Principles and Practice."
- Shumway, R. H., & Stoffer, D. S. (2010). "Time Series Analysis and Its Applications: With R Examples."
- Brownlee, J. (2018). "Introduction to Time Series Forecasting with Python."
- Müller, A. C., & Guido, S. (2016). "Introduction to Machine Learning with Python: A Guide for Data Scientists."

DE: Computer Vision and Image Analytics Program

Specialization Elective								
C. No.	Course Code	Course category	Course Title	L	T	P/ RP	Total Credits	Total Hours
3	CDA25ODE03	DE	Computer Vision and Image Analytics	3	-	1	4	120

Particulars	Details (as per NCrf, 2023)	Four-Quadrant Component (as per UGC, 2020)
Course Code	CDA25ODE03	
Course Title	Computer Vision and Image Analytics Programs	
Course Category	DE (Specialization Elective)	
Course Credits	4	
Number of Units	16	
Number of Topics	48	
Number of Videos	48	Q1 – e-Tutorials (Recorded Video Lectures with Demonstrations)
Self-Learning Material	250 Pages	Q2 – e-Content (SLM, Case Studies, Python Implementations, Research Papers)
Number of Discussion Forums	16	Q3 – Discussion Forum / Lab-Based Interactive Activities
Question Bank	1 (MCQ + Short + Analytical / Coding Questions)	Q4 – Assessment
Number of Assignments	2 (Image Processing Task + Mini Vision Project)	Q4 – Assessment

COURSE DESCRIPTION:

This course introduces the fundamental techniques used for analyzing and interpreting digital images and videos. It covers image processing, feature extraction, object detection, and deep learning models for computer vision. The course enables learners to develop intelligent systems for applications such as image recognition, surveillance, and medical imaging

Learning Outcomes

At the end of the course, the student should be able to:

CO1: Analyze image representation, enhancement, and feature extraction techniques.

CO2: Evaluate classical and deep learning–based computer vision algorithms.

CO3: Analyze object detection and image classification models for accuracy and robustness.

CO4: Develop computer vision solutions using convolutional neural networks.

CO5: Design image analytics systems for real–world applications such as healthcare and surveillance.

Unit	Topics	Specific Learning Objectives
Unit 1: Foundations of Computer Vision	Fundamentals of computer vision; Digital image basics; Image representations	Define computer vision concepts, describe image representation models, analyze pixel–level structures, evaluate image formats, and interpret digital image properties.
Unit 2: OpenCV and Image Handling	OpenCV and Jupyter integration; Reading, displaying, writing images; Drawing and annotation	Implement OpenCV workflows, perform image input/output operations, analyze annotation techniques, evaluate visualization outputs, and construct basic image processing scripts.
Unit 3: Image Processing Fundamentals	Color spaces and transformations; Blending, overlaying, masking; Thresholding techniques	Differentiate color space models, implement blending and masking operations, apply binary and adaptive thresholding, analyze segmentation quality, and optimize preprocessing pipelines.
Unit 4: Filtering and Enhancement Techniques	Blurring and smoothing filters; Morphological operations; Edge detection; Histogram equalization; Contrast enhancement	Apply filtering algorithms, analyze morphological transformations, implement edge detection methods, evaluate histogram equalization effects, and enhance image contrast for analytical tasks.
Unit 5: Object Detection Concepts	Introduction to object detection; Template matching	Describe object detection principles, implement template matching, analyze matching accuracy, evaluate computational complexity, and optimize detection workflows.
Unit 6: Feature and Corner Detection	Harris corner detection; Shi–Tomasi method; Feature detection concepts	Compare corner detection algorithms, implement feature extraction methods, analyze detection robustness, evaluate invariance properties, and select appropriate techniques for recognition tasks.

Unit	Topics	Specific Learning Objectives
Unit 7: Contours and Shape Analysis	Contour detection; Shape analysis	Detect and analyze object contours, compute shape descriptors, evaluate geometric properties, and apply contour-based recognition strategies.
Unit 8: Feature Matching and Haar Cascades	SIFT, SURF, ORB (conceptual overview); Haar cascade classifiers (face and eye detection)	Compare classical feature descriptors, analyze matching techniques, evaluate robustness to transformations, implement Haar cascade classifiers, and assess detection accuracy.
Unit 9: CNN Architecture Fundamentals	Convolutional Neural Networks; Convolution, pooling, fully connected layers	Describe CNN architecture components, analyze convolutional operations, evaluate pooling strategies, and design deep learning models for image classification.
Unit 10: Training CNN Models	Training with MNIST and CIFAR-10 datasets; Optimization strategies	Implement CNN training workflows, analyze dataset preprocessing steps, evaluate optimization algorithms, and assess convergence behavior.
Unit 11: Performance Evaluation of CNNs	Model evaluation metrics; Accuracy, precision, recall, confusion matrix	Compute classification metrics, analyze model performance, evaluate overfitting and underfitting issues, and optimize CNN generalization ability.
Unit 12: Advanced Object Detection Architectures	Introduction to advanced detection; YOLO overview	Explain one-stage detection frameworks, analyze YOLO architecture principles, evaluate speed-accuracy trade-offs, and justify use in real-time systems.
Unit 13: Transfer Learning and Pretrained Models	Pretrained weights; Transfer learning techniques	Implement transfer learning workflows, analyze fine-tuning strategies, evaluate feature reuse efficiency, and optimize deep learning deployment.
Unit 14: Implementing YOLO v3	Real-time detection using YOLO v3 in Python	Develop real-time object detection pipelines, analyze bounding box predictions, evaluate detection confidence thresholds, and optimize inference speed.
Unit 15: Industrial Applications of Computer Vision	Applications of YOLO in industry	Analyze real-world use cases, evaluate system deployment challenges, assess scalability considerations, and design computer vision solutions for industrial environments.



Unit	Topics	Specific Learning Objectives
Unit 16: Integrated Vision System Design	End-to-end vision workflows combining OpenCV and deep learning	Design complete computer vision pipelines, integrate preprocessing and deep models, evaluate system performance, and develop robust image analytics solutions.

TEXTBOOK REFERENCES:

- Richard Szeliski, Computer Vision: Algorithms and Applications, Springer- Texts in Computer Science, Second Edition, 2022.
- Computer Vision: A Modern Approach, D. A. Forsyth, J. Ponce, Pearson Education, Second Edition, 2015.
- Milan Sonka, Vaclav Hlavac, Roger Boyle, "Image Processing, Analysis, and Machine Vision", 4nd edition, Thomson Learning, 2013.

DE: GENERATIVE AI AND DEEP LEARNING MODELS

Specialization Elective								
C. No.	Course Code	Course category	Course Title	L	T	P/ RP	Total Credits	Total Hours
4	CDA25ODE04	DE	Generative AI and Deep Learning Models	3	-	1	4	120

Particulars	Details (as per NCrF, 2023)	Four-Quadrant Component (as per UGC, 2020)
Course Code	CDA25ODE04	
Course Title	Generative AI and Deep Learning Models	
Course Category	DE (Specialization Elective)	
Course Credits	4	
Number of Units	16	
Number of Topics	48	
Number of Videos	48	Q1 – e-Tutorials (Recorded Video Lectures with Demonstrations)
Self-Learning Material	250 Pages	Q2 – e-Content (SLM, Research Articles, Implementation Examples, Case Studies)
Number of Discussion Forums	16	Q3 – Discussion Forum / Model Implementation Activities
Question Bank	1 (MCQ + Short + Analytical / Coding Questions)	Q4 – Assessment
Number of Assignments	2 (Model Development Task + Case Study Analysis)	Q4 – Assessment

COURSE DESCRIPTION:

This course explores advanced deep learning architectures used for generative artificial intelligence applications. It covers generative models such as GANs, variational autoencoders, and transformer-based models. The course enables learners to design systems capable of generating text, images, and other complex data using modern AI techniques.

Learning Outcomes
At the end of the course, the student should be able to:
CO1: Analyze generative modeling principles and deep learning architectures.
CO2: Evaluate generative models such as GANs, VAEs, and transformer-based architectures.
CO3: Analyze ethical, social, and technical challenges of generative AI systems.
CO4: Develop generative deep learning models for synthetic data and content generation.
CO5: Design innovative generative AI solutions for real-world applications.



Unit	Topics	Specific Learning Objectives
Unit 1: Foundations of Generative AI	Generative vs. discriminative models; Overview of generative modeling approaches	Define generative and discriminative models, compare probabilistic learning paradigms, analyze modeling objectives, evaluate likelihood-based frameworks, and justify generative approaches for data synthesis tasks.
Unit 2: Applications and Ethical Considerations	Applications in text, images, music, data augmentation; Ethical considerations and responsible use	Identify generative AI applications across domains, analyze data augmentation strategies, evaluate ethical risks such as bias and misuse, and develop responsible AI usage frameworks.
Unit 3: GAN Architecture and Training	Generator vs. discriminator; Loss functions; Optimization; Training challenges	Explain adversarial learning principles, analyze GAN loss formulations, implement optimization strategies, evaluate convergence behavior, and diagnose instability issues in adversarial training.
Unit 4: Variants of GANs and Applications	DCGAN; Conditional GAN; StyleGAN; Image and data synthesis applications	Compare GAN variants, analyze architectural modifications, implement conditional generation methods, evaluate synthesis quality, and design GAN-based generative systems.
Unit 5: Fundamentals of Variational Autoencoders (VAEs)	Latent space; Probabilistic framework; Encoder-decoder architecture	Describe probabilistic latent variable models, derive VAE objective functions, implement encoder-decoder structures, analyze reconstruction loss and KL divergence, and evaluate latent space representations.
Unit 6: Applications of VAEs	Image generation; Anomaly detection; Data compression	Apply VAE models to generative tasks, analyze anomaly detection mechanisms, evaluate compression efficiency, and optimize probabilistic reconstruction methods.
Unit 7: Autoencoders for Generation	Basic autoencoders; Convolutional autoencoders	Compare basic and convolutional autoencoders, implement representation learning frameworks, analyze reconstruction accuracy, evaluate feature extraction performance, and design generative pipelines.
Unit 8: Transformers for Text Generation	Transformer architecture; GPT family; Language models	Describe self-attention mechanisms, analyze transformer encoder-decoder structures, evaluate language model training objectives, and implement text generation workflows.

Unit	Topics	Specific Learning Objectives
Unit 9: Deep Convolutional GANs (DCGANs)	Architecture; Image generation principles	Construct DCGAN models, analyze convolutional generative layers, evaluate training stability, and optimize image synthesis quality.
Unit 10: Multimodal and Text-to-Image Models	Text-to-image generation; Multimodal generative models; Case studies	Analyze cross-modal representation learning, implement text-conditioned image generation, evaluate multimodal integration techniques, and design generative applications combining multiple data types.
Unit 11: Evaluation Metrics for Generative Models	Inception Score (IS); Fréchet Inception Distance (FID)	Compute IS and FID metrics, analyze model diversity and realism, evaluate statistical validity, and compare generative model performance quantitatively.
Unit 12: Quality, Diversity, and Realism Assessment	Assessing generated content quality	Evaluate perceptual quality measures, analyze diversity-fidelity trade-offs, design validation experiments, and interpret benchmarking results.
Unit 13: Training Challenges in Generative Models	Mode collapse; Overfitting; Stability issues	Diagnose adversarial training failures, analyze gradient instability problems, evaluate regularization strategies, and optimize stable training protocols.
Unit 14: Advanced Optimization and Regularization	Techniques to improve training robustness	Implement gradient penalty methods, analyze normalization techniques, evaluate architectural tuning strategies, and enhance generative model stability.
Unit 15: Responsible and Scalable Deployment	Ethical safeguards; Deployment considerations	Analyze risks in real-world deployment, evaluate bias mitigation strategies, design governance frameworks, and implement responsible AI practices in generative systems.
Unit 16: Future Directions in Generative AI	Emerging research trends; Innovations in generative modeling	Assess emerging generative paradigms, analyze advancements in multimodal and foundation models, evaluate scalability challenges, and formulate research-driven improvements for next-generation generative systems.

TEXTBOOK REFERENCES:

- François Chollet, Deep Learning with Python, 2nd Edition (2021), Manning Publications, ISBN: 978-1617296863.
- Rafael Valle, Hands-On Generative Adversarial Networks with Keras, 1st Edition (2019), Packt Publishing, ISBN: 978-1838557319.

DE: CLINICAL DECISION SUPPORT AND HEALTHCARE ANALYTICS

Specialization Elective								
C. No.	Course Code	Course category	Course Title	L	T	P/ RP	Total Credits	Total Hours
5	CDA25ODE05	DE	Clinical Decision Support and Healthcare Analytics	3	-	1	4	120

Particulars	Details (as per NCeF, 2023)	Four-Quadrant Component (as per UGC, 2020)
Course Code	CDA25ODE05	
Course Title	Clinical Decision Support and Healthcare Analytics	
Course Category	DE (Specialization Elective)	
Course Credits	4	
Number of Units	16	
Number of Topics	48	
Number of Videos	48	Q1 – e-Tutorials (Recorded Video Lectures with Case Demonstrations)
Self-Learning Material	250 Pages	Q2 – e-Content (SLM, Healthcare Case Studies, Research Articles, Implementation Examples)
Number of Discussion Forums	16	Q3 – Discussion Forum / Case-Based Clinical Analysis
Question Bank	1 (MCQ + Short + Analytical / Case-Based Questions)	Q4 – Assessment
Number of Assignments	2 (Healthcare Data Analysis Task + Case Study Evaluation)	Q4 – Assessment

COURSE DESCRIPTION:

This course introduces analytical techniques used in healthcare data analysis and clinical decision support systems. It covers healthcare data management, predictive analytics, medical data visualization, and decision-making frameworks. The course prepares learners to apply data-driven approaches to improve healthcare outcomes and support clinical decision-making.

Learning Outcomes

At the end of the course, the student should be able to:

- CO1:** Analyze healthcare data sources and clinical workflows for decision support systems.
- CO2:** Evaluate predictive and prescriptive analytics techniques for clinical decision-making.
- CO3:** Analyze patient outcomes using healthcare analytics models.
- CO4:** Develop data-driven clinical decision support systems using analytical techniques.
- CO5:** Design ethical and interpretable healthcare analytics solutions for real-world clinical use.

Unit	Topics	Specific Learning Objectives
Unit 1: Foundations of Clinical Decision Support Systems (CDSS)	Role of CDSS in effective and timely medical decisions; Data–Information–Knowledge transformation	Define CDSS concepts, describe knowledge transformation processes in healthcare, analyze decision–support workflows, evaluate impact on clinical outcomes, and justify CDSS adoption in medical environments.
Unit 2: Mathematical and Statistical Models in Healthcare	Statistical and mathematical models for decision-making	Explain quantitative decision models, analyze probabilistic and statistical approaches, evaluate risk prediction frameworks, and apply analytical models for clinical decision-making.
Unit 3: CDSS Architecture and Ethical Considerations	CDSS architectures and frameworks; Ethics, privacy, and legal issues	Describe CDSS system architecture, analyze component interactions, evaluate data security and privacy concerns, assess legal compliance requirements, and design ethically responsible decision–support systems.
Unit 4: CDSS Concepts and Evolution	Definition; Core components; Historical evolution of clinical information systems	Explain foundational CDSS components, analyze system evolution trends, evaluate technological advancements, and interpret their influence on healthcare informatics development.
Unit 5: Decision–Making Process and Lifecycle	Representation of decision–making process; Development lifecycle of CDSS	Model structured clinical decision processes, analyze rule–based and knowledge–based reasoning systems, evaluate lifecycle stages, and design systematic CDSS development workflows.

Unit 6: Electronic Health Records and Interoperability	EHR systems; Interoperability standards	Describe EHR architecture, analyze interoperability challenges, evaluate data exchange standards, and design integration frameworks for seamless healthcare information flow.
Unit 7: Healthcare Data Warehousing and Integration	Clinical data warehouses; Data integration techniques	Compare data warehousing approaches, analyze ETL processes, evaluate integration architectures, and design centralized repositories for healthcare analytics.
Unit 8: Healthcare Data Mining and Predictive Analytics	Predictive analytics; Healthcare data mining	Apply data mining techniques to clinical datasets, analyze predictive modeling outcomes, evaluate performance metrics, and optimize healthcare outcome prediction systems.
Unit 9: Enterprise Systems in Healthcare	ERP and CRM in healthcare; CDSS integration with EHR and other systems	Describe ERP and CRM roles in healthcare management, analyze system interoperability, evaluate integration challenges, and design enterprise-level CDSS solutions.
Unit 10: Querying and Reporting in Healthcare Analytics	Query tools; Reporting mechanisms	Implement structured querying methods, analyze reporting frameworks, evaluate data summarization techniques, and generate actionable clinical reports.
Unit 11: Dashboards and Visualization for Decision Support	Dashboards; Visualization tools; KPIs	Design clinical dashboards, analyze KPI metrics for operational efficiency, evaluate visualization clarity, and optimize user-centered data presentation.
Unit 12: Executive Information Systems and Usability	EIS in healthcare; Human factors; Usability in CDSS interfaces	Explain EIS architecture, analyze usability principles, evaluate human-computer interaction factors, and design user-friendly CDSS interfaces.
Unit 13: OLAP and OLTP in Healthcare Analytics	OLAP vs. OLTP; Data warehousing in patient care analytics	Differentiate OLAP and OLTP systems, analyze multidimensional data structures, evaluate real-time vs. analytical processing needs, and design optimized healthcare analytics architectures.

Unit 14: Multidimensional Analysis Techniques	Drilling, pivoting, multidimensional analysis	Apply OLAP operations, analyze multidimensional datasets, evaluate pattern exploration techniques, and optimize analytical insights for clinical decision-making.
Unit 15: Clinical Data Mining and Predictive Modeling	Predictive modeling for healthcare outcomes	Develop predictive models for clinical risk assessment, analyze outcome prediction metrics, evaluate model interpretability, and design data-driven clinical interventions.
Unit 16: Future Trends in CDSS and Personalized Medicine	AI-driven CDSS; Personalized medicine	Assess emerging AI technologies in healthcare, analyze personalized medicine frameworks, evaluate precision medicine models, and propose advanced CDSS innovations for improved patient care.

TEXTBOOK REFERENCES:

- Efraim Turban, Jay E. Aronson, Ting-Peng Liang, Decision Support and Expert Systems: Management Support Systems, 9th Edition (2011), Prentice Hall, ISBN: 978-0132144879.
- Robert A. Greenes, Clinical Decision Support: The Road Ahead, 2nd Edition (2014), Elsevier, ISBN: 978-0124171450.

DE – TEXT ANALYTICS

Specialization Elective								
C. No.	Course Code	Course category	Course Title	L	T	P/R P	Total Credits	Total Hours
6	CDA25ODE06	DE	Text Analytics	3	-	1	4	120

Particulars	Details (as per NCrf, 2023)	Four-Quadrant Component (as per UGC, 2020)
Course Code	CDA25ODE06	
Course Title	Text Analytics	
Course Category	DE (Specialization Elective)	
Course Credits	4	
Number of Units	16	
Number of Topics	48	
Number of Videos	48	Q1 – e-Tutorials (Recorded Video Lectures with Practical Demonstrations)
Self-Learning Material	250 Pages	Q2 – e-Content (SLM, Case Studies, Python/R Implementations, Research Articles)
Number of Discussion Forums	16	Q3 – Discussion Forum / Text Processing Activities
Question Bank	1 (MCQ + Short + Analytical / Coding Questions)	Q4 – Assessment
Number of Assignments	2 (Text Mining Task + Case Study Analysis)	Q4 – Assessment

COURSE DESCRIPTION:

This course focuses on techniques for extracting meaningful insights from textual data. It covers text preprocessing, feature representation, sentiment analysis, topic modeling, and machine learning approaches for text mining. The course equips learners with tools to analyze large-scale text data from sources such as social media, documents, and web content.

Learning Outcomes

At the end of the course, the student should be able to:

CO1: Analyze textual data using linguistic and statistical text processing techniques.

CO2: Evaluate text representation models and feature extraction methods.

CO3: Analyze sentiment, topic, and semantic patterns in large text corpora.

CO4: Develop text analytics models for classification and information extraction.

CO5: Design scalable text analytics solutions for real-world applications.

Unit	Topics	Specific Learning Objectives
Unit 1: Introduction to Text Analytics	Text analytics overview; Applications; Twitter sentiment illustration	Define text analytics concepts, describe application domains, analyze sentiment analysis workflows, evaluate social media datasets, and interpret textual knowledge extraction processes.
Unit 2: Dataset Creation and Text Representation	Creating dataset; Importing text data in RStudio; Bag of Words model	Construct textual datasets, implement data import techniques in R, analyze Bag-of-Words representations, evaluate feature matrices, and prepare structured text representations for modeling.
Unit 3: Text Preprocessing and Sentiment Prediction	Preprocessing in R; Predicting sentiment	Apply text cleaning methods, analyze token filtering strategies, implement sentiment classification models, evaluate prediction performance, and interpret sentiment outcomes.
Unit 4: Text Manipulation in R	Basic text manipulation; Regular expressions; Pipes; ReadText package	Implement string manipulation techniques, construct regular expression patterns, apply functional pipelines in R, evaluate text parsing accuracy, and optimize text transformation workflows.
Unit 5: Tokenization and Linguistic Processing	Tokenization; N-grams; Stemming; Lemmatization; Stopwords	Differentiate tokenization approaches, implement n-gram extraction, analyze stemming and lemmatization techniques, evaluate stopword removal strategies, and optimize feature engineering for NLP tasks.
Unit 6: Advanced Text Analytics – IBM Watson Case	IBM Watson; Jeopardy system; Database and tools; How Watson works	Analyze large-scale text processing architectures, evaluate knowledge retrieval mechanisms, interpret machine reasoning frameworks, and assess system-level NLP performance.
Unit 7: Predictive Coding and Legal Text Analytics	Enron case study; Preprocessing; Bag of Words; Model building	Construct predictive coding workflows, analyze legal text datasets, implement classification models, evaluate ROC curve metrics, and assess automated document review systems.
Unit 8: Model Evaluation in Text Analytics	ROC curve; Model validation; Predictive coding today	Compute evaluation metrics, analyze model discrimination ability, evaluate predictive reliability, and optimize classification thresholds for text analytics applications.

Unit	Topics	Specific Learning Objectives
Unit 9: Web Scraping and Data Extraction	Extracting data from webpages; CSS selectors; Multiple file formats (CSV, Excel, JSON, PDF, Google Sheets)	Implement web scraping techniques, analyze structured and semi-structured data extraction methods, evaluate data integrity, and construct automated text acquisition pipelines.
Unit 10: Social Media Data Mining	Facebook extraction; Twitter API setup; Amazon data extraction	Design social media mining workflows, implement API-based data collection, analyze user-generated content, evaluate data privacy considerations, and structure social text datasets.
Unit 11: Corpus Analytics	Introduction to corpus analytics; Multiple document analysis; Quanteda package	Construct corpora from textual documents, analyze term frequencies and co-occurrence patterns, implement Quanteda tools, evaluate corpus-level insights, and design scalable text analytics frameworks.
Unit 12: Text Visualization Techniques	Word clouds; Visualization of textual insights	Generate word clouds and graphical summaries, analyze visual representation effectiveness, evaluate term prominence, and interpret textual patterns visually.
Unit 13: Healthcare and Knowledge Automation Case Study	Automating reviews in medicine	Apply text analytics in healthcare contexts, analyze domain-specific vocabulary, evaluate automation workflows, and design structured review extraction systems.
Unit 14: Content Monitoring and Spam Detection	Detecting vandalism on Wikipedia; Spam vs. ham classification	Implement classification models for anomaly detection, analyze content moderation challenges, evaluate precision-recall trade-offs, and design automated filtering systems.
Unit 15: Messaging and Social Text Analysis	WhatsApp text analyzer	Construct conversational text analysis pipelines, analyze communication patterns, evaluate sentiment and keyword extraction techniques, and interpret messaging data insights.
Unit 16: Integrated Text Analytics Solution Design	End-to-end solution development	Design complete text analytics systems, integrate preprocessing and modeling stages, evaluate system performance, and deploy real-world NLP solutions for business and research applications.

TEXTBOOK REFERENCES:

- Julia Silge and David Robinson, Text mining with R: A tidy approach, OReilly, 2017.
- Ted Kwartler, Text mining in Practice with R, Wiley 2017.

DE: REINFORCEMENT LEARNING FOR ARTIFICIAL INTELLIGENCE

Specialization Elective								
C. No.	Course Code	Course category	Course Title	L	T	P/ RP	Total Credits	Total Hours
7	CDA25ODE07	DE	Reinforcement Learning For Artificial Intelligence	3	-	1	4	120

Particulars	Details (as per NCrF, 2023)	Four-Quadrant Component (as per UGC, 2020)
Course Code	CDA25ODE07	
Course Title	Reinforcement Learning for Artificial Intelligence	
Course Category	DE (Specialization Elective)	
Course Credits	4	
Number of Units	14	
Number of Topics	40	
Number of Videos	40	Q1 – e-Tutorials (Recorded Video Lectures with Algorithm Demonstrations)
Self-Learning Material	250 Pages	Q2 – e-Content (SLM, Case Studies, Python Implementations, Research Papers)
Number of Discussion Forums	16	Q3 – Discussion Forum / Algorithm-Based Activities
Question Bank	1 (MCQ + Short + Analytical / Coding Questions)	Q4 – Assessment
Number of Assignments	2 (RL Model Implementation + Case Study Analysis)	Q4 – Assessment

COURSE DESCRIPTION:

This course introduces reinforcement learning techniques used for sequential decision-making in intelligent systems. It covers Markov decision processes, Q-learning, policy optimization, and deep reinforcement learning models. The course enables learners to develop AI systems capable of learning optimal actions through interaction with dynamic environments.

Learning Outcomes

At the end of the course, the student should be able to:

CO1: Analyze reinforcement learning frameworks and Markov decision processes.

CO2: Evaluate value-based and policy-based reinforcement learning algorithms.

CO3: Analyze exploration-exploitation strategies in reinforcement learning systems.

CO4: Develop reinforcement learning agents for sequential decision-making problems.

CO5: Design intelligent systems using reinforcement learning for real-world environments.

Unit	Topics	Specific Learning Objectives
Unit 1: Basics of Reinforcement Learning	Introduction to RL: agent, environment, state, action, reward	Describe the fundamental concepts, agents, and Markov decision processes in reinforcement learning.
Unit 2: Examples of RL Applications	Examples of RL in games and robotics	Describe the fundamental concepts, agents, and Markov decision processes in reinforcement learning.
Unit 3: Markov Property and MDP	Markov property and Markov decision process (MDP)	Describe the fundamental concepts, agents, and Markov decision processes in reinforcement learning.
Unit 4: State Transitions and Policy Concepts	State transitions and reward process – Concept of policy and return.	Describe the fundamental concepts, agents, and Markov decision processes in reinforcement learning.
Unit 5: Value Functions and Bellman Equations	State value and action value functions	Apply value functions and Bellman equations to evaluate and optimize policies in RL environments.
Unit 6: Bellman Equations for Prediction and Control	Bellman equations for prediction and control	Apply value functions and Bellman equations to evaluate and optimize policies in RL environments.
Unit 7: Optimal Value Functions and Policies	Optimal value functions and optimal policies – Relation between policy and value functions.	Apply value functions and Bellman equations to evaluate and optimize policies in RL environments.
Unit 8: Dynamic Programming Methods	Prediction using Dynamic programming	Implement dynamic programming methods for prediction and policy control in reinforcement learning.
Unit 9: Iterative Solutions in Dynamic Programming	Prediction and control using iterative solution	Implement dynamic programming methods for prediction and policy control in reinforcement learning.
Unit 10: Value and Policy Iteration	Value iteration, Policy iteration	Implement dynamic programming methods for prediction and policy control in reinforcement learning.

Unit	Topics	Specific Learning Objectives
Unit 11: Q-Learning and Exploration	Q learning – initializing Q table	Construct Q-learning algorithms to optimize policy selection using exploration-exploitation strategies.
Unit 12: Exploration and Exploitation Strategies	exploration and exploitation, epsilon greedy algorithm for choosing action	Construct Q-learning algorithms to optimize policy selection using exploration-exploitation strategies.
Unit 13: Q-Value Update and Convergence	update of Q values, convergence, policy extraction.	Construct Q-learning algorithms to optimize policy selection using exploration-exploitation strategies.
Unit 14: Monte Carlo Methods and Applications	Monte Carlo algorithm, Monte Carlo policy evaluation, Monte Carlo control, reward shaping in episodic learning	Evaluate Monte Carlo methods to optimize rewards and policy performance in episodic reinforcement learning.

TEXTBOOK REFERENCES:

- Sutton, Richard S., Barto, Andrew G.. Reinforcement Learning: An Introduction. Cambridge: MIT Press, 1998.
- Dynamic Programming and Optimal Control by Dimitri P. Bertsekas ISBNs: 1-886529-43-4 (Vol. I, 4th Edition), 1-886529-44-2 (Vol. II, 4th Edition), 1-886529-08-6 (Two-Volume Set, i.e., Vol. I, 4th ed. and Vol. II, 4th edition) Vol. I, 4TH EDITION, 2017, 576 pages, hardcover

DE: FUNDAMENTALS OF CRYPTOGRAPHY AND NETWORK SECURITY

Specialization Elective								
C. No.	Course Code	Course category	Course Title	L	T	P/ RP	Total Credits	Total Hours
8	CDA25ODE08	DE	FUNDAMENTALS OF CRYPTOGRAPHY AND NETWORK SECURITY	3	-	1	4	120

Particulars	Details (as per NCrf, 2023)	Four-Quadrant Component (as per UGC, 2020)
Course Code	CDA25ODE08	
Course Title	Fundamentals of Cryptography and Network Security	
Course Category	DE (Specialization Elective)	
Course Credits	4	
Number of Units	16	
Number of Topics	48	
Number of Videos	48	Q1 – e-Tutorials (Recorded Video Lectures with Demonstrations)
Self-Learning Material	250 Pages	Q2 – e-Content (SLM, Case Studies, Security Protocol Analysis, Implementation Examples)
Number of Discussion Forums	16	Q3 – Discussion Forum / Security Analysis Activities
Question Bank	1 (MCQ + Short + Analytical Questions)	Q4 – Assessment
Number of Assignments	2 (Cryptographic Implementation Task + Security Case Study)	Q4 – Assessment

COURSE DESCRIPTION:

This course introduces the fundamental principles of cryptography and network security for protecting digital information. It covers encryption techniques, authentication protocols, digital signatures, and network security mechanisms. The course enables learners to understand and implement secure communication systems in modern computing environments.

Learning Outcomes

At the end of the course, the student should be able to:

CO1: Analyze cryptographic principles and security threats in networked systems.

CO2: Evaluate symmetric, asymmetric, and hashing algorithms for security applications.

CO3: Analyze network vulnerabilities and attack mechanisms.

CO4: Develop secure communication mechanisms using cryptographic protocols.

CO5: Design secure network architectures to protect data and communication systems.

Unit	Topics	Specific Learning Objectives
Unit 1: Foundations of Network Security	Network security, threats, attacks, services, mechanisms; OSI security architecture	Define network security terminology, classify types of threats and attacks, analyze OSI security architecture, evaluate security services and mechanisms, and interpret security design principles.
Unit 2: Classical and Basic Cryptography	Plaintext and ciphertext; Security keys; Symmetric and asymmetric ciphers; Caesar, Vigenere, Rail Fence; Substitution, transposition, steganography	Differentiate plaintext and ciphertext transformations, implement classical cipher techniques, analyze substitution and transposition methods, evaluate steganographic approaches, and assess weaknesses of classical encryption schemes.
Unit 3: Product Ciphers and Key Management	Product ciphers; Key management concepts	Explain product cipher construction, analyze multi-round encryption design, evaluate key management challenges, and design secure key distribution strategies.
Unit 4: Number Theory and Algebraic Foundations	Euclidean algorithm; Divisibility; Modular arithmetic; Prime numbers; Congruence; Matrices; Algebraic structures	Apply Euclidean algorithm for GCD computation, analyze modular arithmetic operations, evaluate prime factorization properties, interpret congruence relations, and construct algebraic frameworks for cryptographic systems.
Unit 5: Symmetric Key Cryptosystems	SDES; Block ciphers; AES; Stream ciphers (RC4, Blowfish, RC5, IDEA)	Compare symmetric encryption algorithms, implement block and stream cipher structures, analyze substitution-permutation networks, evaluate security strength, and optimize symmetric key encryption mechanisms.
Unit 6: Mathematical Concepts for Asymmetric Cryptography	Primality testing; Factorization; Euler's totient; Fermat's theorem; Euler's theorem; Discrete logarithms	Analyze number-theoretic foundations, compute totient functions, apply Fermat and Euler theorems, evaluate discrete logarithm complexity, and justify cryptographic hardness assumptions.

Unit	Topics	Specific Learning Objectives
Unit 7: RSA and Key Exchange Mechanisms	RSA cryptosystem; Diffie-Hellman key exchange	Construct RSA encryption and decryption processes, analyze key generation algorithms, implement Diffie-Hellman exchange, evaluate security vulnerabilities, and assess computational feasibility.
Unit 8: Advanced Asymmetric Cryptosystems	ElGamal cryptosystem; Elliptic curve arithmetic; Elliptic curve cryptography (ECC)	Explain ElGamal encryption, analyze elliptic curve group operations, evaluate ECC advantages over RSA, and design secure public key systems using elliptic curves.
Unit 9: Message Authentication Codes and Hashing	Authentication functions; MAC; Hash functions	Define authentication requirements, construct MAC algorithms, analyze cryptographic hash functions, evaluate collision resistance, and implement integrity verification mechanisms.
Unit 10: Digital Signatures and Authentication Protocols	Digital signature; Digital Signature Standard (DSS); Authentication protocols	Implement digital signature schemes, analyze DSS framework, evaluate non-repudiation mechanisms, and design secure authentication protocols.
Unit 11: Key Management and Distribution	Symmetric and asymmetric key distribution; Distribution of public keys	Analyze key lifecycle management, evaluate centralized and decentralized distribution methods, implement hybrid encryption models, and assess public key infrastructure principles.
Unit 12: Entity Authentication Mechanisms	Password systems; Biometric systems	Compare authentication mechanisms, analyze biometric recognition principles, evaluate multi-factor authentication systems, and assess vulnerabilities in identity verification systems.
Unit 13: Electronic Mail Security	PGP; S/MIME	Explain secure email architecture, analyze encryption and signing workflows, evaluate PGP and S/MIME protocols, and design secure electronic communication frameworks.
Unit 14: Network Layer Security	IP security; Web security	Describe IPsec architecture, analyze secure web protocols, evaluate SSL/TLS mechanisms, and design layered network protection strategies.
Unit 15: System Security Threats	Intruders; Malicious software; Viruses	Classify types of system intrusions, analyze malware behavior, evaluate attack vectors, and design detection and prevention strategies.

Unit	Topics	Specific Learning Objectives
Unit 16: Firewalls and Integrated Security Mechanisms	Firewalls; Network defense mechanisms	Explain firewall architectures, analyze packet filtering and proxy services, evaluate intrusion prevention systems, and design integrated security frameworks to mitigate cyber threats.

TEXTBOOK REFERENCES:

- Cryptography and Network Security – Principles and Practice: William Stallings, Pearson Education, 6th Edition
- Cryptography and Network Security: Atul Kahate, Mc Graw Hill, 3rd Edition

OTHER REFERENCES:

- Cryptography and Network Security: C K Shyamala, N Harini, Dr T R Padmanabhan, Wiley India, 1st Edition.
- Cryptography and Network Security: Forouzan Mukhopadhyay, Mc Graw Hill, 3rd Edition
- Information Security, Principles, and Practice: Mark Stamp, Wiley India.
- Principles of Computer Security: WM. Arthur Conklin, Greg White, TMH.
- Introduction to Network Security: Neal Krawetz, CENGAGE Learning.

DE: INTERNET OF THINGS AND ARDUINO PROGRAMMING

Specialization Elective								
C. No.	Course Code	Course category	Course Title	L	T	P/ RP	Total Credits	Total Hours/ Marks
9	CDA25ODE09	DE	Internet of Things and Arduino Programming	3	-	1	4	120

Particulars	Details (as per NCrf, 2023)	Four-Quadrant Component (as per UGC, 2020)
Course Code	CDA25ODE09	
Course Title	Internet of Things and Arduino Programming	
Course Category	DE (Specialization Elective)	
Course Credits	4	
Number of Units	16	
Number of Topics	48	
Number of Videos	48	Q1 – e-Tutorials (Recorded Video Lectures with Hardware Demonstrations)
Self-Learning Material	250 Pages	Q2 – e-Content (SLM, Circuit Diagrams, Programming Examples, Case Studies)
Number of Discussion Forums	16	Q3 – Discussion Forum / Lab-Based Interactive Activities
Question Bank	1 (MCQ + Short + Analytical / Programming Questions)	Q4 – Assessment
Number of Assignments	2 (IoT Prototype Development + Case Study Analysis)	Q4 – Assessment

COURSE DESCRIPTION:

This course introduces the architecture and applications of the Internet of Things (IoT) along with hands-on programming using Arduino platforms. It covers sensor integration, embedded systems, IoT communication protocols, and data acquisition techniques. The course enables learners to design and implement smart connected systems for real-world applications.

Learning Outcomes

At the end of the course, the student should be able to:

CO1: Analyze IoT architectures, communication protocols, and sensor networks.

CO2: Evaluate embedded systems and microcontroller platforms for IoT applications.

CO3: Analyze real-time data acquisition and processing in IoT systems.

CO4: Develop IoT applications using Arduino and connected sensors.

CO5: Design end-to-end IoT solutions for smart and industrial environments.

Unit	Topics	Specific Learning Objectives
Unit 1: Fundamentals of Internet of Things	History of IoT; Working of IoT; IoT applications	Define IoT concepts, describe the evolution of IoT, analyze system architecture and communication models, evaluate application domains, and interpret IoT ecosystem components.
Unit 2: IoT Advantages, Challenges, and Limitations	Advantages; Disadvantages; Challenges in IoT	Identify benefits of IoT systems, analyze implementation challenges, evaluate security and scalability issues, and assess feasibility of IoT deployments.
Unit 3: Electrical Sources and Components for IoT	Batteries and types; Switches; Electrical and electronic loads; Conductors, insulators, semiconductors; Circuit elements	Classify electrical power sources, analyze battery ratings, evaluate switch mechanisms, differentiate conductors and semiconductors, and interpret circuit fundamentals for IoT systems.
Unit 4: Low Power Devices and Breadboard Basics	LED, Buzzer, Speaker, DC Motor, Gear Motor, Servo motor, Display; Breadboard fundamentals	Demonstrate low-power component connections, analyze actuator functionality, implement breadboard circuits, evaluate power consumption, and construct prototype IoT circuits.
Unit 5: Semiconductor Devices in IoT	Diode, LED, Photodiode, LDR, Thermistor, Transistor (BJT, PNP, NPN), Phototransistor, IR Receiver	Explain semiconductor device operation, analyze switching characteristics, evaluate sensing principles, and design basic sensor-driven circuits.
Unit 6: Integrated Circuits and Logic Components	IC741, 555 Timer, LM358, LM386, LM353, Counter IC, Logic gates	Interpret IC pin configurations, analyze operational amplifier functions, implement timer circuits, evaluate logic gate operations, and design functional embedded circuits.
Unit 7: Arduino Architecture and Hardware Overview	Arduino board architecture	Describe Arduino UNO architecture, analyze microcontroller components, evaluate input-output interfaces, and interpret embedded system design principles.

Unit	Topics	Specific Learning Objectives
Unit 8: Arduino Programming Basics	Programming with Arduino UNO; Working with LEDs	Develop basic Arduino programs, implement digital output control, analyze timing functions, and debug microcontroller code.
Unit 9: Input Devices and Voltage Control	Digital switch; Potentiometer; Analog input	Implement digital and analog input reading, analyze voltage adjustment using potentiometers, evaluate signal processing in Arduino, and design interactive control systems.
Unit 10: Sensor Integration with Arduino	Introduction to sensor integration	Connect and configure sensors with Arduino, analyze signal acquisition methods, evaluate calibration procedures, and optimize data collection workflows.
Unit 11: Automated Applications using LDR and Ultrasonic Sensor	LDR for illumination control; Ultrasonic sensor	Design light-controlled automation systems, implement distance measurement modules, analyze sensor accuracy, and evaluate real-time responsiveness.
Unit 12: Environmental and Motion Sensors	DHT11 sensor; PIR sensor	Integrate temperature and humidity sensors, analyze motion detection mechanisms, evaluate data reliability, and construct smart monitoring systems.
Unit 13: Motor Control with Arduino	Servo motor operations	Implement servo motor control algorithms, analyze PWM techniques, evaluate motion precision, and design actuator-based automation systems.
Unit 14: Wireless Communication in IoT	Establishing communication using Bluetooth	Configure Bluetooth modules, analyze wireless data transmission protocols, evaluate communication latency, and implement remote IoT control systems.
Unit 15: Integrated IoT System Design	Combining sensors, actuators, and communication modules	Design complete IoT prototypes, integrate hardware and software components, evaluate system performance, and troubleshoot embedded IoT solutions.
Unit 16: Real-World IoT Application Development	Automated real-world Arduino applications	Develop end-to-end IoT projects, analyze operational efficiency, evaluate power management strategies, and deploy practical automation solutions.

TEXTBOOK REFERENCES:

- “The Internet of Things: Enabling Technologies, Platforms, and Use Cases”, by Pethuru Raj and Anupama C. Raman ,CRC Press, 2017
- Adrian McEwen, Designing the Internet of Things, Wiley,2013

DE: ARTIFICIAL NEURAL NETWORKS AND DEEP LEARNING

Specialization Elective								
C. No.	Course Code	Course category	Course Title	L	T	P/ RP	Total Credits	Total Hours
10	CDA25ODE10	DE	Artificial Neural Networks and Deep Learning	3	-	1	4	120

Particulars	Details (as per NCeF, 2023)	Four-Quadrant Component (as per UGC, 2020)
Course Code	CDA25ODE10	
Course Title	Artificial Neural Networks and Deep Learning	
Course Category	DE (Specialization Elective)	
Course Credits	4	
Number of Units	16	
Number of Topics	48	
Number of Videos	48	Q1 – e-Tutorials (Recorded Video Lectures with Model Demonstrations)
Self-Learning Material	250 Pages	Q2 – e-Content (SLM, Algorithm Explanations, Python Implementations, Case Studies)
Number of Discussion Forums	16	Q3 – Discussion Forum / Model-Building Activities
Question Bank	1 (MCQ + Short + Analytical / Coding Questions)	Q4 – Assessment
Number of Assignments	2 (ANN Model Implementation + Deep Learning Case Study)	Q4 – Assessment

COURSE DESCRIPTION:

This course provides an introduction to artificial neural networks and advanced deep learning architectures. It covers perceptron, multilayer neural networks, backpropagation, convolutional neural networks, and recurrent neural networks. The course enables learners to build intelligent models capable of solving complex pattern recognition and predictive analytics problems.

Learning Outcomes

At the end of the course, the student should be able to:

CO1: Analyze neural network architectures and learning mechanisms.

CO2: Evaluate deep learning models for classification, regression, and pattern recognition tasks.

CO3: Analyze optimization techniques and regularization strategies in deep learning.

CO4: Develop deep neural network models for real-world applications.

CO5: Design scalable and efficient deep learning systems using modern frameworks.

Unit	Topics	Specific Learning Objectives
Unit 1: Foundations of AI and Neural Networks	Introduction to AI and Machine Learning; Overview of Neural Networks	Define AI and machine learning concepts, describe neural network foundations, analyze supervised learning paradigms, and interpret the role of neural models in intelligent systems.
Unit 2: Biological and Artificial Neuron Models	Biological neuron; Artificial neuron model; Perceptron	Explain neuron structure, construct artificial neuron models, implement perceptron learning, analyze linear separability, and evaluate classification boundaries.
Unit 3: Activation, Loss Functions and Learning Mechanisms	Activation functions; Loss functions; Gradient descent; Hyperparameters (epoch, batch size, learning rate)	Compare activation functions, compute loss functions, apply gradient descent optimization, analyze hyperparameter tuning strategies, and evaluate model convergence.
Unit 4: Multilayer Neural Networks and Backpropagation	Feedforward networks; Backpropagation algorithm; Deep neural networks	Implement forward and backward propagation, derive gradient updates, analyze vanishing/exploding gradients, and optimize deep neural network performance.
Unit 5: Model Generalization and Regularization Techniques	Underfitting and overfitting; L1 and L2 regularization; Dropout; Batch normalization	Diagnose model bias and variance, apply regularization methods, evaluate dropout effectiveness, implement batch normalization, and improve generalization capability.
Unit 6: Optimization Algorithms in Deep Learning	SGD; Adam; RMSProp	Compare optimization algorithms, implement adaptive learning rate techniques, analyze convergence behavior, and select optimizers for specific learning tasks.

Unit	Topics	Specific Learning Objectives
Unit 7: Fundamentals of Convolutional Neural Networks (CNNs)	Convolution; Kernels; Feature maps; Padding; Stride	Explain convolution operations, compute feature maps, analyze stride and padding effects, and design convolution layers for feature extraction.
Unit 8: Pooling and CNN Architectures	Pooling operations; LeNet; AlexNet; VGGNet	Implement pooling techniques, analyze architecture differences, evaluate model depth impact, and construct CNN models for classification tasks.
Unit 9: Autoencoders and Image Applications	Autoencoders; Image recognition applications	Design encoder–decoder architectures, implement dimensionality reduction, evaluate reconstruction loss, and apply models to image recognition problems.
Unit 10: Transfer Learning Fundamentals	Pre-trained models; Transfer learning; Fine-tuning	Explain transfer learning principles, adapt pre-trained networks, implement fine-tuning strategies, and evaluate performance improvements on new datasets.
Unit 11: Advanced CNN Architectures	ResNet; InceptionNet; VGGNet; Skip connections	Analyze deep architecture innovations, implement residual connections, evaluate multi-branch structures, and compare architectural efficiency.
Unit 12: Applications of Advanced Architectures	Object detection; Image classification	Design deep learning solutions for object detection, analyze classification performance metrics, and optimize deployment for real-world AI systems.
Unit 13: Sequential Data and Recurrent Neural Networks	Sequential data; Time-series; RNN	Explain temporal dependencies, implement RNN models, analyze sequence learning behavior, and evaluate performance on time-series datasets.
Unit 14: Long Short-Term Memory Networks (LSTM)	LSTM architecture	Analyze LSTM gating mechanisms, implement memory cell operations, evaluate long-term dependency learning, and optimize sequential model training.
Unit 15: Advanced Recurrent Architectures	BiLSTM; GRU	Compare GRU and LSTM models, implement bidirectional architectures, analyze computational efficiency, and select suitable recurrent models.
Unit 16: Applications of Sequential Models	Speech processing; Text processing	Develop RNN-based solutions for speech and text tasks, evaluate language modeling performance, optimize sequential architectures, and deploy real-world AI applications.



TEXTBOOK REFERENCES:

- Ian Goodfellow, Yoshua Bengio, and Aaron Courville, Deep Learning, MIT Press, 2016.
- Aurélien Géron, Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow, O'Reilly Media, 2nd Ed., 2019.
- Michael Nielsen, Neural Networks and Deep Learning, Determination Press, 2015.

OTHER REFERENCES:

- Stuart Russell and Peter Norvig, Artificial Intelligence: A Modern Approach.
- Ethem Alpaydin, Introduction to Machine Learning.
- Information Security, Principles, and Practice: Mark Stamp, Wiley India.
- François Chollet, Deep Learning with Python, Manning Publications, 2017.
- Christopher M. Bishop, Pattern Recognition and Machine Learning, Springer.

SKILL ENHANCEMENT COURSES

SL: ADVANCED EXCEL FOR DATA ANALYTICS

Skill Enhancement Courses								
C. No.	Course Code	Course category	Course Title	L	T	P/ RP	Total Credits	Total Hours
1	CDA25OSLO1	SL	Advanced Excel for Data Analytics	-	-	2	2	60

Particulars	Details (as per NCrf, 2023)	Four-Quadrant Component (as per UGC, 2020)
Course Code	CDA25OSLO1	
Course Title	Advanced Excel for Data Analytics	
Course Category	SL (Skill Specialization)	
Course Credits	2	
Number of Units	8	
Number of Topics	24	
Number of Videos	24	Q1 – e-Tutorials (Recorded Video Demonstrations)
Self-Learning Material	120 Pages	Q2 – e-Content (Step-by-Step Guides, Practice Sheets, Case Studies)
Number of Discussion Forums	8	Q3 – Interactive Lab Discussions
Question Bank	1 (Practical + Objective Questions)	Q4 – Assessment
Number of Assignments	1 (Excel Dashboard / Analytical Report)	Q4 – Assessment

COURSE DESCRIPTION:

This course focuses on advanced spreadsheet techniques used for data analysis and decision support. It covers advanced formulas, pivot tables, data visualization, data cleaning, and analytical tools in Excel. The course enables learners to perform efficient data analysis, reporting, and dashboard development for business and research applications.

Learning Outcomes

At the end of the course, the student should be able to:

CO1: Analyze datasets using advanced Excel functions and data analysis tools.

CO2: Evaluate data quality and trends using pivot tables, charts, and dashboards.

CO3: Analyze business problems using Excel-based statistical and analytical techniques.

CO4: Develop automated analytical workflows using formulas, macros, and Power Query.

CO5: Design Excel-based decision-support dashboards for real-world applications.

Unit	Topics	Specific Learning Objectives
Unit 1: Advanced Excel Functions	IF, IFS, VLOOKUP, HLOOKUP, XLOOKUP, INDEX, MATCH; Text, date, and time functions; Conditional formatting with formulas	Identify advanced Excel functions, implement logical and lookup operations, analyze differences between lookup techniques, apply text and date manipulations, and design formula-based conditional formatting for analytical computations.
Unit 2: Data Cleaning and Preparation	Data import/export (CSV, databases, web); Data validation; Removing duplicates; Text-to-columns; Power Query; Handling missing values and outliers	Import multi-source datasets, apply validation and cleaning tools, transform data using Power Query, evaluate missing data strategies, and prepare structured datasets for analysis.
Unit 3: Data Summarization using PivotTools	PivotTables; Grouping; Filtering; Slicers; PivotCharts	Construct PivotTables, analyze aggregated insights, implement grouping and slicers for interactivity, design PivotCharts, and interpret exploratory data patterns.
Unit 4: Advanced Data Visualization	Advanced charting techniques; Conditional formatting for visualization	Design professional charts, evaluate trend patterns, apply visualization best practices, and enhance interpretability through dynamic formatting techniques.
Unit 5: Statistical Analysis Tools	Descriptive statistics (Analysis ToolPak); Correlation; Regression; Hypothesis testing	Compute descriptive statistics, perform correlation and regression analysis, interpret hypothesis testing outputs, and evaluate statistical relationships for decision-making.
Unit 6: Optimization and What-If Analysis	Solver; Data Tables; Goal Seek; Scenario Manager	Formulate optimization problems, apply Solver with constraints, perform sensitivity analysis using What-If tools, and evaluate alternative business scenarios.

Unit	Topics	Specific Learning Objectives
Unit 7: Automation with Macros and VBA	Introduction to Macros; VBA basics	Record and modify macros, analyze VBA structure, automate repetitive tasks, and implement basic procedural scripts for efficiency.
Unit 8: Dashboard Design and Case Applications	Interactive dashboards with form controls; Business/Healthcare/Financial case study	Design interactive dashboards, integrate controls for user interaction, analyze domain-specific datasets, and develop end-to-end Excel-based analytical solutions.

TEXTBOOK REFERENCES:

- Winston, W.L. Microsoft Excel Data Analysis and Business Modeling, Microsoft Press.
- Alexander, M. & Kusleika, D. Excel 2021 Power Programming with VBA.

REFERENCE BOOKS:

- Walkenbach, J. Excel Bible.

SL : TABLEAU FOR DATA ANALYSIS

Skill Enhancement Courses								
C. No.	Course Code	Course category	Course Title	L	T	P/RP	Total Credits	Total Hours
2	CDA25OSLO2	SL	Tableau for Data Analysis	-	-	2	2	60

Particulars	Details (as per NCrf, 2023)	Four-Quadrant Component (as per UGC, 2020)
Course Code	CDA25OSLO2	
Course Title	Tableau for Data Analysis	
Course Category	SL (Skill Specialization)	
Course Credits	2	
Number of Units	8	
Number of Topics	24	
Number of Videos	24	Q1 – e-Tutorials (Recorded Practical Demonstrations)
Self-Learning Material	120 Pages	Q2 – e-Content (Step-by-Step Guides, Case Studies, Practice Datasets)
Number of Discussion Forums	8	Q3 – Interactive Dashboard Discussions
Question Bank	1 (Practical + Objective Questions)	Q4 – Assessment
Number of Assignments	1 (Interactive Dashboard Development Project)	Q4 – Assessment

COURSE DESCRIPTION:

This course introduces Tableau as a powerful tool for data visualization and interactive dashboard development. It covers data connection, data transformation, visualization techniques, and storytelling with data. The course enables learners to create meaningful visual analytics to support data-driven decision-making.

Learning Outcomes

At the end of the course, the student should be able to:

- CO1:** Analyze datasets to identify patterns and insights suitable for visual analytics.
- CO2:** Evaluate different visualization techniques for effective data storytelling.
- CO3:** Analyze dashboard performance and usability for analytical decision-making.
- CO4:** Develop interactive dashboards using Tableau for business analytics.
- CO5:** Design end-to-end visual analytics solutions for real-world datasets.

Unit	Topics	Specific Learning Objectives
Unit 1: Tableau Environment and Data Connections	Overview of Tableau interface and workflow; Connecting to Excel, SQL, cloud data, CSV files; Data types and cleaning	Identify Tableau components, connect to multiple data sources, analyze data types, perform basic data cleaning, and evaluate data readiness for visualization workflows.
Unit 2: Data Preparation Techniques	Joins, blends, unions, data extracts	Differentiate joins, blends, and unions, implement data integration techniques, create extracts for performance optimization, and construct structured datasets for analysis.
Unit 3: Basic Data Visualization	Bar, line, pie, scatter, histogram charts; Shelves, marks, filters	Create fundamental visualizations, apply filters and marks effectively, analyze multidimensional data representations, and interpret visual patterns.
Unit 4: Structuring and Customizing Visuals	Sorting, grouping, hierarchies; Formatting and customization	Implement sorting and grouping mechanisms, construct hierarchical views, customize visual layouts, and evaluate clarity and readability of dashboards.
Unit 5: Calculated Fields and Advanced Analytics	Calculated fields; Table calculations; Quick table functions	Develop calculated fields, apply table calculations, analyze aggregated insights, and optimize analytical workflows for deeper data interpretation.
Unit 6: Parameters, Sets, and Forecasting	Parameters; Sets; Trend lines; Forecasting; Reference lines; Geographic mapping	Design dynamic parameter-driven analyses, construct sets for segmentation, implement forecasting models, analyze trend behavior, and visualize geographic data spatially.
Unit 7: Interactive Dashboard Design	Dashboard construction; Filter, highlight, and URL actions; Layout best practices	Construct interactive dashboards, implement action filters, evaluate layout efficiency, and design decision-support interfaces following visualization best practices.
Unit 8: Tableau for Data-Driven Decisions	What-if analysis; Integration with R/Python; Publishing to Tableau Public/Server/Online; Security and sharing	Perform scenario-based analysis, integrate advanced analytics tools, publish and share dashboards securely, evaluate real-world business and healthcare cases, and deploy Tableau solutions for decision-making.



TEXTBOOK REFERENCES:

- Murray, D. Tableau Your Data!: Fast and Easy Visual Analysis with Tableau Software.
- Jones, J. Learning Tableau. Packt Publishing.

REFERENCE BOOKS:

- Gertz, D. Visual Analytics with Tableau.
- Tableau Public Gallery (real-world dashboards).

SL : UNIX SHELL PROGRAMMING

Skill Enhancement Courses								
C. No.	Course Code	Course category	Course Title	L	T	P/ RP	Total Credits	Total Hours
3	CDA25OSLO3	SL	Unix Shell Programming	-	-	2	2	60

Particulars	Details (as per NCrF, 2023)	Four-Quadrant Component (as per UGC, 2020)
Course Code	CDA25OSLO3	
Course Title	Unix Shell Programming	
Course Category	SL (Skill Specialization)	
Course Credits	2	
Number of Units	8	
Number of Topics	24	
Number of Videos	24	Q1 – e-Tutorials (Recorded Practical Demonstrations)
Self-Learning Material	120 Pages	Q2 – e-Content (Command References, Script Examples, Practice Exercises)
Number of Discussion Forums	8	Q3 – Interactive Lab Discussions
Question Bank	1 (Practical + Objective Questions)	Q4 – Assessment
Number of Assignments	1 (Shell Script Development Task)	Q4 – Assessment

COURSE DESCRIPTION:

This course provides a foundation in Unix operating systems and shell scripting for automation and data processing tasks. It covers Unix commands, file management, shell scripting concepts, and process control. The course enables learners to automate workflows and manage data efficiently in Unix-based environments.

Learning Outcomes

At the end of the course, the student should be able to:

- CO1:** Analyze Unix file systems and command-line utilities for efficient data handling.
- CO2:** Evaluate shell commands and utilities for text processing and automation tasks.
- CO3:** Analyze system-level tasks using pipes, filters, and redirection mechanisms.
- CO4:** Develop shell scripts to automate data processing and system operations.
- CO5:** Design robust shell-based solutions for real-world data and system management problems.

Unit	Topics	Specific Learning Objectives
Unit 1: Fundamentals of Unix/Linux	Basics of Unix/Linux OS; File system structure; Directories; Permissions; CLI vs GUI	Identify Unix/Linux components, describe file system hierarchy, interpret directory structures and permissions, compare CLI and GUI environments, and evaluate command-line advantages.
Unit 2: Basic Unix Commands and Utilities	File handling commands; Text processing commands; Compression and archiving tools	Execute file manipulation commands, analyze text processing utilities, implement compression and archiving techniques, and optimize command-line workflows.
Unit 3: Shell Environment and Syntax	Types of shells; Command syntax; Environment variables; Configuration files	Differentiate shell types, construct valid command syntax, configure environment variables, analyze shell initialization files, and manage execution environments.
Unit 4: Redirection, Pipes, and Filters	Input/output redirection; Pipes; grep, sed, awk (basics)	Implement redirection mechanisms, construct pipelines for data flow, apply grep/sed/awk for text filtering, and analyze command chaining efficiency.
Unit 5: Shell Scripting Fundamentals	Writing and executing scripts; Variables; Constants; Command substitution	Develop executable shell scripts, declare and manipulate variables, implement command substitution, and evaluate script functionality.
Unit 6: Control Structures and Error Handling	if-else; case; for, while, until loops; Exit status and error handling	Analyze control flow structures, implement iterative and conditional logic, interpret exit statuses, and design scripts with robust error handling.
Unit 7: Advanced Shell Programming Techniques	Functions; String manipulation; File manipulation; Process management (ps, jobs, kill, bg, fg)	Construct reusable shell functions, manipulate strings and files programmatically, analyze system processes, and manage background and foreground tasks effectively.
Unit 8: Applications of Shell Scripting in Analytics	Automating backups; System monitoring; Batch processing; Log file analysis; Data preprocessing	Design automation scripts for backups and monitoring, process batch data efficiently, analyze log files, and optimize data analytics workflows using shell scripting.

TEXTBOOK REFERENCES:

- Yashavant P. Kanetkar, Unix Shell Programming, BPB Publications.
- M. G. Venkateshmurthy, Introduction to Unix and Shell Programming, Pearson Education.
- Sumitabha Das, Unix Concepts and Applications, Tata McGraw-Hill.

REFERENCE BOOKS:

- Stephen G. Kochan, Unix Shell Programming, Pearson Education.
- Brian W. Kernighan and Rob Pike, The Unix Programming Environment, Prentice-Hall.
- Mark Sobell, A Practical Guide to Linux Commands, Editors, and Shell Programming, Pearson.
- Arnold Robbins, Linux Programming by Example: The Fundamentals, Pearson.
- Richard Blum, Linux Command Line and Shell Scripting Bible, Wiley.

SL : AGILE METHODOLOGIES FOR PROJECT MANAGEMENT

Skill Enhancement Courses								
C. No.	Course Code	Course category	Course Title	L	T	P/ RP	Total Credits	Total Hours
4	CDA25OSLO4	SL	Agile Methodologies for Project Management	-	-	2	2	60

Particulars	Details (as per NCeF, 2023)	Four-Quadrant Component (as per UGC, 2020)
Course Code	CDA25OSLO4	
Course Title	Agile Methodologies for Project Management	
Course Category	SL (Skill Specialization)	
Course Credits	2	
Number of Units	8	
Number of Topics	24	
Number of Videos	24	Q1 – e-Tutorials (Recorded Conceptual & Case-Based Sessions)
Self-Learning Material	120 Pages	Q2 – e-Content (SLM, Agile Framework Guides, Case Studies, Templates)
Number of Discussion Forums	8	Q3 – Interactive Discussions / Sprint Planning Simulations
Question Bank	1 (Objective + Scenario-Based Questions)	Q4 – Assessment
Number of Assignments	1 (Agile Project Plan / Sprint Documentation Task)	Q4 – Assessment

COURSE DESCRIPTION:

This course introduces Agile principles and frameworks used in modern software and data analytics project management. It covers Agile practices such as Scrum, Kanban, sprint planning, and iterative development. The course enables learners to manage projects efficiently through adaptive planning, teamwork, and continuous improvement

Learning Outcomes

At the end of the course, the student should be able to:

CO1: Analyze Agile principles, frameworks, and roles in software project management

CO2: Evaluate Agile methodologies such as Scrum, Kanban, and XP for project suitability.

CO3: Analyze project risks, stakeholder requirements, and sprint outcomes in Agile projects.

CO4: Develop Agile project plans including sprint backlogs and release plans.

CO5: Design Agile-based project management strategies for real-world organizational contexts.

Unit	Topics	Specific Learning Objectives
Unit 1: Foundations of Agile Project Management	Traditional vs Agile project management; Agile Manifesto values and principles; Benefits and challenges	Differentiate traditional and Agile methodologies, interpret Agile values and principles, analyze benefits and limitations, and evaluate suitability for modern project environments.
Unit 2: Agile Frameworks Overview	Scrum, Kanban, Lean, XP (Extreme Programming)	Compare Agile frameworks, analyze workflow structures, evaluate framework selection criteria, and apply Agile approaches to project scenarios.
Unit 3: Agile Roles and Responsibilities	Product Owner; Scrum Master; Development Team	Explain role responsibilities, analyze team collaboration dynamics, evaluate stakeholder engagement, and design effective Agile team structures.
Unit 4: Agile Project Lifecycle	User stories; Backlog management; Sprint planning and execution	Construct user stories, prioritize backlogs, implement sprint planning techniques, analyze iterative workflows, and evaluate incremental delivery outcomes.
Unit 5: Continuous Delivery and Feedback Mechanisms	Incremental delivery; Continuous feedback	Analyze feedback loops, evaluate sprint reviews and retrospectives, optimize delivery cycles, and improve project adaptability through iterative refinement.
Unit 6: Agile Tools and Collaboration Practices	Jira, Trello, Asana, Azure DevOps; Communication techniques; Lightweight documentation	Implement Agile tools for tracking tasks, analyze collaboration workflows, design adaptive documentation strategies, and evaluate tool effectiveness for project monitoring.
Unit 7: Agile in Data Analytics Projects	Agile for data collection, preprocessing, and modeling	Apply Agile principles to analytics workflows, structure iterative model development, analyze uncertainty management in data projects, and optimize sprint-based analytics tasks.
Unit 8: Agile Strategy and Project Optimization	Iterative validation; Managing uncertainty; Strategic delivery planning	Formulate Agile strategies for analytics project delivery, evaluate risk mitigation approaches, optimize team productivity, and design adaptable project roadmaps

TEXTBOOK REFERENCES:

- Kenneth S. Rubin, Essential Scrum: A Practical Guide to the Most Popular Agile Process, Addison–Wesley.
- Mike Cohn, Agile Estimating and Planning, Pearson Education.
- Jeff Sutherland, Scrum: The Art of Doing Twice the Work in Half the Time, Crown Business.

REFERENCE BOOKS:

- Jonathan Rasmusson, The Agile Samurai: How Agile Masters Deliver Great Software, Pragmatic Bookshelf.
- Mike Cohn, User Stories Applied: For Agile Software Development, Addison–Wesley.
- Dean Leffingwell, Agile Software Requirements: Lean Requirements Practices for Teams, Programs, and the Enterprise, Addison–Wesley.
- Mark C. Layton & Steven J. Ostermiller, Agile Project Management for Dummies, Wiley.
- Lisa Crispin & Janet Gregory, Agile Testing: A Practical Guide for Testers and Agile Teams, Addison–Wesley.

SL : SQL: ADVANCED CONCEPTS AND APPLICATIONS

Skill Enhancement Courses								
C. No.	Course Code	Course category	Course Title	L	T	P/ RP	Total Credits	Total Hours
5	CDA25OSLO5	SL	SQL: Advanced Concepts and Applications	-	-	2	2	60

Particulars	Details (as per NCeF, 2023)	Four-Quadrant Component (as per UGC, 2020)
Course Code	CDA25OSLO5	
Course Title	SQL: Advanced Concepts and Applications	
Course Category	SL (Skill Specialization)	
Course Credits	2	
Number of Units	8	
Number of Topics	24	
Number of Videos	24	Q1 – e-Tutorials (Recorded Practical Demonstrations)
Self-Learning Material	120 Pages	Q2 – e-Content (Query Examples, Case Studies, Practice Datasets)
Number of Discussion Forums	8	Q3 – Interactive Query Solving Sessions
Question Bank	1 (Practical + Objective Questions)	Q4 – Assessment
Number of Assignments	1 (Database Query Project / Case-Based Task)	Q4 – Assessment

COURSE DESCRIPTION:

This course focuses on advanced SQL techniques used for managing and analyzing relational databases. It covers complex queries, joins, indexing, stored procedures, triggers, and database optimization. The course enables learners to efficiently retrieve, manipulate, and manage large datasets for analytical applications.

Learning Outcomes

At the end of the course, the student should be able to:

CO1: Analyze complex database schemas and relational structures for advanced querying.

CO2: Evaluate query performance and optimization techniques using indexes and execution plans.

CO3: Analyze transactional data using advanced SQL constructs such as subqueries and joins

CO4: Develop optimized SQL solutions for large-scale data processing tasks.

CO5: Design secure and efficient database queries for enterprise-level applications.

Unit	Topics	Specific Learning Objectives
Unit 1: Advanced Query Construction	Complex SELECT statements; Subqueries; UNION; INTERSECT	Construct complex SELECT queries, implement nested and correlated subqueries, apply UNION and INTERSECT operators, analyze result set combinations, and optimize data retrieval logic.
Unit 2: Joins and Conditional Data Retrieval	Inner joins; Outer joins; Self joins; CASE statements; Handling NULLs	Differentiate join types, implement multi-table queries, apply CASE expressions for conditional outputs, manage NULL values effectively, and analyze relational data structures.
Unit 3: Database Objects and SQL Programming	Views; Stored procedures; Functions; Triggers	Develop reusable database objects, implement stored procedures and user-defined functions, construct triggers for automated actions, and evaluate database modularity and security.
Unit 4: Query Optimization Techniques	Indexing; Query execution plans; Performance tuning	Analyze indexing strategies, interpret execution plans, identify performance bottlenecks, optimize query efficiency, and evaluate database tuning techniques.
Unit 5: Analytical SQL Functions	Window functions; Aggregation; Ranking functions	Apply window functions for advanced analytics, implement partitioning and ranking operations, analyze aggregated insights, and construct analytical queries for business intelligence.
Unit 6: Pivoting and Data Transformation	Pivot operations; Data reshaping techniques	Implement pivot queries, transform row-based data into columnar formats, analyze multidimensional summaries, and optimize reporting structures.

Unit	Topics	Specific Learning Objectives
Unit 7: SQL for Data Analytics Workflows	SQL in preprocessing and reporting	Integrate SQL into data preprocessing pipelines, design reporting queries, evaluate real-world analytics use cases, and support decision-making processes using structured data.
Unit 8: SQL Case Studies and Applications	Analytics case studies; Real-world scenarios	Analyze domain-specific datasets, design advanced query solutions, evaluate performance and accuracy, and construct SQL-driven analytical systems for practical applications.

TEXTBOOK REFERENCES:

- C. J. Date, SQL and Relational Theory.
- Ben Forta, SQL in 10 Minutes.

REFERENCE BOOKS:

- Joe Celko, SQL for Smarties.
- Anthony Molinaro, SQL Cookbook

SL : STATISTICAL ANALYSIS USING JAMOVI

Skill Enhancement Courses								
C. No.	Course Code	Course category	Course Title	L	T	P/ RP	Total Credits	Total Hours
6	CDA25OSLO6	SL	Statistical Analysis using Jamovi	-	-	2	2	60

Particulars	Details (as per NCrf, 2023)	Four-Quadrant Component (as per UGC, 2020)
Course Code	CDA25OSLO6	
Course Title	Statistical Analysis using Jamovi	
Course Category	SL (Skill Specialization)	
Course Credits	2	
Number of Units	8	
Number of Topics	24	
Number of Videos	24	Q1 – e-Tutorials (Recorded Software Demonstrations)
Self-Learning Material	120 Pages	Q2 – e-Content (Step-by-Step Analysis Guides, Case Studies, Sample Datasets)
Number of Discussion Forums	8	Q3 – Interactive Data Analysis Discussions
Question Bank	1 (Objective + Practical Questions)	Q4 – Assessment
Number of Assignments	1 (Statistical Analysis Report using Jamovi)	Q4 – Assessment

COURSE DESCRIPTION:

This course introduces Jamovi as an open-source statistical software for data analysis and research. It covers descriptive statistics, hypothesis testing, regression analysis, and data visualization using Jamovi tools. The course enables learners to perform statistical analysis and interpret results for academic and applied research.

Learning Outcomes

At the end of the course, the student should be able to:

CO1: Analyze datasets using statistical methods through Jamovi software.

CO2: Evaluate statistical test results for hypothesis testing and inference.

CO3: Analyze relationships among variables using correlation and regression techniques.

CO4: Develop statistical models and reports using Jamovi outputs.

CO5: Design data-driven analytical interpretations for research and business problems.

Unit	Topics	Specific Learning Objectives
Unit 1: Introduction to Jamovi and Data Management	Jamovi interface and features; Data import/export (CSV, Excel, SPSS); Data cleaning and preparation	Describe Jamovi's interface and modules, import and export datasets from multiple formats, perform data cleaning operations, manage variable types, and prepare datasets for statistical analysis.
Unit 2: Descriptive Statistics and Data Visualization	Measures of central tendency and dispersion; Frequency tables; Cross-tabulations; Graphs (bar, histogram, scatter, boxplots)	Compute descriptive statistics, construct frequency distributions, generate cross-tabulations, create graphical visualizations, and interpret summary measures for analytical insights.
Unit 3: Inferential Statistics – Hypothesis Testing	t-test; z-test; Chi-square test; Confidence intervals; Effect size	Formulate null and alternative hypotheses, conduct parametric and non-parametric tests, compute confidence intervals, interpret effect sizes, and evaluate statistical significance.
Unit 4: Correlation and Covariance Analysis	Correlation; Covariance	Analyze relationships between variables, compute correlation coefficients, interpret covariance measures, and evaluate strength and direction of associations.
Unit 5: Regression Analysis	Simple regression; Multiple regression; Logistic regression (basics)	Implement regression models, interpret regression coefficients, evaluate model fit, analyze predictive performance, and apply logistic regression for classification tasks.
Unit 6: ANOVA and MANOVA	One-way ANOVA; MANOVA	Conduct variance analysis, compare group means, interpret F-statistics, evaluate multivariate effects, and assess assumptions of variance models.
Unit 7: Non-Parametric and Factor Analysis	Non-parametric tests; Factor analysis; Reliability analysis	Apply non-parametric tests for non-normal data, perform factor extraction, evaluate reliability coefficients (e.g., Cronbach's alpha), and analyze latent constructs.
Unit 8: Advanced Analytics Applications and Case Studies	Case studies in data analytics and research reporting	Analyze complex datasets, design complete statistical workflows, interpret Jamovi output reports, and formulate research conclusions for academic and industry applications.

TEXTBOOK REFERENCES:

- Jamovi Project, The Jamovi User Guide (Official Documentation).
- Peter Richardson, Learning Statistics with Jamovi.

REFERENCE BOOKS:

- Andy Field et al., Discovering Statistics Using Jamovi, SAGE Publications.
- Danielle J. Navarro & David R. Foxcroft, Learning Statistics with Jamovi.
- Allen Downey, Think Stats: Probability and Statistics for Programmers (for conceptual grounding).

SL: WEB SCRAPING WITH PYTHON

Skill Enhancement Courses								
C. No.	Course Code	Course category	Course Title	L	T	P/ RP	Total Credits	Total Hours
7	CDA25OSLO7	SL	Web Scraping with Python	-	-	2	2	60

Particulars	Details (as per NCrf, 2023)	Four-Quadrant Component (as per UGC, 2020)
Course Code	CDA25OSLO7	
Course Title	Web Scraping with Python	
Course Category	SL (Skill Specialization)	
Course Credits	2	
Number of Units	8	
Number of Topics	24	
Number of Videos	24	Q1 – e-Tutorials (Recorded Practical Coding Demonstrations)
Self-Learning Material	120 Pages	Q2 – e-Content (Code Examples, Case Studies, Practice Exercises)
Number of Discussion Forums	8	Q3 – Interactive Coding Discussions
Question Bank	1 (Objective + Coding-Based Questions)	Q4 – Assessment
Number of Assignments	1 (Web Data Extraction Project)	Q4 – Assessment

COURSE DESCRIPTION:

This course introduces techniques for extracting data from websites using Python programming. It covers web scraping tools and libraries such as BeautifulSoup, requests, and Selenium. The course enables learners to collect, process, and analyze web-based data for data science and research applications.

Learning Outcomes

At the end of the course, the student should be able to:

- CO1:** Analyze web structures and data extraction techniques for scraping tasks.
- CO2:** Evaluate ethical and legal considerations in web data extraction.
- CO3:** Analyze unstructured web data for preprocessing and storage.
- CO4:** Develop automated web scraping pipelines using Python libraries.
- CO5:** Design scalable data collection systems for real-world analytics applications.

Unit	Topics	Specific Learning Objectives
Unit 1: Foundations of Web Scraping	Basics of web scraping and data extraction; HTML and CSS structure; Legal and ethical aspects	Identify web scraping concepts, interpret HTML tags and CSS selectors, analyze webpage structure, evaluate legal and ethical boundaries, and justify responsible data extraction practices.
Unit 2: Parsing and Extracting Data using BeautifulSoup	BeautifulSoup library; Parsing HTML; Navigating DOM; Extracting and cleaning static page data	Implement BeautifulSoup for HTML parsing, navigate DOM elements, extract structured content, clean scraped data, and evaluate extraction accuracy.
Unit 3: Automated Scraping using Scrapy Framework	Introduction to Scrapy; Creating spiders; Handling pagination; Data export	Develop Scrapy spiders, automate multi-page extraction, manage pagination workflows, export data in structured formats, and analyze scraping efficiency.
Unit 4: Dynamic Web Scraping with Selenium	Selenium for browser automation; Scraping dynamic content; JavaScript rendering; Managing browser interactions	Implement Selenium for automated browsing, scrape JavaScript-rendered content, simulate user interactions, capture dynamic data, and evaluate runtime performance.
Unit 5: Data Cleaning and Preprocessing	Structuring extracted data; Handling missing/ inconsistent data	Transform raw scraped data into structured datasets, handle inconsistencies, remove duplicates, and prepare data for analytical workflows.
Unit 6: Designing a Web Scraping Pipeline	Project planning; Target website selection; Pipeline development	Plan scraping projects, analyze target site architecture, design modular scraping pipelines, and evaluate scalability considerations.
Unit 7: Data Analysis and Visualization of Scraped Data	Data analysis; Basic visualization of scraped datasets	Perform exploratory data analysis on scraped data, generate visual summaries, interpret patterns, and validate extracted insights.
Unit 8: End-to-End Real-World Scraping Project	Complete scraping workflow: collection, analysis, visualization	Develop a full web scraping project, integrate extraction, cleaning, analysis, and visualization steps, evaluate project outcomes, and present analytical findings professionally.

TEXTBOOK REFERENCES:

- Web Scraping with Python: Collecting Data from the Modern Web by Ryan Mitchell
- Automate the Boring Stuff with Python by Al Sweigart

SL: PYSPARK FOR BIG DATA AND ANALYTICS

Skill Enhancement Courses								
C. No.	Course Code	Course category	Course Title	L	T	P/ RP	Total Credits	Total Hours
8	CDA25OSLO8	SL	PYSPARK FOR BIG DATA AND ANALYTICS	-	-	2	2	60

Particulars	Details (as per NCrF, 2023)	Four-Quadrant Component (as per UGC, 2020)
Course Code	CDA25OSLO8	
Course Title	PySpark for Big Data and Analytics	
Course Category	SL (Skill Specialization)	
Course Credits	2	
Number of Units	8	
Number of Topics	24	
Number of Videos	24	Q1 – e-Tutorials (Recorded Practical Demonstrations)
Self-Learning Material	120 Pages	Q2 – e-Content (Code Examples, Case Studies, Practice Datasets)
Number of Discussion Forums	8	Q3 – Interactive Coding and Data Processing Discussions
Question Bank	1 (Objective + Practical Coding Questions)	Q4 – Assessment
Number of Assignments	1 (Big Data Processing Project using PySpark)	Q4 – Assessment

COURSE DESCRIPTION:

This course introduces PySpark as a framework for processing large-scale datasets using distributed computing. It covers Spark architecture, data processing with Spark DataFrames, machine learning libraries, and big data analytics workflows. The course enables learners to analyze large datasets efficiently using scalable data processing techniques.

Learning Outcomes

At the end of the course, the student should be able to:

- CO1:** Analyze distributed data processing concepts using PySpark.
- CO2:** Evaluate Spark transformations and actions for large-scale data analytics.
- CO3:** Analyze performance and scalability issues in Spark-based applications.
- CO4:** Develop PySpark programs for real-time and batch data processing.
- CO5:** Design scalable analytics pipelines using Spark for Big Data environments.

UNIT	TOPICS	SPECIFIC LEARNING OBJECTIVES
Unit 1: Big Data and PySpark Fundamentals	Overview of Big Data; Apache Spark fundamentals; Setting up PySpark environment	Describe big data characteristics, explain distributed computing concepts, configure the PySpark environment, and evaluate Spark architecture components.
Unit 2: RDD Operations in PySpark	Resilient Distributed Datasets (RDDs); Basic transformations and actions	Implement RDD transformations and actions, analyze distributed data processing workflows, evaluate fault tolerance mechanisms, and optimize basic Spark operations.
Unit 3: PySpark DataFrames and Data Wrangling	Introduction to DataFrames; Data loading; Basic transformations	Load structured datasets into DataFrames, perform column operations, apply filtering and selection techniques, and transform distributed datasets efficiently.
Unit 4: Data Cleaning and Preprocessing	Handling null values; Removing duplicates; Data preparation techniques	Clean large-scale datasets, manage missing values, eliminate inconsistencies, and prepare distributed data for analytics and modeling.
Unit 5: Data Aggregation and SQL Processing	Aggregation techniques; Data processing pipelines; SQL queries in PySpark	Construct aggregation queries, implement distributed data pipelines, apply Spark SQL for querying, and analyze structured big data efficiently.
Unit 6: Performance Optimization Techniques	Partitioning; Caching; Optimization strategies	Optimize data storage through partitioning, implement caching for performance enhancement, evaluate execution efficiency, and analyze query performance improvements.
Unit 7: PySpark MLlib for Machine Learning	Introduction to MLlib; Data preparation for ML; Building and evaluating simple ML models	Prepare distributed datasets for modeling, implement MLlib algorithms, evaluate model performance metrics, and analyze scalability of machine learning workflows.
Unit 8: Real-World Big Data Analytics Project	Project planning; Dataset selection; Building pipeline; Analysis and documentation	Design an end-to-end big data pipeline, integrate data ingestion, transformation, modeling, and evaluation, analyze large-scale insights, and present documented project results professionally.

TEXTBOOK REFERENCES:

- Learning PySpark: Perform Data Wrangling, Data Analysis, and Machine Learning with Spark by Tomasz Drabas and Denny Lee
- Spark: The Definitive Guide: Big Data Processing Made Simple by Bill Chambers and Matei Zaharia

REFERENCE BOOKS:

- The Complete Guide to Apache Spark with PySpark (Udemy Course)
- Data Wrangling with PySpark (YouTube Series by Databricks)
- PySpark Python for Data Science and Big Data Analytics

SL: MICROSOFT AZURE AI PLATFORM FOR AI BASED APPLICATION DEVELOPMENT

Skill Enhancement Courses								
C. No.	Course Code	Course category	Course Title	L	T	P/ RP	Total Credits	Total Hours
9	CDA25OSLO9	SL	Microsoft Azure AI platform for AI based application development	-	-	2	2	60

Particulars	Details (as per NCrf, 2023)	Four-Quadrant Component (as per UGC, 2020)
Course Code	CDA25OSLO9	
Course Title	Microsoft Azure AI Platform for AI-Based Application Development	
Course Category	SL (Skill Specialization)	
Course Credits	2	
Number of Units	8	
Number of Topics	24	
Number of Videos	24	Q1 – e-Tutorials (Recorded Platform Demonstrations)
Self-Learning Material	120 Pages	Q2 – e-Content (Platform Guides, Case Studies, Deployment Tutorials)
Number of Discussion Forums	8	Q3 – Interactive Application Development Discussions
Question Bank	1 (Objective + Practical Questions)	Q4 – Assessment
Number of Assignments	1 (AI-Based Application Deployment Project)	Q4 – Assessment

COURSE DESCRIPTION:

This course focuses on the development of AI-powered applications using Microsoft Azure AI services. It covers cloud-based machine learning, cognitive services, model deployment, and AI application integration. The course enables learners to design and deploy scalable AI solutions using cloud platforms

Learning Outcomes

At the end of the course, the student should be able to:

CO1: Analyze Azure AI services and cloud-based AI architectures.

CO2: Evaluate Azure machine learning tools for model development and deployment.

CO3: Analyze cloud-based AI workflows for scalability and performance.

CO4: Develop AI-enabled applications using Microsoft Azure AI services.

CO5: Design end-to-end cloud-based AI solutions for real-world applications.

Unit	Topics	Specific Learning Objectives
Unit 1: Introduction to Artificial Intelligence	Introduction to Artificial Intelligence	Students able to learn Python libraries for machine learning
Unit 2: Artificial Intelligence on Microsoft Azure	Artificial Intelligence on Microsoft Azure.	Students able to learn Python libraries for machine learning
Unit 3: Standardized AI Processes	Standardized AI processes and Azure Resources	Students able to find the DevOps solution
Unit 4: Microsoft Azure Machine Learning	Microsoft Azure Machine Learning	Students able to find the DevOps solution
Unit 5: Azure Cognitive APIs	Azure Cognitive APIs.	Students can able to use REST API's
Unit 6: Computer Vision and NLP in Microsoft Azure	Computer Vision in Microsoft Azure. Natural Language Processing in Microsoft Azure	Students can able to use REST API's
Unit 7: Azure Machine Learning Service – Model Training	Azure Machine Learning Service: Model Training	Students can able to use Azure ML service
Unit 8: Azure Machine Learning Service – Model Management	Azure Machine Learning Service: Model Management	Students can able to sending JSON objects to the API

TEXTBOOK REFERENCES:

- “AI-900: Microsoft Azure AI Fundamentals Certification Guide” by Julian Sharp

SL: BUSINESS INTELLIGENCE AND VISUALIZATION WITH POWER BI

Skill Enhancement Courses								
C. No.	Course Code	Course category	Course Title	L	T	P/ RP	Total Credits	Total Hours
10	CDA25OSL10	SL	Business Intelligence and Visualization with Power BI	-	-	2	2	60

Particulars	Details (as per NCrf, 2023)	Four-Quadrant Component (as per UGC, 2020)
Course Code	CDA25OSL10	
Course Title	Business Intelligence and Visualization with Power BI	
Course Category	SL (Skill Specialization)	
Course Credits	2	
Number of Units	8	
Number of Topics	24	
Number of Videos	24	Q1 – e-Tutorials (Recorded Practical Demonstrations)
Self-Learning Material	120 Pages	Q2 – e-Content (Step-by-Step Guides, Case Studies, Sample Business Datasets)
Number of Discussion Forums	8	Q3 – Interactive Dashboard Review Discussions
Question Bank	1 (Objective + Practical Questions)	Q4 – Assessment
Number of Assignments	1 (Interactive BI Dashboard Development Project)	Q4 – Assessment

COURSE DESCRIPTION:

This course introduces Power BI as a business intelligence tool for data analysis and visualization. It covers data modeling, data transformation, dashboard creation, and interactive reporting. The course enables learners to develop insightful dashboards and visual reports to support strategic business decisions.

Learning Outcomes

At the end of the course, the student should be able to:

CO1: Analyze business datasets to identify key performance indicators and trends.

CO2: Evaluate data models and transformations for BI reporting.

CO3: Analyze interactive reports and dashboards for decision support.

CO4: Develop dynamic Power BI dashboards integrating multiple data sources.

CO5: Design enterprise-level BI solutions to support strategic decision-making.

Unit	Topics	Specific Learning Objectives
Unit 1: Fundamentals of Business Intelligence and Power BI	Power BI Desktop interface; Components: Power Query, Power Pivot, Power View; Data connectivity from multiple sources	Identify Power BI components, describe BI concepts, establish connections to Excel, SQL, and cloud sources, and analyze the environment for analytical workflows.
Unit 2: Data Import, Cleaning, and Transformation	Power Query Editor; M language; Merging, appending, profiling datasets	Apply ETL techniques using Power Query, transform and merge datasets, implement profiling operations, and ensure data accuracy and readiness for modeling.
Unit 3: Data Modeling and Relationships	Relational modeling; Hierarchies; DAX functions: SUMX, CALCULATE, FILTER	Construct relational data models, define relationships and hierarchies, implement DAX calculations, and derive dynamic analytical measures from multidimensional datasets.
Unit 4: Visualization Fundamentals	Charts, filters, slicers; Interaction features	Design visual elements, apply filters and slicers, customize charts, and create interactive visualizations for effective business storytelling.
Unit 5: Advanced Dashboard Design	Integrating visuals; Interactive dashboard development	Construct comprehensive dashboards, optimize layout and interactivity, analyze user engagement, and implement analytical interpretation for decision support.
Unit 6: Publishing and Sharing Reports	Publishing to Power BI Service; Workspaces; Collaborative access	Deploy reports to Power BI Service, manage workspaces, assign access permissions, and evaluate collaborative analytics workflows.
Unit 7: Data Refresh and Scheduling	Refresh scheduling; Incremental refresh; Real-time data connections	Configure scheduled refreshes, implement incremental data updates, connect to real-time data streams, and analyze data currency for timely insights.

Unit	Topics	Specific Learning Objectives
Unit 8: Security and Enterprise Management	Row-Level Security (RLS); Controlled access; Governance	Implement RLS, define security roles, manage access levels, evaluate enterprise reporting governance, and design secure Power BI analytics environments.

TEXTBOOK REFERENCES:

- Russo, M., & Ferrari, A. (2019). The Definitive Guide to DAX: Business Intelligence for Microsoft Power BI, SQL Server Analysis Services, and Excel. Microsoft Press.
- Deckler, G., & Powell, B. (2022). Mastering Microsoft Power BI. Packt Publishing Limited.

OTHER REFERENCES:

- Maslyuk, D. (2018). Exam Ref 70-778 Analyzing and Visualizing Data with Microsoft Power BI. Microsoft Press.
- Microsoft Docs: <https://learn.microsoft.com/en-us/power-bi/>

GE1: RESPONSIBLE AI AND DATA ETHICS

C. No.	Course Code	Course Category	Course Title	L	P/ RP	Total Credits	Total Hours
1	CDA25OGE01	GE	Responsible AI and Data Ethics	3	–	3	90

Particulars	Details (as per NCrf, 2023)	Four-Quadrant Component (as per UGC, 2020)
Course Number	1	
Course Code	CDA25OGE01	
Course Category	GE	
Course Title	Responsible AI and Data Ethics	
Course Credits	3	
Number of Units	12	
Number of Topics	36	
Number of Videos	36	Q1 – e-Tutorials
Self-Learning Material	200 Pages	Q2 – e-Content
Number of Discussion Forums	12	Q3 – Discussion Forum
Question Bank	1	Q4 – Assessment
Number of Assignments	2	Q4 – Assessment

COURSE DESCRIPTION

This course introduces the ethical, societal, and regulatory aspects of Artificial Intelligence and data-driven technologies. It focuses on responsible AI development, data governance, privacy protection, fairness, transparency, and accountability in automated decision systems. The course enables learners to critically evaluate AI technologies and apply ethical principles in the design, deployment, and governance of intelligent systems.

Learning Outcomes

- CO1:** Explain the principles and foundations of responsible AI and data ethics
- CO2:** Examine ethical challenges in data collection, privacy, and governance.
- CO3:** Analyze bias, fairness, and transparency issues in AI systems.
- CO4:** Evaluate legal and policy frameworks governing AI and data usage.
- CO5:** Design responsible AI solutions incorporating ethical and accountability principles.



Unit	Topics	Specific Learning Objectives
Unit 1: Introduction to AI and Ethics	AI overview, history of AI, role of data in AI systems	Define AI and ethics concepts, identify key applications of AI, and analyze ethical implications of AI technologies in society.
Unit 2: Foundations of Data Ethics	Ethical principles in data usage, responsible data practices, ethical decision frameworks	Describe core principles of data ethics, examine ethical challenges in data usage, and evaluate responsible data practices in organizations.
Unit 3: Data Privacy and Protection	Data privacy concepts, personal data protection, privacy risks	Explain data privacy principles, identify risks to personal data, and assess mechanisms for protecting privacy in digital systems.
Unit 4: Data Governance and Stewardship	Data ownership, data lifecycle management, governance frameworks	Outline data governance structures, classify stages of the data lifecycle, and evaluate effective data stewardship practices.
Unit 5: Bias in Data and Algorithms	Sampling bias, algorithmic bias, measurement bias	Define types of bias in datasets and algorithms, examine sources of bias, and analyze impacts of bias on AI decisions.
Unit 6: Fairness and Accountability in AI	Fairness principles, accountability mechanisms, ethical AI evaluation	Describe fairness concepts in AI, examine accountability in automated decisions, and evaluate fairness metrics for AI systems.
Unit 7: Transparency and Explainable AI	Explainable AI (XAI), model interpretability, transparency principles	Explain concepts of explainable AI, differentiate interpretable models, and analyze transparency requirements in AI systems.
Unit 8: Ethical AI Development Practices	Responsible AI design, human-centered AI, ethical frameworks	Identify responsible AI development principles, examine human-centered design approaches, and apply ethical frameworks in AI development.
Unit 9: AI Governance and Policy Frameworks	Global AI governance initiatives, policy guidelines, ethical standards	Describe AI governance principles, compare international AI ethics guidelines, and evaluate governance frameworks for responsible AI adoption.
Unit 10: Legal and Regulatory Aspects of AI	Data protection laws, digital rights, regulatory compliance	Explain AI-related legal regulations, examine digital rights issues, and assess compliance requirements in AI deployment.

Unit	Topics	Specific Learning Objectives
Unit 11: Societal Impacts of AI	AI and employment, social inequality, sectoral impacts (healthcare, education, governance)	Identify societal implications of AI technologies, analyze impacts across sectors, and evaluate ethical challenges in AI-driven systems.
Unit 12: Responsible AI Implementation	AI risk assessment, ethical AI case studies, future trends	Explain AI risk assessment principles, analyze ethical AI case studies, and design responsible AI implementation strategies.

Textbook References

- Floridi, L. – *Ethics of Artificial Intelligence*, Oxford University Press.
- Russell, S. & Norvig, P. – *Artificial Intelligence: A Modern Approach*, Pearson.
- Barocas, S., Hardt, M., Narayanan, A. – *Fairness and Machine Learning*, MIT Press.
- Mittelstadt, B., Allo, P., Taddeo, M., Wachter, S., Floridi, L. – *The Ethics of Algorithms*, Oxford University Press.
- Jobin, A., Ienca, M., Vayena, E. – *Global Landscape of AI Ethics Guidelines*, Nature Machine Intelligence.

GE2: AI TOOLS FOR EVERYDAY PRODUCTIVITY

C. No.	Course Code	Course Category	Course Title	L	P/ RP	Total Credits	Total Hours
2	CDA25OGE02	GE	AI Tools for Everyday Productivity	3	–	3	90

Particulars	Details (as per NCrf, 2023)	Four-Quadrant Component (as per UGC, 2020)
Course Number	2	
Course Code	CDA25OGE02	
Course Category	GE	
Course Title	AI Tools for Everyday Productivity	
Course Credits	3	
Number of Units	12	
Number of Topics	36	
Number of Videos	36	Q1 – e-Tutorials
Self-Learning Material	200 Pages	Q2 – e-Content
Number of Discussion Forums	12	Q3 – Discussion Forum
Question Bank	1	Q4 – Assessment
Number of Assignments	2	Q4 – Assessment

Course Description

This course introduces practical Artificial Intelligence tools that enhance everyday productivity in academic, professional, and personal tasks. It focuses on the use of AI-powered applications for writing, data analysis, communication, design, automation, and decision-making. The course enables learners to effectively apply AI tools for improving efficiency, creativity, and problem-solving while understanding responsible usage practices.

Learning Outcomes
CO1: Explain the role of AI tools in improving everyday productivity.
CO2: Apply AI-powered tools for writing, communication, and content creation.
CO3: Analyze AI tools used for data organization and decision support.
CO4: Evaluate the effectiveness of AI tools for workflow automation and productivity improvement.
CO5: Design efficient workflows using multiple AI tools for real-world tasks.

Unit	Topics	Specific Learning Objectives
Unit 1: Introduction to AI Tools	Overview of AI tools, productivity applications, benefits of AI tools	Define AI productivity tools, identify common AI applications, and analyze their role in improving efficiency in daily tasks.
Unit 2: AI Tools for Writing and Content Creation	AI writing assistants, grammar and editing tools, automated content generation	Describe AI writing tools, use AI for text generation and editing, and evaluate the effectiveness of AI-assisted writing.
Unit 3: AI Tools for Communication and Collaboration	AI email assistants, meeting summarization tools, chatbots	Explain AI communication tools, examine their role in collaboration, and analyze productivity improvements in communication workflows.
Unit 4: AI Tools for Information Search and Research	AI-powered search engines, research assistants, summarization tools	Identify AI research tools, apply AI summarization techniques, and evaluate the reliability of AI-generated information.
Unit 5: AI Tools for Data Organization and Analysis	Spreadsheet AI features, data visualization tools, automated insights	Describe AI tools for data organization, apply AI features in spreadsheets, and analyze data insights using AI-assisted tools.
Unit 6: AI Tools for Presentation and Design	AI presentation tools, graphic design tools, automated slide generation	Explain AI design tools, apply AI tools to create presentations, and evaluate design quality using AI-assisted methods.
Unit 7: AI Tools for Image and Media Generation	Image generation tools, video creation tools, AI media editing	Describe AI media tools, create visual content using AI, and analyze the role of generative AI in creative tasks.
Unit 8: AI Tools for Task Management and Productivity	AI task planners, scheduling assistants, productivity automation	Identify AI productivity tools, use AI scheduling assistants, and evaluate improvements in task management efficiency.
Unit 9: AI Tools for Learning and Education	AI tutoring tools, adaptive learning platforms, AI study assistants	Explain AI learning tools, examine their role in personalized learning, and analyze their impact on educational productivity.
Unit 10: AI Tools for Business and Workplace Productivity	AI customer support tools, AI analytics platforms, workplace automation	Describe AI tools used in organizations, analyze AI-driven business productivity improvements, and evaluate workplace automation benefits.
Unit 11: Responsible Use of AI Tools	Ethical use of AI tools, data privacy concerns, responsible AI practices	Explain ethical concerns in AI tool usage, identify risks of misuse, and evaluate responsible practices for AI-assisted productivity.
Unit 12: AI Workflow Integration and Future Trends	Integrating multiple AI tools, AI workflow optimization, future AI productivity tools	Explain AI workflow integration concepts, analyze productivity workflows using AI tools, and design efficient AI-supported productivity strategies.



Textbook References

- Mollick, E. – *Co-Intelligence: Living and Working with AI*, Portfolio Publications.
- Russell, S. & Norvig, P. – *Artificial Intelligence: A Modern Approach*, Pearson.
- Marr, B. – *Artificial Intelligence in Practice*, Wiley.
- Davenport, T. & Miller, S. – *Working with AI*, MIT Press.

GE3: DIGITAL MARKETING ANALYTICS

C. No.	Course Code	Course Category	Course Title	L	P/ RP	Total Credits	Total Hours
3	CDA25OGE03	GE	Digital Marketing Analytics	3	–	3	90

Particulars	Details (as per NCeF, 2023)	Four-Quadrant Component (as per UGC, 2020)
Course Number	3	
Course Code	CDA25OGE03	
Course Category	GE	
Course Title	Digital Marketing Analytics	
Course Credits	3	
Number of Units	12	
Number of Topics	36	
Number of Videos	36	Q1 – e-Tutorials
Self-Learning Material	200 Pages	Q2 – e-Content
Number of Discussion Forums	12	Q3 – Discussion Forum
Question Bank	1	Q4 – Assessment
Number of Assignments	2	Q4 – Assessment

Course Description

This course introduces the principles and techniques of digital marketing analytics used to measure and optimize online marketing performance. It focuses on data-driven decision making using web analytics, social media analytics, customer behavior analysis, and digital marketing metrics. The course equips learners with analytical skills to evaluate marketing campaigns, interpret digital data, and improve marketing strategies through insights derived from analytics tools.

Learning Outcomes

- CO1:** Explain fundamental concepts of digital marketing and analytics.
- CO2:** Examine digital marketing metrics and performance indicators.
- CO3:** Analyze customer behavior using web and social media analytics.
- CO4:** Evaluate marketing campaign effectiveness using data-driven insights.
- CO5:** Design data-driven strategies to optimize digital marketing performance.

Unit	Topics	Specific Learning Objectives
Unit 1: Introduction to Digital Marketing	Digital marketing concepts, online marketing channels, role of analytics in marketing	Define digital marketing concepts, identify key digital channels, and analyze the role of analytics in marketing decisions.
Unit 2: Digital Marketing Metrics and KPIs	Marketing metrics, key performance indicators (KPIs), marketing dashboards	Describe digital marketing metrics, examine key performance indicators, and evaluate marketing performance using dashboards.
Unit 3: Web Analytics Fundamentals	Web analytics concepts, website traffic metrics, visitor behavior analysis	Explain web analytics concepts, identify traffic metrics, and analyze user behavior on websites.
Unit 4: Search Engine Optimization (SEO) Analytics	SEO metrics, keyword analytics, search ranking analysis	Describe SEO analytics concepts, examine keyword performance metrics, and analyze search engine ranking data.
Unit 5: Social Media Analytics	Social media engagement metrics, follower analytics, campaign insights	Define social media analytics metrics, examine engagement indicators, and analyze campaign performance on social platforms.
Unit 6: Content Marketing Analytics	Content performance metrics, audience engagement, content optimization	Explain content marketing metrics, identify engagement indicators, and evaluate content effectiveness using analytics.
Unit 7: Email Marketing Analytics	Email marketing metrics, open rates, click-through rates, conversion metrics	Describe email marketing analytics metrics, examine campaign performance indicators, and analyze email marketing effectiveness.
Unit 8: Customer Behavior Analytics	Customer journey analysis, user segmentation, behavioral insights	Identify customer behavior metrics, analyze user journey data, and evaluate segmentation strategies for marketing decisions.
Unit 9: Conversion Rate Optimization (CRO)	Conversion metrics, funnel analysis, A/B testing	Explain conversion metrics, examine marketing funnels, and evaluate A/B testing strategies for optimizing conversions.
Unit 10: Marketing Analytics Tools	Web analytics tools, social media analytics tools, marketing dashboards	Describe marketing analytics tools, apply analytics platforms to interpret marketing data, and analyze insights from dashboards.
Unit 11: Data Visualization for Marketing Insights	Marketing reports, visualization techniques, decision dashboards	Explain data visualization techniques, interpret marketing reports, and evaluate insights for marketing decision-making.

Unit	Topics	Specific Learning Objectives
Unit 12: Digital Marketing Strategy and Future Trends	Data-driven marketing strategies, predictive marketing analytics, emerging trends	Describe data-driven marketing strategies, analyze predictive marketing insights, and design effective digital marketing strategies using analytics.

Textbook References

- Chaffey, D. & Ellis-Chadwick, F. – *Digital Marketing: Strategy, Implementation and Practice*, Pearson.
- Ryan, D. – *Understanding Digital Marketing*, Kogan Page.
- Clifton, B. – *Advanced Web Metrics with Google Analytics*, Wiley.
- Marr, B. – *Data Strategy: How to Profit from a World of Big Data, Analytics and AI*, Kogan Page.
- Kaushik, A. – *Web Analytics 2.0*, Wiley

LIBRARY RESOURCES

Hard Copy Resources

1. Statistical methods
2. Bio Statistics: Basic concepts & methodology for the Health sciences
3. Statistical & Numerical methods
4. Doing Data science
5. A Beginner's guide to learning Analytics
6. Big Data and Analytics
7. Business Analytics
8. Internet of Things
9. Machine Learning
10. Python programming
11. Deep learning
12. A first course in artificial Intelligence
13. Statistical Methods
14. Introducing Data Science
15. SQL,PI/SQL(the programming language of oracle)

E Resources

- Scopus Research Database
- Springer Journals Medicine Collection
- Springer Nature Uptodate
- BMJ Best Practice
- BMJ Research to Publication
- BMJ Case Report
- DELNET IESTC
- DELNET IPC



SRI RAMACHANDRA Online

INSTITUTE OF HIGHER EDUCATION AND RESEARCH

(Category - I Deemed to be University) Porur, Chennai.



<https://sriamachandraonline.edu.in>