**Anekant Education Society's**

# Tuljaram Chaturchand College

**of Arts, Science and Commerce, Baramati**

***(Empowered Autonomous)***

**Four Year B.Sc. Degree Program in Data Science**

**(Faculty of Science & Technology)**

**CBCS Syllabus**

## F.Y.B.Sc. (Data Science) Semester – I

**For Department of Data Science**

**Tuljaram Chaturchand College of Arts, Science and Commerce, Baramati**

**Choice Based Credit System Syllabus**

## As Per NEP 2.0 (2024 Pattern)

**To be implemented from Academic Year 2026 – 2027**

# Title of the Programme: Bachelor of Science (B.Sc.) in Data Science

## Preamble

In the era of digital transformation, data has become a critical resource for decision-making across various sectors such as business, healthcare, finance, governance, and scientific research. The rapid growth of data generation has created a strong demand for professionals who can collect, analyze, interpret, and derive meaningful insights from large and complex datasets. Data Science, as an interdisciplinary field, integrates concepts from statistics, computer science, mathematics, and domain knowledge to extract valuable information from data.

The **Bachelor of Science (B.Sc.) in Data Science** program is designed to equip students with fundamental knowledge and practical skills in data analysis, statistical modeling, programming, machine learning, and data visualization. The program emphasizes both theoretical understanding and hands-on training using modern computational tools and technologies. The curriculum aims to develop analytical thinking, problem-solving ability, and computational skills among students so that they can effectively handle real-world data-driven problems. It also focuses on building a strong foundation in statistics, programming languages such as Python and R, database management, and machine learning techniques.

This program prepares students for diverse career opportunities in industries such as information technology, finance, healthcare analytics, market research, and government sectors. In addition, it provides a strong academic foundation for higher studies and research in data science, statistics, artificial intelligence, and related disciplines.

Overall, the B.Sc. in Data Science program aims to produce competent data professionals who can contribute effectively to the rapidly evolving data-driven economy.

1. **Name of the Program:** Bachelor of Science (B.Sc.) in Data Science
2. **Duration:** 4 Years (8 Semester)
3. **Total Credits:** 176 Credits [*Core (Major + Minor + Electives + Practical + Skill Courses) = 136, Project / Thesis (FP, CEP, OJT, Research Project) = 22, Extra Mandatory (AEC, VEC, IKS, CC) = 18*]
4. **Intake Capacity: 60**
5. **Course Fees:** Rs. 42,800 per year
6. **Eligibility:**

   The candidate must have passed **Higher Secondary Examination (10+2)** from stream Science or equivalent from a recognized board are eligible. Preference may be given to students who have studied: Mathematics / Computer Science / IT. The candidate must have obtained minimum 40% marks (or as per university norms) in 12th standard. Admission will be based on: Merit ($12^{th}$ Marks) or as per college admission rules.
7. **Examination:**

   **A)** (i) **Pattern of examination**: There would be Continuous Internal assessment (CIA) (40%) or in semester assessment and an End of Term Examination (ETE) (60%) for each course.

   (ii) **Pattern of Continuous Internal Assessment:** CIA includes written

examinations, along with at least two methods of evaluation such as assignments, MCQ test, small projects, viva-voce examinations, presentations, seminars, open notebook test, group discussion, quizzes etc.

(iii) **Pattern of the question paper at End of Term Examination (ESE)**: Duration of ESE will be 120 minutes having 60 marks for each course. Question paper contain objective type questions, short answer questions, long answer questions, examples, etc.

**Exam. Seat No.** |  |

**Total No. of Questions : 5]** **[Total No. of Pages : 1**

**Anekant Education Society's**
**Tuljaram Chaturchand College of Arts, Science and Commerce, Baramati**
**(Empowered Autonomous)**
**Affiliated to Savitribai Phule Pune University, Pune**
**F.Y./S.Y./T.Y.B.Sc. (Data Science)**
**Semester – I/II/III/IV/V/VI/VII/VIII**
**Course Code: Course Title**
**(2024 Pattern)**

**Time: Two Hours** **(No. of Credits:02/04)** **Max. Marks : 60**

**Instructions to the Candidates : (If any)**

I. ----------
II. ----------
III. ----------

Q1. (A) Attempt **each** of the following (1 Marks each)

(i)
(ii)
(iii)
(iv)

(B) Attempt **each** of the following (2 Marks each)

(i)
(ii)
(iii)
(iv)

Q2. Attempt any **three** of the following (4 Marks each)

(i)
(ii)
(iii)
(iv)

Q3. Attempt any **two** of the following (6 Marks each)

(i)
(ii)
(iii)

Q4. Attempt any **two** of the following (6 Marks each)

(i)
(ii)
(iii)

Q5. Attempt any **one** of the following (12 Marks each)

(i)
(ii)

**B)** (i) **Standard of Passing**: For passing the course, student has to obtain marks at least 40 % ESE and CIA separately as well as combined.

(ii) Explanation of Grade and Grade Point Average

| Grade Point Average | Marks Obtained % | Final Grade/Result | Grade Point |
|---|---|---|---|
| 09.00 – 10.00 | 90 ≤ Marks ≤ 100 | O : Outstanding | 10 |
| 08.00 – < 09.00 | 80 ≤ Marks ≤ 89 | A+ : Excellent | 9 |
| 07.00 – < 08.00 | 70 ≤ Marks ≤ 79 | A : Very Good | 8 |
| 06.00 – < 07.00 | 60 ≤ Marks ≤ 69 | B+ : Good | 7 |
| 05.50 – < 06.00 | 55 ≤ Marks ≤ 59 | B : Above Average | 6 |
| 05.00 – < 05.50 | 50 ≤ Marks ≤ 54 | C : Average | 5 |
| 04.00 – < 05.00 | 40 ≤ Marks ≤ 49 | P : Pass | 4 |
| 00.00 – < 04.00 | 00 ≤ Marks ≤ 39 | F : Fail | 0 |
| AA | AA | AA: Absent | 0 |

**Anekant Education Society's**

# Tuljaram Chaturchand College

**of Arts, Science and Commerce Baramati, Dist.-Pune, MS, India.**

***(Empowered Autonomous)***

## Board of Studies in Data Science
### (Academic Year 2025-26 to 2027-28)

| Sr. No. | Name of Members | Designation |
|---|---|---|
| 1. | **Dr. Swami Chandrashekhar Panchayya**<br>Assistant Professor, Department of Statistics, T. C. College, Baramati | **Chairperson** |
| 2. | **Dr. Malusare Priti Sandeep**<br>Assistant Professor, Department of Statistics, T. C. College, Baramati | Member |
| 3. | **Dr. Jagtap Nilambari Arvind**<br>Assistant Professor, Department of Statistics, T. C. College, Baramati | Member |
| 4. | **Dr. Gaikwad Pooja Sujit**<br>Assistant Professor, Department of Statistics, T. C. College, Baramati | Member |
| 5. | **Miss. Rakate Priya Nanasaheb**<br>Assistant Professor, Department of Statistics, T. C. College, Baramati | Member |
| 6. | **Dr. Shashikant Chandrakant Nakate**<br>Assistant Professor, Department of Computer Science, T. C. College, Baramati | Member |
| 7. | **Dr. Vishal Vilaskumar Shaha**<br>Assistant Professor, Department of Computer Science, T. C. College, Baramati | Member |
| 8. | **Dr. Rahul Adesh Shah**<br>Assistant Professor, Department of Computer Science, T. C. College, Baramati | Member |
| 9. | **Dr. Aniket Siddhaling Kothawale**<br>Assistant Professor, Department of Electronics, T. C. College, Baramati | Member |
| 10. | **Dr. Shaila Shivaji Jadhav**<br>Assistant Professor, Department of Statistics, T. C. College, Baramati | Member |
| 11. | | Vice-Chancellor Nominee<br>Subject Expert from SPPU, Pune |
| 12. | **Dr. Chandrakant G. Gardi** | Subject Expert from Outside the Parent University |
| 13. | **Dr. Ritesh A. Magre** | Subject Expert from Outside the Parent University |
| 14. | **Mr. Kunal Kishor Pagariya** | Representative from industry/corporate sector/allied areas |
| 15. | **Mr. Bharat Arjun Jambhulkar** | Member of the College Alumni |

| | | |
|---|---|---|
| 16. | **Miss. Mrunmai Shrinivas Bopardikar** | PG Student |
| 17. | **Mr. Yogiraj Santosh Jadhav** | PG Student |

Anekant Education Society's

# Tuljaram Chaturchand College

of Arts, Science & Commerce, Baramati.

Tuljaram Chaturchand College of Arts, Science & Commerce, Baramati is an empowered autonomous & dynamic institute and has successfully implemented the National Education Policy 2.0 2024 pattern since the academic year 2024-25. We are updating our academic policies as per local needs keeping in view the global perspectives. Accordingly, we have updated our program outcomes as per the graduate attributes defined in New Education Policy. In general, program outcomes are categorized into two categories as disciplinary & interdisciplinary outcomes and generic outcomes.

## Program Outcomes for B.Sc.

**PO.1.** **Comprehensive Knowledge and Understanding**: Graduates will possess a profound understanding of their field of study, including foundational theories, principles, methodologies, and key concepts, within a broader multidisciplinary context.

**PO.2.** **Practical, Professional, and Procedural Knowledge**: Graduates will acquire practical skills and expertise essential for professional tasks within their field. This includes knowledge of industry standards, best practices, regulations, and ethical considerations, with the ability to apply this knowledge effectively in real-world scenarios.

**PO.3.** **Entrepreneurial Mindset and Knowledge**: Graduates will cultivate an entrepreneurial mindset, identifying opportunities, fostering innovation, and understanding business principles, market dynamics, and risk management strategies.

**PO.4.** **Specialized Skills and Competencies**: Graduates will demonstrate proficiency in technical skills, analytical abilities, problem-solving, effective communication, and leadership, relevant to their field of study. They will also adapt and innovate in response to changing circumstances.

**PO.5.** **Capacity for Application, Problem-Solving, and Analytical Reasoning**: Graduates will possess the capacity to apply learned concepts in practical settings,

solve complex problems, and analyze data effectively. This requires critical thinking, creativity, adaptability, and a readiness to learn and take calculated risks.

**PO.6.** **Communication Skills and Collaboration**: Graduates will effectively communicate complex information, both orally and in writing, using appropriate media and language. They will also collaborate effectively in diverse teams, demonstrating leadership qualities and facilitating cooperative efforts toward common goals.

**PO.7.** **Research-related Skills**: Graduates will demonstrate observational and inquiry skills, formulate research questions, and utilize appropriate methodologies for data collection and analysis. They will also adhere to research ethics and effectively report research findings.

**PO.8.** **Learning How to Learn Skills**: Graduates will acquire new knowledge and skills through self-directed learning, adapt to changing demands, and set and achieve goals independently.

**PO.9.** **Digital and Technological Skills**: Graduates will demonstrate proficiency in using ICT, accessing information sources, and analyzing data using appropriate software.

**PO.10.** **Multicultural Competence, Inclusive Spirit, and Empathy**: Graduates will engage effectively in multicultural settings, respecting diverse perspectives, leading diverse teams, and demonstrating empathy and understanding of others' perspectives and emotions.

**PO.11.** **Value Inculcation and Environmental Awareness**: Graduates will embrace ethical and moral values, practice responsible citizenship, recognize and address ethical issues, and take appropriate actions to promote sustainability and environmental conservation.

**PO.12.** **Autonomy, Responsibility, and Accountability**: Graduates will apply knowledge and skills independently, manage projects effectively, and demonstrate responsibility and accountability in work and learning contexts.

**PO.13.** **Community Engagement and Service**: Graduates will actively participate in community-engaged services and activities, promoting societal well-being.

# Programme Specific Outcomes (PSOs)

***PSO1: Statistical and Mathematical Proficiency***

Graduates will develop the ability to apply core concepts of mathematics, probability, and statistics to analyze data and solve quantitative problems accurately.

***PSO2: Data Acquisition, Management, and Organization***

Graduates will gain practical skills in collecting, cleaning, storing, and managing structured and unstructured data using databases, SQL, and modern data management tools.

***PSO3: Programming and Computational Skills***

Graduates will demonstrate proficiency in programming languages such as Python, R, and SQL, using them effectively for data manipulation, analysis, and automation.

***PSO4: Data Analysis and Machine Learning***

Graduates will be able to apply statistical models, machine learning techniques, and algorithmic approaches to extract meaningful insights and make data-driven predictions.

***PSO5: Data Visualization and Communication***

Graduates will develop the ability to create effective visualizations using modern tools, and communicate technical results and complex findings clearly to both technical and non-technical audiences.

***PSO6: Critical Thinking and Problem-Solving***

Graduates will cultivate analytical reasoning and problem-solving skills to identify real-world challenges, choose appropriate data science techniques, and propose innovative solutions.

***PSO7: Ethical and Professional Application of Data Science***

Graduates will practice ethical data handling, responsible use of technology, and apply their skills in domains such as business, healthcare, finance, and social sciences for societal benefit.

## Credit Distribution Structure for Three/Four Year Honours/Honours with Research Degree Programme With Multiple Entry and Exit options as per National Education Policy (2024 Pattern as per NEP-2020)

| Level/ Difficulty | Sem | Subject DSC-1 | | | | Subject DSC-2 | Subject DSC-3 | GE/OE | SEC | IKS | AEC | VEC | CC | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4.5/100 | I | 2(T)+2(P) | | | | 2(T)+2(P) | 2(T)+ 2(P) | 2(T) | 2 (T/P) | 2(T) (Generic) | 2(T) | 2(T) | -- | 22 |
| | II | 2(T)+2(P) | | | | 2(T)+2(P) | 2(T)+2(P) | 2(P) | 2 (T/P) | -- | 2(T) | 2(T) | 2(T | 22 |
| **Exit option**: Award of UG Certificate in Major with 44 credits and an additional 4 credits core NSQF course/Internship OR Continue with Major and Minor<br>**Continue option**: Student will select one subject among the (subject 1, subject 2 and subject 3) as major and other as minor and third subject will be dropped. | | | | | | | | | | | | | | |
| **Level/ Difficulty** | **Sem** | **Credits Related to Major** | | | | **Minor** | -- | **GE/OE** | **SEC** | **IKS** | **AEC** | **VEC** | **CC** | **Total** |
| | | **Major Core** | **Major Elective** | **VSC** | **FP/OJT/CEP/RP** | | | | | | | | | |
| 5.0/200 | III | 4(T)+2(P) | -- | 2 (T/P) | 2(FP) | 2(T)+2(P) | -- | 2(T) | -- | 2(T) | 2(T) | -- | 2(T) | 22 |
| | IV | 4(T)+2(P) | -- | 2 (T/P) | 2(CEP) | 2(T)+2(P) | -- | 2(P) | 2 (T/P) | -- | 2(T) | -- | 2(T) | 22 |
| **Exit option: Award of UG Diploma** in Major and Minor with 88 credits and an additional 4credits core NSQF course/Internship OR Continue with Major and Minor | | | | | | | | | | | | | | |
| 5.5/300 | V | 8(T)+4(P) | 2(T)+2(P) | | 4 (OJT) | 2(T) | -- | -- | -- | -- | -- | -- | -- | 22 |
| | VI | 8(T)+4(P) | 2(T)+2(P) | 4 (T/P) | 2(FP/CEP) | -- | -- | -- | -- | -- | -- | -- | -- | 22 |
| **Total 3Years** | | **44** | **8** | **8** | **10** | **18** | **8** | **8** | **6** | **4** | **8** | **4** | **6** | **132** |
| **Exit option**: Award of **UG Degree in Major** with 132 credits OR Continue with Major and Minor | | | | | | | | | | | | | | |
| 6.0/400 | VII | 6(T)+4(P) | 2(T)+2 (T/P) | -- | 4(RP) | 4(RM)(T) | -- | -- | -- | -- | -- | -- | -- | 22 |
| | VIII | 6(T)+4(P) | 2(T)+2 (T/P) | -- | 8(RP) | -- | -- | -- | -- | -- | -- | -- | -- | 22 |
| **Total 4Years** | | **64** | **16** | **8** | **22** | **22** | **8** | 8 | **6** | **4** | **8** | **4** | **6** | **176** |
| Four Year **UG Honours with Research Degree** in Major and Minor with 176 credits | | | | | | | | | | | | | | |
| 6.0/400 | VII | 10(T)+4(P) | 2(T)+2 (T/P) | -- | -- | 4(RM) (T) | -- | -- | -- | -- | -- | -- | -- | 22 |
| | VIII | 10(T)+4(P) | 2(T)+2 (T/P) | -- | 4 (OJT) | -- | -- | -- | -- | -- | -- | -- | -- | 22 |
| **Total 4Years** | | **72** | **16** | **8** | **14** | **22** | **8** | 8 | **6** | **4** | **8** | **4** | **6** | **176** |
| Four Year **UG Honours Degree** in Major and Minor with 176 credits | | | | | | | | | | | | | | |

**T =** Theory **P =** Practical **DSC =** Discipline Specific Course **OE =** Open Elective **SEC =** Skill Enhancement Course
**IKS =** Indian Knowledge System **AEC =** Ability Enhancement Course **VEC =** Value Education Course **CC =** Co-curricular Course
**VSC**= Vocational Skill Course **OJT**= On Job Training **CEP**= Community Engagement Project **FP**= Field Project **RP**= Research Project

## Course Structure for F.Y.B.Sc. (Data Science) (2024 Pattern as per NEP- 2.0)

| Sem | Course Type | Course Code | Course Title | Theory/ Practical | Credits |
|---|---|---|---|---|---|
| I | DSC-I (General) | DSC-101-GEN | Basic Python Programming | T | 02 |
| | | DSC-102-GEN | Practical Based on Basic Python Programming | P | 02 |
| | DSC-II (General) | DSC-103-GEN | Fundamentals of Statistics | T | 02 |
| | | DSC-104-GEN | Practical Based on Fundamental of Statistics Using Excel | P | 02 |
| | DSC-III (General) | DSC-105-GEN | Linear Algebra | T | 02 |
| | | DSC-106-GEN | Practical Based on Linear Algebra | P | 02 |
| | Open Elective (OE) | DSC-107-OE | Internet Awareness | T | 02 |
| | Skill Enhancement Course (SEC) | DSC-108-SEC | Electronics and Digital Logic | P | 02 |
| | Ability Enhancement Course (AEC) | ENG-104-AEC | Functional English-I | T | 02 |
| | Value Education Course (VEC) | ENV-105-VEC | Environmental Science | T | 02 |
| | Generic Indian Knowledge System (GIKS) | GEN-106-IKS | Generic Indian Knowledge System | T | 02 |
| | | | | **Total Credits Semester- I** | **22** |
| II | DSC-I (General) | DSC-151-GEN | Advanced Python Programming | T | 02 |
| | | DSC-152-GEN | Practical Based on Advanced Python Programming | P | 02 |
| | DSC-II (General) | DSC-153-GEN | Discrete Probability and Probability Distributions | T | 02 |
| | | DSC-154-GEN | Practical Based on Discrete Probability and Probability Distributions | P | 02 |
| | DSC-III (General) | DSC-155-GEN | Set Theory and Logic | T | 02 |
| | | DSC-156-GEN | Practical Based on Set Theory and Logic | P | 02 |
| | Open Elective (OE) | DSC-157-OE | Introduction to Google Tools | P | 02 |
| | Skill Enhancement Course (SEC) | DSC-158-SEC | Applied Arduino Systems | P | 02 |
| | Ability Enhancement Course (AEC) | ENG-154-AEC | Functional English-II | T | 02 |
| | Value Education Course (VEC) | COS-155-VEC | Digital and Technological Solutions | T | 02 |
| | Co-curricular Course (CC) | YOG/PES/CUL/NSS/NCC-156-CC | To be selected from CC Basket | T | 02 |
| | | | | **Total Credits Semester- II** | **22** |
| | | | | **Cumulative Credits Semester I + Semester II** | **44** |

| Sem | Course Type | Course Code | Course Title | Theory / Practical | Credits |
|---|---|---|---|---|---|
| I | Open Elective (OE) | ACC-107-OE | Accounting Foundations | T | 02 |
| II | Open Elective (OE) | ACC-157-OE | Business Accounting Practices and Applications | P | 02 |

## Course Structure for S.Y.B.Sc. (Data Science) (2024 Pattern as per NEP- 2.0)

| Sem | Course Type | Course Code | Course Title | Theory/ Practical | Credits |
|---|---|---|---|---|---|
| III | Major Mandatory | DSC-201-MRM | Data Structure using Python – I | T | 02 |
| | Major Mandatory | DSC-202-MRM | Data Base Management System | T | 02 |
| | Major Mandatory | DSC-203-MRM | Practical Based on Data Structure using Python – I and DBMS. | P | 02 |
| | Vocational Skill Course (VSC) | DSC-204-VSC | Numerical Analysis using Python and R | P | 02 |
| | Field Project (FP) | DSC-205-FP | Field Project | P | 02 |
| | Minor | DSC-206-MN | Standard Probability Distributions | T | 02 |
| | Minor | DSC-207-MN | Statistical Computing Using R Software | P | 02 |
| | Open Elective (OE) | DSC-208-OE | Application of AI in MS-Office | T | 02 |
| | Subject Specific Indian Knowledge System (IKS) | DSC-209-IKS | Heritage of Data Science | T | 02 |
| | Ability Enhancement Course (AEC) | MAR-210-AEC | | T (Any One) | 02 |
| | | HIN-210-AEC | | | |
| | | SAN-210-AEC | | | |
| | Co-curricular Course (CC) | YOG/PES/CUL/ NSS/NCC-211-CC | To be continued from the Semester - II | | 02 |
| | | | | **Total Credits Semester-III** | **22** |
| IV | Major Mandatory | DSC-251-MRM | Data Structure Using Python II | T | 02 |
| | Major Mandatory | DSC-252-MRM | Relational Data Base Management System | T | 02 |
| | Major Mandatory | DSC-253-MRM | Practical on Data Structure Using Python II and RDBMS | P | 02 |
| | Vocational Skill Course (VSC) | DSC-254-VSC | Graph Theory | T | 02 |
| | Community Engagement Project (CEP) | DSC-255-CEP | Community Engagement Project | P | 02 |
| | Minor | DSC-256-MN | Testing of Hypothesis | T | 02 |
| | Minor | DSC-257-MN | Practical Based on Testing of Hypothesis | P | 02 |
| | Open Elective (OE) | DSC-258-OE | Practical Based on Application of AI in MS-Office | P | 02 |
| | Skill Enhancement Course (SEC) | DSC-259-SEC | Sensor Data Analysis Using Raspberry Pi | P | 02 |

| | | | | | |
|---|---|---|---|---|---|
| | Ability Enhancement Course (AEC) | MAR-260-AEC | | T (Any One) | 02 |
| | | HIN-260-AEC | | | |
| | | SAN-260-AEC | | | |
| | Co-curricular Course (CC) | YOG/PES/CUL/ NSS/ NCC-261-CC | To be Continued from the Semester - III | | 02 |
| | **Total Credits Semester-IV** | | | | **22** |
| | **Total Credits Semester III + IV** | | | | **44** |

| Sem | Course Type | Course Code | Course Title | Theory / Practical | Credits |
|---|---|---|---|---|---|
| III | Open Elective (OE) | ACC-208-OE | Management Accounting | T | 02 |
| IV | Open Elective (OE) | ACC-258-OE | Financial Data Analysis | P | 02 |

## Course Structure for T.Y.B.Sc. (Data Science) (2024 Pattern as per NEP- 2.0)

| Sem | Course Type | Course Code | Course Title | Theory/ Practical | Credits |
|---|---|---|---|---|---|
| V | Major Mandatory | DSC-301-MRM | Data Security and Privacy | T | 02 |
| | Major Mandatory | DSC-302-MRM | NOSQL database (MongoDB) | T | 02 |
| | Major Mandatory | DSC-303-MRM | Introduction to Machine Learning | T | 02 |
| | Major Mandatory | DSC-304-MRM | Predictive Analysis | T | 02 |
| | Major Mandatory | DSC-305-MRM | Practical based on NOSQL database (MongoDB) | P | 02 |
| | Major Mandatory | DSC-306-MRM | Practical Based on Machine learning and predictive analysis. | P | 02 |
| | Major Elective (MJE) | DSC-307-MJE(A) | Business Analytics | T (Any one) | 02 |
| | | DSC-307-MJE(B) | Cyber Security Analytics | | |
| | Major Elective (MJE) | DSC-308-MJE(A) | Practical based on Business Analytics | P (Any one) | 02 |
| | | DSC-308-MJE(B) | Practical based on Cyber Security Analytics | | |
| | On Job Training (OJT) | DSC-309-OJT | On Job Training | P | 04 |
| | Minor | DSC-310-MN | Estimation Theory | T | 02 |
| | **Total Credits Semester – V** | | | | **22** |
| VI | Major Mandatory | DSC-351-MRM | Introduction to IoT | T | 02 |
| | Major Mandatory | DSC-352-MRM | Introduction to Artificial Intelligence | T | 02 |
| | Major Mandatory | DSC-353-MRM | Bayesian Inference | T | 02 |
| | Major Mandatory | DSC-354-MRM | Big Data Analytics | T | 02 |
| | Major Mandatory | DSC-355-MRM | Practical based on Data Visualization Techniques | P | 02 |
| | Major Mandatory | DSC-356-MRM | Practical based on Big Data Analytics | P | 02 |
| | Major Elective (MJE) | DSC-357-MJE (A) | Time Series Analysis | T (Any one) | 02 |
| | Major Elective (MJE) | DSC-357-MJE (B) | Recommendations System for Data Science | | |
| | Major Elective (MJE) | DSC-358-MJE (A) | Practical based on Time series Analysis | P (Any one) | 02 |
| | Major Elective (MJE) | DSC-358-MJE (B) | Practical Based on Recommendations System for Data Science | | |
| | Vocational Skill Course (VSC) | DSC-359-VSC | Data Ethics | T | 02 |

| | | | | | |
|---|---|---|---|---|---|
| | Vocational Skill Course (VSC) | DSC-360-VSC | Advance R programming | P | 04 |
| | Field Project/CEP | DSC-361-FP | Field Project | P | 02 |
| | **Total Credits Semester-VI** | | | | **22** |
| | **Total Credits Semester V + VI** | | | | **44** |

# Course and Credit Structure for Fourth Year UG Honours Degree (2024 Pattern)

| Sem. | Course Type | Course Code | Course Title | Theory/ Practical | Credits |
|---|---|---|---|---|---|
| VII | Major Mandatory | DSC-401-MRM | Deep Learning | Theory | 02 |
| | Major Mandatory | DSC-402-MRM | Advanced Machine Learning | Theory | 02 |
| | Major Mandatory | DSC-403-MRM | Introduction to Generative AI and LLM's | Theory | 02 |
| | Major Mandatory | DSC-404-MRM | Data Warehouse | Theory | 02 |
| | Major Mandatory | DSC-405-MRM | Cloud Computing | Theory | 02 |
| | Major Mandatory | DSC-406-MRM | Practical based on Deep Learning and Advanced Machine Learning | Practical | 02 |
| | Major Mandatory | DSC-407-MRM | Practical Based on Cloud Computing | Practical | 02 |
| | Major Elective | DSC-408-MJE(A) | Bioinformatics and Genomic Data Science | Theory (Any One) | 02 |
| | | DSC-408-MJE(B) | Climate Informatics and Environmental Data Science | | |
| | Major Elective | DSC-409-MJE(A) | Practical Based on Bioinformatics and Genomic Data Science | Practical (Any one) | 02 |
| | | DSC-409-MJE(B) | Practical Based on Climate Informatics and Environmental Data Science | | |
| | Research Methodology (RM) | DSC-410-RM | Research Methodology | Theory | 04 |
| | | | **Total Credits Sem-VII** | | **22** |
| VIII | Major Mandatory | DSC-451-MRM | Actuarial Science | Theory | 02 |
| | Major Mandatory | DSC-452-MRM | Block Chain for Data Integrating | Theory | 02 |
| | Major Mandatory | DSC-453-MRM | Text Mining and Natural Language Processing | Theory | 02 |
| | Major Mandatory | DSC-454-MRM | Reinforcement Learning | Theory | 02 |
| | Major Mandatory | DSC-455-MRM | Cloud Data Engineering | Theory | 02 |
| | Major Mandatory | DSC-456-MRM | Practical Based on Block Chain for Data Integrating and Text Mining and NLP | Practical | 02 |
| | Major Mandatory | DSC-457-MRM | Practical Based on Reinforcement Learning and Cloud Data Engineering | Practical | 02 |
| | Major Elective | DSC-458-MJE (A) | Retail and E-commerce Analytics | Theory (Any one) | 02 |
| | | DSC-458-MJE (B) | Supply Chain and Logistics | | |
| | Major Elective | DSC-459-MJE (A) | Introduction to Hadoop | Practical (Any one) | 02 |
| | | DSC-459-MJE (B) | Web Application Development | | |
| | On Job Training (OJT) | DSC-460-OJT | On Job Training | Practical | 04 |
| | | | **Total Credits Semester-VIII** | | **22** |
| | | | **Grand Total Sem VII + Sem VIII** | | **44** |

# Course and Credit Structure for Four Year UG Honours with Research Degree (2024 Pattern)

| Sem. | Course Type | Course Code | Course Title | Theory/ Practical | Credits |
|---|---|---|---|---|---|
| VII | Major Mandatory | DSC-401-MRM | Deep learning | Theory | 02 |
| | Major Mandatory | DSC-402-MRM | Advanced Machine Learning | Theory | 02 |
| | Major Mandatory | DSC-403-MRM | Introduction to Generative AI and LLM's | Theory | 02 |
| | Major Mandatory | DSC-404-MRM | Practical based on Deep learning and Advanced Machine Learning | Practical | 02 |
| | Major Mandatory | DSC-405-MRM | Practical Based on Generative AI and LLM's | Practical | 02 |
| | Major Elective | DSC-406-MJE(A) | Bioinformatics and Genomic Data Science | Theory (Any one) | 02 |
| | | DSC-406-MJE(B) | Climate Informatics and Environmental Data Science | | |
| | Major Elective | DSC-407-MJE(A) | Practical Based on Bioinformatics and Genomic Data Science | Practical (Any one) | 02 |
| | | DSC-407-MJE(B) | Practical Based on Climate Informatics and Environmental Data Science | | |
| | Research Methodology (RM) | DSC-408-RM | Research Methodology | Theory | 04 |
| | Research Project (RP) | DSC-409-RP | Research Project | Practical | 04 |
| | | | | **Total Credits Sem-VII** | **22** |
| VIII | Major Mandatory | DSC-451-MRM | Block Chain For Data Integrating | Theory | 02 |
| | Major Mandatory | DSC-452-MRM | Text Mining and Natural Language Processing | Theory | 02 |
| | Major Mandatory | DSC-453-MRM | Reinforcement Learning | Theory | 02 |
| | Major Mandatory | DSC-454-MRM | Practical Based on DSC-452-MRM and DSC-453-MRM | Practical | 02 |
| | Major Mandatory | DSC-455-MRM | Practical Based on Reinforcement Learning | Practical | 02 |
| | Major Elective | DSC-456-MJE(A) | Retail and E-commerce Analytics | Theory (Any One) | 02 |
| | | DSC-456-MJE(B) | Supply Chain and Logistics | | |
| | Major Elective | DSC-457-MJE(A) | Introduction to Hadoop | Practical (Any One) | 02 |
| | | DSC-457-MJE(B) | Web Application Development-II | | |
| | Research Project (RP) | DSC-458-RP | Research Project | Practical | 08 |
| | | | | **Total Credits Semester-VIII** | **22** |
| | | | | **Grand Total Sem VII + Sem VIII** | **44** |

# CBCS Syllabus as per NEP 2020 for F.Y.B.Sc. Data Science (2024 Pattern)

**Name of the Programme** : B.Sc. Data Science

**Programme Code** : USDS

**Class** : F.Y.B.Sc.

**Semester** : I

**Course Type** **:** DSC (General) (Theory)

**Course Code** **:** DSC-101-GEN

**Course Title** **:** Basic Python Programming

**No. of Credits** **:** 02

**No. of Teaching Hours** **:** 30

## Course Objectives:

1. To understand the fundamental concepts of problem solving, including its definition, steps, and systematic approaches used in computational thinking.
2. To develop and analyze algorithms, flowcharts, and pseudocode for solving real-world problems, and compare their advantages and limitations.
3. To convert logical problem solutions into executable programs by understanding programming languages, paradigms, and basic program structure.
4. To acquire foundational knowledge of Python programming, including installation, syntax, data types, operators, and program execution.
5. To apply control structures such as conditional statements, loops, and control statements to develop structured Python programs.
6. To utilize Python data structures including strings, lists, tuples, and dictionaries for efficient data manipulation and processing.
7. To design and implement modular programs using functions, including different types of arguments, anonymous functions, and variable scope (local and global).

## Course Outcome:

By the end of the course, students should be able to:

CO1. Design efficient algorithms for problem-solving.

CO2. Implement algorithms using Python programs.

CO3. Debug and fix errors in Python programs.

CO4. Create and use classes and objects in Python.

CO5. Apply inheritance and polymorphism in programs.

CO6. Use basic Python constructs like syntax, control structures, and functions.

CO7. Work with built-in data structures such as lists and dictionaries.

## Topics and Learning Points

**Unit - 1. Introduction to Problem Solving (5 L)**

**1.1** Introduction to problem solving: definition, steps, and approaches
**1.2** Algorithms: definition, characteristics, examples, advantages, and limitations
**1.3** Flowcharts: definition, notations, examples, advantages, limitations, and comparison with algorithms
**1.4** Pseudocode: notations, examples, advantages, and limitations
**1.5** Introduction to programming: programming languages, paradigms, types, and converting pseudocode to programs.

**Unit - 2. Introduction to Python (10 L)**

**2.1** History and features of Python, installation, path setting, interpreter
**2.2** Basic syntax, variables, data types, operators
**2.3** Conditional statements: if, if-else, nested if-else (examples)
**2.4** Looping: for, while, nested loops (examples)
**2.5** Control statements: break, continue, pass
**2.6** String manipulation: accessing, operations, slicing, functions & methods (examples)
**2.7** Lists: introduction, accessing, operations, functions & methods
**2.8** Tuples: introduction, accessing, operations, functions & methods (examples)
**2.9** Dictionaries: introduction, accessing values, operations, properties, functions (examples)
**2.10** Functions: defining, calling, arguments, types, anonymous functions, global & local variables (examples).

**Unit – 3 Classes, Objects (10 L)**

**3.1** Understanding classes as user-defined data types
**3.2** Understanding objects as instances of classes
**3.3** Creating classes and objects in Python
**3.4** Initializing objects by passing values
**3.5** Using variables and methods in a class.

**Unit – 4 Inheritance (5 L)**

**4.1** Single Inheritance
**4.2** Multilevel Inheritance
**4.3** Multiple Inheritance
**4.4** Hybrid Inheritance

**4.5** Hierarchical Inheritance

**4.6** Object relationships: IS-A and HAS-A

## References:


1. Mark Lutz, *Learning Python*, 4th Edition, O'Reilly, 2013
2. Mark Lutz, *Programming Python*, 4th Edition, O'Reilly, 2010
3. John Zelle, *Python Programming: An Introduction to Computer Science*, 3rd Edition, Franklin, Beedle & Associates, 2010
4. Mike McGrath, *Dive into Python*, Apress, 2005
5. Dmitry Zinoviev, *Data Science Essentials in Python: Collect, Organize, Explore, Predict, Value*, The Pragmatic Programmers, 2016
6. Gowrishankar S., Veena A., *Introduction to Python Programming, CRC Press, Taylor & Francis Group*, 2019.


## Programme Outcomes and Course Outcomes Mapping:

| COs / POs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PO13 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 2 | 2 | 3 | 2 | 1 | 1 | 2 | 2 | 2 | 2 | 1 | 3 |
| **CO2** | 2 | 3 | 1 | 3 | 2 | 3 | 1 | 3 | 2 | 1 | 2 | 1 | 2 |
| **CO3** | 1 | 3 | 1 | 3 | 1 | 3 | 1 | 3 | 2 | 1 | 2 | 1 | 1 |
| **CO4** | 3 | 3 | 1 | 3 | 3 | 3 | 1 | 3 | 2 | 1 | 2 | 1 | 3 |
| **CO5** | 3 | 3 | 1 | 3 | 3 | 3 | 1 | 3 | 2 | 1 | 2 | 1 | 3 |
| **CO6** | 3 | 3 | 1 | 3 | 2 | 3 | 1 | 3 | 2 | 1 | 1 | 1 | 2 |
| **CO7** | 3 | 3 | 2 | 3 | 3 | 3 | 1 | 3 | 2 | 2 | 2 | 1 | 3 |

Weight: 1 - Partially related 2 - Moderately Related 3 - Strongly related

**Justification of CO-PO Mapping:**

**PO1: Comprehensive Knowledge and Understanding**

- Strongly mapped with **CO1, CO4, CO5, CO6, CO7** as they provide foundation in algorithms, OOP, and data structures.
- Justification: Students gain a strong base in programming logic, OOP concepts, and data structures, aligning with core computational knowledge.

**PO2: Practical, Professional, and Procedural Knowledge**

- Strongly mapped with CO2, CO3, CO4, CO5, CO6, CO7.
- Justification: Python programming, debugging, OOP, and data structures ensure hands-on, professional-level coding skills in line with industry practices.

**PO3: Data Handling, Storage, and Retrieval**

- Partially mapped with CO1 and CO7.
- Justification: While not a database-focused course, data structures (lists, dictionaries) and algorithm efficiency contribute to storage and retrieval knowledge.

**PO4: Analytical and Problem-Solving Skills**

- Strongly mapped with CO1, CO2, CO3, CO4, CO5, CO6, CO7.
- Justification: Algorithm design, debugging, OOP, and data structures foster problem-solving, logical reasoning, and analytical thinking.

**PO5: Specialized and Technical Competencies**

- Strongly mapped with CO4, CO5, CO7 (OOP + DS).
- Justification: Application of inheritance, polymorphism, and data structures strengthens specialized programming competency useful in analytics and domain-specific areas.

**PO6: Research and Innovation Skills**

- Strongly mapped with CO2, CO3, CO4, CO5, CO6, CO7.
- Justification: Students learn to experiment with code, debug, and implement innovative solutions, which builds inquiry-based learning and research aptitude.

**PO7: Communication and Collaboration Skills**

- Weakly mapped with CO1–CO7.
- Justification: Indirect mapping – explaining algorithms or debugging steps in groups may enhance communication, but this course is more technical than collaborative.

**PO8: Digital and Technological Proficiency**

- Strongly mapped with CO2, CO3, CO4, CO5, CO6, CO7.
- Justification: Python programming develops strong ICT tool usage, hands-on coding proficiency, and adaptability to new platforms and libraries.

**PO9: Lifelong Learning and Adaptability**

- Moderately mapped with CO1–CO7.
- Justification: Exposure to Python programming and OOP principles prepares students for continuous learning and adaptation to advanced technologies.

**PO10: Ethics, Values, and Social Responsibility**

- Weak to moderate mapping with CO1, CO7.
- Justification: Coding practices (clarity, debugging, responsible handling of data structures) encourage discipline and responsibility, though ethical aspects are limited in scope.

**PO11: Autonomy, Responsibility, and Accountability**

- Moderately mapped with CO1–CO7.
- Justification: Students independently design, implement, and debug programs, taking responsibility for correctness and efficiency of their code.

**PO12: Community Engagement and Service**

- Weakly mapped with CO1–CO7.
- Justification: Only indirect relevance – programming skills may later support community-based projects (automation, data solutions), but not directly in this course.

**PO13: Creativity and Entrepreneurial Mindset**

- Strongly mapped with CO1, CO4, CO5, CO7.
- Justification: Algorithm design, OOP principles, and data structures encourage creativity and innovation, which can lead to entrepreneurial ideas in software solutions.

# CBCS Syllabus as per NEP 2020 for F.Y.B.Sc. Data Science (2024 Pattern)

| | |
|---|---|
| **Name of the Programme** | **:** B.Sc. Data Science |
| **Programme Code** | **:** USDS |
| **Class** | **:** F.Y.B.Sc. |
| **Semester** | **:** I |
| **Course Type** | **:** DSC (General) (Practical) |
| **Course Code** | **:** DSC-102-GEN |
| **Course Title** | **:** Practical Based on Basic Python Programming |
| **No. of Credits** | **:** 02 |
| **No. of Teaching Hours** | **:** 60 |

## Course Objectives:

The main objective of this course is to get knowledge about

1. To develop Python programs to solve basic mathematical and logical problems using appropriate programming constructs.
2. To apply conditional and looping statements to implement decision-making and repetitive tasks in Python programs.
3. To utilize control statements such as break, continue, and pass to manage program flow effectively.
4. To perform string manipulation and implement operations on Python data structures such as lists, tuples, and dictionaries.
5. To design modular programs using functions, incorporating different types of arguments, return values, anonymous functions, and scope management.
6. To create and manipulate classes and objects, demonstrating the use of instance variables and methods.
7. To implement object-oriented programming principles including constructors, various types of inheritance, and object relationships such as IS-A and HAS-A.

## Course Outcomes:

After completing this course, students will possess skills concerning:

**CO 1.** Write Python programs to solve real-world problems using basic constructs.

**CO 2.** Implement algorithms practically using Python.

**CO 3.** Identify and correct errors in Python code.

**CO 4.** Create and use classes and objects in Python programs.

**CO 5.** Apply inheritance concepts in Python programs.

**CO 6.** Perform operations on strings, lists, tuples, and dictionaries using Python.

**CO 7.** Develop small projects integrating Python programming concepts

## Topics and Learning Points

| Sr. No. | Title of Practical |
|---|---|
| 1 | Write Python programs to solve simple mathematical and logical problems |
| 2 | Implement conditional statements (if, if-else, nested if-else) with examples |
| 3 | Implement looping constructs (for, while, nested loops) with examples |
| 4 | Use control statements (break, continue, pass) in programs |
| 5 | Perform string operations: slicing, concatenation, methods, and functions |
| 6 | Work with lists: creation, indexing, operations, methods |
| 7 | Work with tuples: creation, indexing, operations, methods |
| 8 | Work with dictionaries: accessing, updating, deleting elements, and iteration |
| 9 | Define and call functions, use arguments, return values, anonymous functions, and scope |
| 10 | Create classes and objects, use instance variables and methods |
| 11 | Implement object initialization with values |
| 12 | Implement single, multilevel, multiple, hybrid, and hierarchical inheritance |
| 13 | Exercises on IS-A and HAS-A relationships |
| 14 | Mini-project integrating strings, lists, dictionaries, functions, and OOP concepts |

## References:


1. Mark Lutz, Learning Python, 4th Edition, O'Reilly, 2013
2. Mark Lutz, Programming Python, 4th Edition, O'Reilly, 2010
3. John Zelle, Python Programming: An Introduction to Computer Science, 3rd Edition, Franklin, Beedle & Associates, 2010
4. Mike McGrath, Dive into Python, Apress, 2005
5. Dmitry Zinoviev, Data Science Essentials in Python: Collect, Organize, Explore, Predict, Value, The Pragmatic Programmers, 2016
6. Gowrishankar S., Veena A., Introduction to Python Programming, CRC Press, Taylor & Francis Group, 2019


## Programme Outcomes and Course Outcomes Mapping:

| COs / POs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PO13 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 3 | 2 | 3 | 2 | 2 | 1 | 3 | 2 | 1 | 2 | 1 | 2 |
| **CO2** | 2 | 3 | 2 | 3 | 2 | 2 | 1 | 3 | 2 | 1 | 2 | 1 | 2 |
| **CO3** | 1 | 3 | 1 | 3 | 1 | 3 | 1 | 3 | 2 | 1 | 2 | 1 | 1 |
| **CO4** | 3 | 3 | 1 | 3 | 3 | 2 | 1 | 3 | 2 | 1 | 2 | 1 | 3 |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO5** | 3 | 3 | 1 | 3 | 3 | 2 | 1 | 3 | 2 | 1 | 2 | 1 | 3 |
| **CO6** | 3 | 3 | 2 | 3 | 2 | 2 | 1 | 3 | 2 | 1 | 2 | 1 | 2 |
| **CO7** | 3 | 3 | 2 | 3 | 3 | 3 | 2 | 3 | 3 | 2 | 3 | 2 | 3 |

Weight: 1 - Partially related 2 - Moderately Related 3 - Strongly related

**PO1 (Comprehensive Knowledge)**

- Strongly mapped with **CO1, CO4, CO5, CO6, CO7** (foundation of programming, OOP, and data structures).

**PO2 (Practical & Professional Knowledge)**

- Directly supported by **CO1–CO7**, as students gain programming, debugging, and project-building skills.

**PO3 (Data Handling):**

- Moderately supported by **CO1, CO2, CO6, CO7** (data structures, storage & retrieval using Python). Weak in CO3/CO4/CO5.

**PO4 (Analytical & Problem-Solving)**

- Strong mapping with **all COs** (algorithms, debugging, OOP, projects).

**PO5 (Specialized Competencies)**

- Strong for **CO4, CO5, CO7** (OOP, inheritance, project applications). Moderate for CO1/CO2/CO6.

**PO6 (Research & Innovation)**

- Supported by **CO3 (debugging), CO7 (project work)**, moderate in others through experimentation and testing.

**PO7 (Communication & Collaboration)**

- Weak mapping; only **CO7** contributes when projects are presented or team-based.

**PO8 (Digital Proficiency)**

- Strongly mapped across **CO1–CO7** (ICT tools, programming environments, Python practice).

**PO9 (Lifelong Learning)**

- Moderately mapped across **all COs** (Python foundation encourages continuous tech learning).

**PO10 (Ethics & Social Responsibility)**

- Weak mapping (mainly **CO7**) as coding indirectly relates to responsible solutions.

**PO11 (Autonomy & Accountability)**

- Moderately mapped with **CO1–CO7**, since independent coding and debugging require responsibility.

**PO12 (Community Engagement)**

- Weakly mapped (only **CO7**) when small projects are extended to real-world/social use cases.

**PO13 (Creativity & Entrepreneurship)**

- Strongly mapped with **CO1, CO4, CO5, CO7**, as algorithms, OOP, and projects foster innovation.

# CBCS Syllabus as per NEP 2020 for F.Y.B.Sc. Data Science (2024 Pattern)

**Name of the Programme** : B.Sc. Data Science

**Programme Code** : USDS

**Class** : F.Y.B.Sc.

**Semester** : I

**Course Type** : DSC (General) (Theory)

**Course Code** : DSC-103-GEN

**Course Title** : Fundamentals of Statistics

**No. of Credits** : 02

**No. of Teaching Hours** : 30

## Course Objectives:

1. Understand the foundations of statistics and its importance in data science for effective data-driven decision-making.
2. Identify and classify types of data, variables, and populations to build a strong base for statistical analysis.
3. Apply appropriate sampling techniques for data collection in real-life situations.
4. Compute and interpret measures of central tendency and dispersion for both ungrouped and grouped data.
5. Analyze data distributions using moments, skewness, and kurtosis to study shape and variability.
6. Examine and quantify relationships between variables using correlation and regression methods.
7. Develop problem-solving and analytical skills by applying statistical tools in data science contexts

## Course Outcome:

By the end of the course, students should be able to:

**CO 1.** Explain fundamental statistical concepts and their relevance in the field of data science.

**CO 2.** Differentiate between attributes, variables, types of data, populations, and samples in practical situations.

**CO 3.** Demonstrate knowledge of sampling methods and select appropriate sampling techniques for various datasets.

**CO 4.** Calculate and interpret measures of central tendency (AM, Median, Mode, GM, HM) and dispersion (Range, Variance, SD, CV).

**CO 5.** Evaluate data distributions using raw and central moments and interpret skewness and kurtosis effectively.

**CO 6.** Apply correlation and regression techniques to measure and model the relationship between two variables.

**CO 7.** Utilize statistical techniques in analyzing real-life data science problems and draw valid conclusions.

## Topics and Learning Points

### Unit–1 : Foundations of Statistics for Data Science (5L)

**1.1** Introduction to Statistics and its Role in Data Science

**1.2** Types of characteristics

**1.3** Attributes: Nominal scale, ordinal scale

**1.4** Variable: Interval scale, ratio scale, discrete and continuous variables

**1.5** **Types of Data:** Primary data (e.g., questionnaire design) and secondary data; cross-sectional and chronological data; structured data (organized/tabular) and unstructured data (text, images, audio, video).

**1.6** Notion of a statistical population: Finite population, infinite population, homogeneous population and heterogeneous population. Notion of a sample and a random sample.

**1.7** Methods of sample (Description only): Simple random sampling with and without replacement (SRSWR and SRSWOR), stratified random sampling, systematic sampling, cluster sampling and two-stage sampling.

**1.8** Classification : Raw data and its classification, ungrouped frequency distribution, Sturges' rule, method of classification inclusive and exclusive, open end classes , (grouped frequency distribution cumulative frequency distribution), relative frequency distribution

### Unit–2: Measures of Central Tendency (7L)

**2.1** Concept of central tendency of statistical data, statistical average, characteristics of a good statistical average.

**2.2** Arithmetic Mean (AM): Definition, effect of change of origin and scale, combined mean of a number of groups, merits and demerits, trimmed arithmetic mean.

**2.3** Median: Definition, merits and demerits, Partition values: Quartiles deciles and percentiles (for ungrouped and grouped data).

**2.4** Mode: Definition, merits and demerits, empirical relation between mean, median and mode (without proof)

**2.5** Geometric Mean (GM): Definition, formula, merits and demerits Harmonic Mean (HM): Definition, formula, merits and demerits Relation between H.M., G.M. and A.M.

**Unit–3: Measures of Dispersion (6L)**

**3.1** Concept of dispersion, characteristics of good measures of dispersion. Range, semi-interquartile range (quartile deviation): Definition, merits and demerits. Mean deviation, Definition, merits and demerits

**3.2** Variance and standard deviation: Definition merits and demerits, effect of change of origin and scale, combined variance for n groups (derivation for two groups).

**3.3** Mean squared deviation: Definition, minimality property of mean squared deviation (without proof), merits and demerits measures of dispersion for comparison: coefficient of range, coefficient of quartile deviation and coefficient of mean deviation, coefficient of variation (CV)

**Unit–4: Moments, Skewness and Kurtosis (4L)**

**4.1** Raw moments $\mu'_r$ ; $r$ = 1, 2, 3 ,4 for ungrouped and grouped data.

**4.2** Central moments $\mu_r$ ; $r$ = 1, 2, 3 ,4 for ungrouped and grouped data, effect of change of origin and scale.

**4.3** Relations between central moments and raw moments, up to 4th order.

**4.4** Concept of skewness of frequency distribution: Definition, type of skewness, measures of skewness;

**4.5** Karl Pearson coefficient of skewness

**4.6** Pearsonian coefficient of skewness

**4.7** Bowley's coefficient of skewness

**4.8** Bowley's coefficient of skewness lies between -1 to 1 Interpretation using box plot.

**4.9** Concept of kurtosis of frequency distribution: Definition, types of kurtosis, measure of kurtosis based on moments and partition values.

**4.10** Examples and problem.

**Unit–5: Correlation and Regression (8L)**

**5.1** Bivariate data, bivariate frequency distribution.

**5.2** Concept of correlation between two variables, positive correlation, negative correlation, no correlation. Interpretation of correlation.

**5.3** Scatter diagram, interpretation of the type of correlation from scatter diagram.

**5.4** Covariance between two variables: Definition, computation, the effect of change of origin, and scale.

**5.5** Karl Pearson's coefficient of correlation (r): Definition, computation for ungrouped data, and interpretation. Properties:

i) $-1 \leq r \leq 1$

ii) Effect of change of origin and scale.

**5.6** Spearman's rank correlation coefficient: Definition, derivation of formula, computation, and interpretation (without ties). In case of ties, compute Karl Pearson's correlation coefficient between ranks. (Spearman's rank correlation coefficient formula with correction for ties not expected.)

**5.7** Concept of dependent (response) and independent (predictor or regressor) variables. Meaning of regression, connection between correlation and regression. Fitting of line $Y = \beta_0 + \beta_1 X$, $\beta_0$ and $\beta_1$ are regression coefficients which are estimated using least-square method. Properties of regression coefficients. Concept of explained and unexplained variation, coefficient of determination, standard error of an estimate of line of regression.

## References:


1. Goon A. M., Gupta M. K., Das Gupta B. (1999): Fundamentals of Statistics, Vol.II, World Press, Calcutta.
2. Gupta and Kapoor: Fundamentals of Mathematical Statistics, Sultan Chand and Sons, New Delhi.
3. Sharma K. V. S. (2001) Statistics made it simple: Do it yourself on PC. Prentce Hall of India, New Delhi.
4. Gupta and Kapoor: Fundamentals of Applied Statistics, Sultan Chand and Sons, New Delhi.
5. B. L. Agarwal: Programmed Statistics, New Age International Publishers, New Delhi.
6. David Freedman, Robert Pisani, Roger Purves: Statistics
7. Ronald E. Walpole, Raymond H. Myers, Sharon L. Myers, Keying Ye: Probability & Statistics for Engineers & Scientists.


## Programme Outcomes and Course Outcomes Mapping:

| Course Outcomes | Programme Outcomes (POs) | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PO13 |
| CO1 | 3 | 2 | 1 | 2 | 1 | 1 | 2 | 1 | 2 | 1 | 1 | 0 | 0 |
| CO2 | 3 | 2 | 2 | 2 | 1 | 1 | 1 | 1 | 2 | 0 | 1 | 0 | 0 |
| CO3 | 3 | 2 | 2 | 2 | 2 | 2 | 1 | 1 | 2 | 0 | 1 | 0 | 0 |
| CO4 | 3 | 3 | 1 | 3 | 2 | 1 | 2 | 2 | 2 | 0 | 1 | 0 | 1 |
| CO5 | 3 | 2 | 1 | 3 | 2 | 2 | 1 | 1 | 2 | 0 | 1 | 0 | 1 |
| CO6 | 3 | 3 | 1 | 3 | 3 | 2 | 2 | 2 | 2 | 0 | 2 | 0 | 2 |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO7** | 2 | 3 | 1 | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 2 | 1 | 3 |

Weight: 1 - Partially related 2 - Moderately Related 3 - Strongly related

**Justification of CO-PO Mapping:**

**PO1: Comprehensive Knowledge and Understanding**

- Strongly relates to CO1, CO2, CO3, CO4, CO5, CO6 because these cover statistical foundations, data concepts, sampling, measures, distributions, and regression, all of which build core knowledge. CO7 is moderately related as it applies broader concepts.

**PO2: Practical, Professional, and Procedural Knowledge**

- Strongly related to CO4, CO6, CO7 (practical calculations, regression, real-life data analysis).Moderately related to CO1, CO2, CO3, CO5 (theory-to-practice link).

**PO3: Data Handling, Storage, and Retrieval**

- Moderately related to CO2, CO3 (data types, sampling require data handling awareness).Partially related to CO4, CO5, CO6, CO7 (applies when analyzing data).

**PO4: Analytical and Problem-Solving Skills**

- Strongly related to CO4, CO5, CO6, CO7 (applying statistical techniques, interpreting data, solving problems).Moderately related to CO1, CO2, CO3 (conceptual understanding supports analysis).

**PO5: Specialized and Technical Competencies**

- Strongly related to CO6, CO7 (correlation, regression, applied data science problems).Moderately related to CO3, CO4, CO5 (sampling, measures, distributions).Partially related to CO1, CO2 (basic foundations).

**PO6: Research and Innovation Skills**

- Moderately related to CO3, CO5, CO6, CO7 (sampling, distributions, regression, real-life applications help in research) Partially related to CO1, CO2, CO4 (conceptual and calculation skills support inquiry).

**PO7: Communication and Collaboration Skills**

- Moderately related to CO1, CO4, CO6, CO7 (explaining, interpreting, and presenting results).Partially related to CO2, CO3, CO5.

**PO8: Digital and Technological Proficiency**

- Moderately related to CO4, CO6, CO7 (analysis requires use of tools/software).Partially related to CO1, CO2, CO3, CO5 (when implemented via software).

**PO9: Lifelong Learning and Adaptability**

- Moderately related to all COs (1 for foundations, 2 for application) as every statistical concept supports adaptability in data science learning.

**PO10: Ethics, Values, and Social Responsibility**

- Partially related to CO7 (valid conclusions require responsible analysis). Less relevant to CO1–CO6, but statistical accuracy underpins ethical analysis.

**PO11: Autonomy, Responsibility, and Accountability**

- Moderately related to CO6, CO7 (applying regression and statistical analysis independently). Partially related to CO3, CO4, CO5.

**PO12: Community Engagement and Service**

- Partially related to CO7 (real-life applications can benefit society). Minimal relevance for CO1–CO6 (mainly theoretical).

**PO13: Creativity and Entrepreneurial Mindset**

- Moderately related to CO6, CO7 (innovative application of regression, correlation, and statistical methods in real data). Partially related to CO4, CO5 (innovative interpretation of data).

# CBCS Syllabus as per NEP 2020 for F.Y.B.Sc. Data Science (2024 Pattern)

**Name of the Programme** : B.Sc. Data Science

**Programme Code** : USDS

**Class** : F.Y.B.Sc.

**Semester** : I

**Course Type** : DSC (General) (Practical)

**Course Code** : DSC-104-GEN

**Course Title** : Practical Based on Fundamental of Statistics Using Excel

**No. of Credits** : 02

**No. of Teaching Hours** : 60

## Course Objectives:

1. Able to performing statistical and mathematical computations with MS-Excel as a tool
2. Represent statistical data diagrammatically and graphically using Excel tools.
3. Compute measures of central tendency, partition values, and dispersion for grouped and ungrouped data.
4. Interpret probability distributions using measures of skewness and kurtosis.
5. Analyze relationships between variables through correlation, rank correlation, and scatter diagrams.
6. Apply regression analysis and diagnostics to model and evaluate relationships between variables.
7. Develop practical problem-solving skills through case studies in data analysis using Excel.

## Course Outcomes:

By the end of the course, students should be able to:

**CO 1.** Explain fundamental statistical concepts and their relevance in the field of data science.

**CO 2.** Apply built-in statistical functions in Excel to compute averages, variance, correlation, and regression.

**CO 3.** Construct and interpret diagrams and graphs (bar diagrams, pie charts, histograms, ogives, frequency curves).

**CO 4.** Compute and interpret measures of central tendency, partition values, and dispersion for real-world data.

**CO 5.** Identify characteristics of frequency distributions through skewness and kurtosis measures.

**CO 6.** Perform correlation analysis (Karl Pearson and Spearman) and interpret the strength and direction of relationships.

**CO 7.** Fit a simple linear regression model and evaluate its adequacy using residual diagnostics.

## Topics and Learning Points

| Sr. No. | Title of Experiment |
|---|---|
| 1 | Introduction to MS-Excel |
| 2 | Basic Mathematical and Statistical Function in Excel |
| 3 | Diagrammatic Representation of Statistical Data (Simple and Subdivided Bar Diagrams, Multiple Bar Diagram, Percentage Bar Diagram, Pie Diagram) |
| 3 | Diagrammatic Representation of Statistical Data (Simple and Subdivided Bar Diagrams, Multiple Bar Diagram, Percentage Bar Diagram, Pie Diagram) |
| 4 | Graphical Representation of Statistical Data (Histogram, Frequency Curve and Ogive Curves, Determination of Mode and Median Graphically) |
| 5 | Computation of Measures of Central Tendency for grouped and ungrouped data |
| 6 | Computation of partition values for grouped and ungrouped data |
| 7 | Computation of Measures of Dispersion for grouped and ungrouped data |
| 7 | Identification of nature of probability distribution based on measures of Skewness and Kurtosis |
| 8 | Plotting a scatter diagram and computation of Correlation coefficient |
| 9 | Computation of Spearman's rank Correlation coefficient |
| 10 | Simple Linear Regression Analysis and Diagnostics by Residual Plots |
| 11 | Case study (2 Practical's) |

**Note:**

1. Every practical is equivalent to four hours per batch per week
2. Practical batch should be of 15 students
3. Students must complete all the practical's to the satisfaction of the teacher concerned.
4. Students must produce at the time of practical examination, the laboratory journal along with the completion certificate signed by the Head of the Department.

## Programme Outcomes and Course Outcomes Mapping:

| Course Outcomes | Programme Outcomes (POs) | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PO13 |
| CO1 | 3 | 3 | 2 | 2 | 2 | 1 | 1 | 3 | 2 | 1 | 1 | 1 | 1 |
| CO2 | 3 | 3 | 2 | 2 | 2 | 1 | 1 | 3 | 2 | 1 | 1 | 1 | 1 |
| CO3 | 3 | 3 | 2 | 2 | 2 | 1 | 2 | 3 | 2 | 1 | 1 | 1 | 1 |
| CO4 | 3 | 3 | 2 | 3 | 2 | 1 | 1 | 3 | 2 | 1 | 1 | 1 | 1 |
| CO5 | 3 | 3 | 2 | 3 | 2 | 1 | 1 | 3 | 2 | 1 | 1 | 1 | 1 |
| CO6 | 3 | 3 | 2 | 3 | 2 | 1 | 1 | 3 | 2 | 1 | 1 | 1 | 1 |
| CO7 | 3 | 3 | 2 | 3 | 2 | 2 | 2 | 3 | 2 | 1 | 2 | 1 | 2 |

Weight: 1 - Partially related 2 - Moderately Related 3 - Strongly related

**Justification of CO-PO Mapping:**

**PO1: Comprehensive Knowledge and Understanding**

- Strongly related to **CO1, CO2, CO3, CO4, CO5, CO6, CO7** since Excel is used to operationalize mathematical/statistical concepts.

  **Weightage: 3**

**PO2: Practical, Professional, and Procedural Knowledge**

- Strong link with **CO1–CO7** because the course emphasizes hands-on Excel applications for real-world datasets.

  **Weightage: 3**

**PO3: Data Handling, Storage, and Retrieval**

- Moderately related to **CO1, CO2, CO3, CO4** because Excel handles and organizes data, though limited compared to DBMS.

  **Weightage: 2**

**PO4: Analytical and Problem-Solving Skills**

- Strongly linked to **CO4, CO5, CO6, CO7** where Excel is applied to analyze datasets and solve statistical problems.

  **Weightage: 3**

**PO5: Specialized and Technical Competencies**

- Moderately related to **CO1, CO2, CO6, CO7** since Excel-based analysis builds domain-applicable competencies but at a foundational level.

  **Weightage: 2**

**PO6: Research and Innovation Skills**

- Moderately linked to **CO7** because practical Excel-based case studies help in research data handling, but innovation scope is limited.

  **Weightage: 2**

**PO7: Communication and Collaboration Skills**

- Moderately linked to **CO3, CO7** as graphs, tables, and Excel outputs are useful for presenting results.

  **Weightage: 2**

**PO8: Digital and Technological Proficiency**

- Strongly related to **CO1–CO7** because Excel itself is a technological tool, enhancing ICT proficiency.

  **Weightage: 3**

**PO9: Lifelong Learning and Adaptability**

- Moderately linked to **CO1, CO2, CO7** as students gain practical Excel skills transferable to advanced tools.

  **Weightage: 2**

**PO10: Ethics, Values, and Social Responsibility**

- Partially related to **CO7** where students must handle data responsibly in real-life case studies.

  **Weightage: 1**

**PO11: Autonomy, Responsibility, and Accountability**

- Moderately related to **CO7** because students independently analyze datasets using Excel.

  **Weightage: 2**

**PO12: Community Engagement and Service**

- Partially related to **CO7** when Excel-based analysis is applied to social/community datasets.

  **Weightage: 1**

**PO13: Creativity and Entrepreneurial Mindset**

- Moderately related to **CO7** since case studies encourage applying Excel skills innovatively.

  **Weightage: 2**

# CBCS Syllabus as per NEP 2020 for F.Y.B.Sc. Data Science (2024 Pattern)

| | |
|---|---|
| **Name of the Programme** | **:** B.Sc. Data Science |
| **Programme Code** | **:** USDS |
| **Class** | **:** F.Y.B.Sc. |
| **Semester** | **:** I |
| **Course Type** | **:** DSC (General) (Theory) |
| **Course Code** | **:** DSC-105-GEN |
| **Course Title** | **:** Linear Algebra |
| **No. of Credits** | **:** 02 |
| **No. of Teaching Hours** | **:** 30 |

## Course Objectives:

1. To provide a solid foundation in the principles of linear algebra essential for data science and machine learning.
2. To develop the ability to represent data as vectors and matrices and perform fundamental operations on them.
3. To understand the geometric interpretation of vectors, matrices, and their operations.
4. To understand and solve systems of linear equations, a common problem in data modeling and optimization.
5. To grasp the concepts of vector spaces, orthogonality, and their application in algorithms like least squares regression.
6. To learn about eigenvalues and eigenvectors and their significance in analyzing linear transformations.
7. To understand decomposition techniques like PCA and SVD for dimensionality reduction, problem-solving skills in calculus.

## Course Outcome:

By the end of the course, students should be able to:

**CO 1.** Represent data effectively using vectors and matrices.

**CO 2.** Perform fundamental vector and matrix operations to manipulate data.

**CO 3.** Solve systems of linear equations using various algebraic and matrix-based methods.

**CO 4.** Analyze vector spaces to understand concepts of linear independence, basis, and dimension.

**CO 5.** Apply principles of orthogonality and projections to solve least squares problems, fundamental to linear regression.

**CO 6.** Calculate eigenvalues and eigenvectors to analyze the properties of matrices.

**CO 7.** Perform dimensionality reduction using techniques like Principal Component Analysis (PCA) and SVD

## Topics and Learning Points

**Unit 1: Systems of Linear Equations and Vectors** **(8 L)**

1.1. Intro to Systems of Linear Equations, Gaussian Elimination.

1.2. Vectors in Rn, Dot product, Norm of a vector.

1.3. Span and Linear Independence.

**Unit 2: Matrices and Vector Spaces** **(8 L)**

2.1 Matrix Operations, The Inverse of a Matrix.

2.2 Subspaces, Basis and Dimension.

2.3 The Four Fundamental Subspaces of a Matrix.

**Unit 3: Orthogonality and Least Squares** **(7 L)**

**3.1** Orthogonal Vectors and Subspaces, Projections.

**3.2** The Gram-Schmidt Process.

**3.3** The Method of Least Squares and data fitting.

**Unit 4: Eigenvalues, Eigenvectors, and SVD** **(7 L)**

4.1 Introduction to Eigenvalues and Eigenvectors, Diagonalization.

4.2 Introduction to Principal Component Analysis (PCA).

4.3 Introduction to Singular Value Decomposition (SVD).

## References:


1. Hadrien Jean, Linear Algebra for Data Science with Python, Chapman & Hall/CRC.
2. T.S. V. S. Suryanarayana Murthy, et al., Practical Linear Algebra for Data Science: From Core Concepts to Applications Using Python, Cambridge University Press.
3. Charu C. Aggarwal, Linear Algebra and Optimization for Machine Learning, Springer.
4. Gilbert Strang, Introduction to Linear Algebra, 5th Edition, Wellesley-Cambridge Press.
5. David C. Lay, et al., Linear Algebra and Its Applications, 6th Edition, Pearson.
6. Marc P. Deisenroth, A. Aldo Faisal, C. S. Ong, Mathematics for Machine Learning, Cambridge University Press.
7. Sheldon Axler, Linear Algebra Done Right, 3rd Edition, Springer.
8. Howard Anton and Chris Rorres, Elementary Linear Algebra, 11th Edition, Wiley.

## Programme Outcomes and Course Outcomes Mapping:

| CO \ PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PO13 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 2 | 2 | 2 | 2 | 1 | 1 | 1 | 2 | 1 | 2 | 1 | 1 |
| **CO2** | 3 | 2 | 1 | 2 | 2 | 1 | 1 | 1 | 2 | 1 | 2 | 1 | 1 |
| **CO3** | 3 | 3 | 1 | 3 | 2 | 2 | 1 | 1 | 2 | 1 | 2 | 1 | 1 |
| **CO4** | 3 | 2 | 1 | 3 | 2 | 2 | 1 | 1 | 2 | 1 | 2 | 1 | 1 |
| **CO5** | 3 | 3 | 1 | 3 | 2 | 3 | 1 | 1 | 2 | 1 | 2 | 1 | 2 |
| **CO6** | 3 | 2 | 1 | 3 | 2 | 2 | 1 | 1 | 2 | 1 | 2 | 1 | 1 |
| **CO7** | 3 | 3 | 1 | 3 | 2 | 3 | 1 | 1 | 2 | 1 | 2 | 1 | 2 |

Weight: 1 – Partially related 2 – Moderately Related 3 – Strongly related

**Justification of CO-PO Mapping:**

**PO 1: Comprehensive Knowledge and Understanding**

- All COs have a strong relation as this course is entirely focused on building a comprehensive theoretical foundation in linear algebra, which is a core pillar of data science.

**PO 2: Practical, Professional, and Procedural Knowledge**

- Application-focused outcomes like solving linear systems (CO3), applying least squares (CO5), and performing dimensionality reduction (CO7) have a strong relation as they represent key procedures in data modeling. Foundational concepts (CO1, CO2, CO4, CO6) have a moderate relation as they are necessary prerequisites for these procedures.

**PO 3: Data Handling, Storage, and Retrieval**

- There is a moderate relation for CO1, which involves representing data as vectors and matrices. This is a fundamental aspect of data structuring before handling. Other COs have a weak relation as they focus on mathematical manipulation rather than data management technologies like DBMS or SQL.

**PO 4: Analytical and Problem-Solving Skills**

- COs requiring direct problem-solving, such as solving equations (CO3), analyzing vector spaces (CO4), applying regression principles (CO5), and using PCA/SVD (CO7), have a strong relation. Foundational skills (CO1, CO2) have a moderate relation as they enable the analytical process.

**PO 5: Specialized and Technical Competencies**

- All COs have a moderate relation. While linear algebra is a critical technical competency, this foundational course provides the general principles that are later applied in specialized domains like business analytics or finance.

**PO 6: Research and Innovation Skills**

- COs covering direct research methods like least squares (CO5) and PCA/SVD (CO7) have a strong relation. Other advanced topics (CO3, CO4, CO6) have a moderate relation as they provide the analytical tools required for inquiry-based work. Basic concepts have a weak relation.

**PO 7: Communication and Collaboration Skills**

- All COs have a weak relation as this theory course emphasizes individual mathematical problem-solving rather than collaborative work or the presentation of insights.

**PO 8: Digital and Technological Proficiency**

- All COs have a weak relation. The course teaches the mathematical theory behind digital tools but does not involve the use of ICT, software, or programming environments itself.

**PO 9: Lifelong Learning and Adaptability**

- All COs have a moderate relation. A strong grasp of fundamental linear algebra is essential for self-directed learning and adapting to new, more complex algorithms and technologies in the dynamic field of data science.

**PO 10: Ethics, Values, and Social Responsibility**

- All COs have a weak relation as the course content is purely mathematical and does not directly address ethical practices or societal impact.

**PO 11: Autonomy, Responsibility, and Accountability**

- All COs have a moderate relation. Solving abstract mathematical problems requires students to work independently and apply concepts responsibly to arrive at correct conclusions.

**PO 12: Community Engagement and Service**

- All COs have a weak relation as the theoretical concepts do not have a direct application in community-based projects.

**PO 13: Creativity and Entrepreneurial Mindset**

- COs related to innovative applications like least squares (CO5) and dimensionality reduction (CO7) have a moderate relation, as understanding these techniques can inspire novel solutions to data problems. Other COs have a weak relation.

# CBCS Syllabus as per NEP 2020 for F.Y.B.Sc. Data Science (2024 Pattern)

**Name of the Programme** : B.Sc. Data Science

**Programme Code** : USDS

**Class** : F.Y.B.Sc.

**Semester** : I

**Course Type** : DSC (General) (Practical)

**Course Code** : DSC-106-GEN

**Course Title** : Practical Based on Linear Algebra

**No. of Credits** : 02

**No. of Teaching Hours** : 60

## Course Objectives:

1. To provide hands-on experience in implementing linear algebra concepts using Python.
2. To develop proficiency in using scientific computing libraries such as NumPy for numerical operations.
3. To build skills in using Matplotlib for visualizing vectors, transformations, and data projections.
4. To solve practical problems in data science by applying vector and matrix operations.
5. To gain practical skills in visualizing linear transformations and their effects on geometric objects.
6. To implement fundamental data science algorithms like Least Squares Regression from a linear algebra perspective.
7. To apply decomposition techniques like PCA and SVD to solve real-world problems like image compression.

## Course Outcome:

By the end of the course, students should be able to:

**CO 1.** Write Python code to perform vector and matrix algebra using the NumPy library.

**CO 2.** Implement algorithms to solve systems of linear equations and visualize their geometric interpretation.

**CO 3.** Visualize the effect of linear transformations such as rotation, scaling, and shear on 2D points.

**CO 4.** Apply the method of least squares to fit linear models to data.

**CO 5.** Implement the Gram-Schmidt process to obtain an orthonormal basis from a set of vectors.

**CO 6.** Use eigenvalues to understand the behavior of matrix transformations on eigenvectors.

**CO 7.** Use SVD to implement practical applications such as dimensionality reduction and image compression.

## Topics and Learning Points

**I) Introduction to Python Programming** **12 Hours**

**II) Course Practicals** **48 Hours**

1. Introduction to NumPy: Creating arrays, examining attributes, indexing and slicing.
2. Vector Operations: Vector addition, scalar multiplication, dot products, calculating norms, and visualizing vectors.
3. Matrix Operations: Matrix addition, multiplication, transpose, and inverse.
4. Solving Systems of Linear Equations: Using np.linalg.solve().
5. Visualizing Linear Transformations: Applying rotation, scaling, and shear matrices and plotting results.
6. Determinants and Invertibility: Calculating the determinant to check for invertibility.
7. Projections: Implementing and visualizing orthogonal projection of one vector onto another.
8. Least Squares Regression: Fitting a linear model using the least squares formula.
9. Gram-Schmidt Orthonormalization: Creating an orthonormal basis.
10. Eigenvalues and Eigenvectors: Computing eigenvalues and eigenvectors
11. Principal Component Analysis (PCA): Implementing PCA from scratch on a 2D dataset.
12. Image Compression with SVD: Using Singular Value Decomposition to compress an image.

## References:

**1.** Hadrien Jean, Linear Algebra for Data Science with Python, Chapman & Hall/CRC.

**2.** T.S. V. S. Suryanarayana Murthy, et al., *Practical Linear Algebra for Data Science: From Core Concepts to Applications Using Python*, Cambridge University Press.

**3.** Charu C. Aggarwal, *Linear Algebra and Optimization for Machine Learning*, Springer.

## Programme Outcomes and Course Outcomes Mapping:

| CO \ PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PO13 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 2 | 3 | 2 | 3 | 3 | 2 | 1 | 3 | 3 | 1 | 3 | 1 | 2 |
| **CO2** | 2 | 3 | 2 | 3 | 3 | 2 | 2 | 3 | 3 | 1 | 3 | 1 | 2 |
| **CO3** | 2 | 3 | 2 | 3 | 3 | 2 | 2 | 3 | 3 | 1 | 3 | 1 | 2 |
| **CO4** | 2 | 3 | 2 | 3 | 3 | 3 | 1 | 3 | 3 | 1 | 3 | 1 | 2 |
| **CO5** | 2 | 3 | 2 | 3 | 3 | 2 | 1 | 3 | 3 | 1 | 3 | 1 | 2 |
| **CO6** | 2 | 3 | 2 | 3 | 3 | 2 | 1 | 3 | 3 | 1 | 3 | 1 | 2 |
| **CO7** | 2 | 3 | 2 | 3 | 3 | 3 | 1 | 3 | 3 | 1 | 3 | 1 | 3 |

Weight: 1 - Partially related 2 - Moderately Related 3 - Strongly related

**Justification of CO-PO Mapping:**

**PO 1: Comprehensive Knowledge and Understanding**

- All COs have a **moderate relation**. While the primary focus is practical implementation, applying these concepts reinforces and deepens the students' understanding of the underlying theory.

**PO 2: Practical, Professional, and Procedural Knowledge**

- All COs have a strong relation. This course is entirely focused on providing hands-on proficiency in implementing linear algebra algorithms using industry-standard tools like Python and NumPy.

**PO 3: Data Handling, Storage, and Retrieval**

- All COs have a **moderate relation**. Students directly manipulate data by creating and performing operations on NumPy arrays, which are the in-memory data structures for large-scale datasets in Python.

**PO 4: Analytical and Problem-Solving Skills**

- All COs have a strong relation. Each practical requires students to implement an algorithm (e.g., least squares, SVD) to solve a real-world data problem, such as model fitting or image compression.

**PO 5: Specialized and Technical Competencies**

- All COs have a strong relation. Proficiency in using libraries like NumPy to implement mathematical concepts is a core, non-negotiable technical competency for a data scientist.

**PO 6: Research and Innovation Skills**

- Implementing research-grade techniques like Least Squares Regression (CO4) and PCA/SVD (CO7) has a strong relation. Other COs have a moderate relation as they build the fundamental implementation skills needed for research.

**PO 7: Communication and Collaboration Skills**

- COs involving visualization of equations (CO2) and transformations (CO3) have a moderate relation, as creating effective visuals is a key form of data communication. Other COs have a weak relation.

**PO 8: Digital and Technological Proficiency**

- All COs have a **strong relation**. The entire course is based on using ICT tools, specifically the Python programming environment and its scientific computing libraries, to solve problems.

**PO 9: Lifelong Learning and Adaptability**

- All COs have a **strong relation**. By mastering the implementation of these concepts, students develop the core skills needed to independently learn new libraries, frameworks, and evolving technologies in the data science landscape.

**PO 10: Ethics, Values, and Social Responsibility**

- All COs have a **weak relation**. The focus is on the technical implementation of algorithms, not their ethical application.

**PO 11: Autonomy, Responsibility, and Accountability**

- All COs have a strong relation. Practical labs require students to independently write, debug, and validate their code, fostering accountability for producing a functional and correct outcome.

**PO 12: Community Engagement and Service**

- All COs have a weak relation as the practical's are self-contained technical exercises with no direct link to community projects.

**PO 13: Creativity and Entrepreneurial Mindset**

- Applying SVD to a novel problem like image compression (CO7) has a **strong relation**, as it encourages innovative thinking. Other COs have a **moderate relation** as building a practical toolkit enables students to explore creative solutions to problems.

# CBCS Syllabus as per NEP 2020 for F.Y.B.Sc. Data Science (2024 Pattern)

**Name of the Programme** : B.Sc. Data Science
**Programme Code** : USDS
**Class** : F.Y.B.Sc.
**Semester** : I
**Course Type** : Open Elective (Theory)
**Course Code** : DSC-107-OE
**Course Title** : Internet Awareness
**No. of Credits** : 02
**No. of Teaching Hours** : 30

## Prerequisites:

1. Basic Computer Literacy.

## Course Objectives:

**1.** Understand the fundamental concepts and history of the Internet, including its infrastructure, protocols, and governance.
**2.** Identify and explain the various components of Internet infrastructure, such as ISPs, data centers, and content delivery networks.
**3.** Demonstrate knowledge of essential web technologies, including HTTP, HTML, and web development basics.
**4.** Explore and analyze different forms of online communication, such as email, instant messaging, social media, and online communities.
**5.** Develop a sense of digital citizenship and ethical responsibility in online environments.
**6.** Cultivate information literacy skills and critical thinking abilities for evaluating online sources, recognizing biases, and identifying misinformation.

## Course Outcomes:

By the end of the course, students should be able to:

**CO1.** Explain the historical development and key concepts of the Internet, including its infrastructure, protocols, and governance.
**CO2.** Identify and describe the components of Internet infrastructure, such as ISPs, data centers, and content delivery networks.
**CO3.** Apply web technologies, including HTML, HTTP, and basic web development

principles, to create and navigate web content.

**CO4.** Communicate effectively using various online communication tools, such as email, instant messaging, and social media platforms.

**CO5.** Evaluate and implement strategies to enhance online safety and security, including recognizing and mitigating common online threats.

**CO6.** Demonstrate ethical behaviour and responsible digital citizenship in online interactions.

**CO7.** Analyse the social, cultural, and political implications of the Internet, including its impact on access, commerce, censorship, and freedom of speech.

## Topics and Learning Points

**Unit 1: Introduction to the Internet** **(8L)**

**1.1** Definition and evolution of the Internet

**1.2** Key concepts: networks, protocols, IP addresses, domain names

**1.3** Internet governance and organizations

**1.4** Internet Infrastructure

**1.5** Internet Service Providers (ISPs)

**1.6** Wired and wireless technologies

**Unit 2: Web Technologies** **(8 L)**

**2.1** Hypertext Transfer Protocol (HTTP) and

**2.2** Hypertext Markup Language (HTML)

**2.3** Web browsers and search engines

**2.4** Web standards and accessibility

**Unit 3: Online Communication** **(8 L)**

**3.1** Email and instant messaging

**3.2** Voice over IP (VoIP) and video conferencing

**3.3** Social media platforms and their impact

**3.4** Online communities and forums

**3.5** Password security and two-factor authentication

**Unit 4: Emerging Trends and Future of the Internet** **(6 L)**

**4.1** Internet of Things (IoT)

**4.2** Artificial intelligence and machine learning

**4.3** Virtual reality (VR) and augmented reality (AR)

## References

### Books:

1. The Internet Book 5th Edition by Douglas E Comer
2. The Internet Basics: Discover the Basics of Internet by Freeda Vock
3. Encyclopaedia of Computer Science Volume 1 to 5 by John Jacob

### Weblinks:

1. https://www.tutorialspoint.com/html/html_tutorial.pdf
2. https://en.wikipedia.org/wiki/Internet_of_things
3. https://www.fusionvr.in/virtual-reality
4. https://en.wikipedia.org/wiki/Internet_safety

## Programme Outcomes and Course Outcomes Mapping:

| Course Outcomes | Programme Outcomes (POs) | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PO13 |
| CO1 | 2 | 3 | 2 | 2 | 1 | 2 | 3 | 3 | 2 | 2 | 3 | 2 | 3 |
| CO2 | 2 | 3 | 3 | 1 | 1 | 1 | 2 | 3 | 2 | 3 | 3 | 2 | 2 |
| CO3 | 2 | 2 | 1 | 1 | 1 | 1 | 3 | 3 | 2 | 2 | 2 | 3 | 3 |
| CO4 | 3 | 3 | 3 | 3 | 2 | 3 | 2 | 3 | 3 | 3 | 3 | 3 | 3 |
| CO5 | 2 | 3 | 2 | 2 | 1 | 2 | 3 | 3 | 3 | 2 | 2 | 3 | 3 |
| CO6 | 3 | 3 | 3 | 2 | 21 | 2 | 2 | 3 | 3 | 3 | 3 | 2 | 3 |
| CO7 | 3 | 3 | 2 | 2 | 2 | 2 | 3 | 3 | 3 | 2 | 3 | 2 | 3 |

Weight: 1 - Partially related 2 - Moderately Related 3 - Strongly related

**Justification of CO-PO Mapping:**

**1. Justification of PO1 to All COs :**

- CO1:PO1-Requires understanding of basic computer concepts and data handling to create and share documents effectively.
- CO2:PO1-Involves knowledge of cloud computing principles for secure file storage and management.
- CO3:PO1-Applies fundamental ICT concepts for managing communication and scheduling tools.
- CO4:PO1-Strongly integrates data collection and analysis principles aligning with data science fundamentals.
- CO5:PO1-Requires multidisciplinary understanding for collaborative use of Google Workspace tools.
- CO6:PO1-Strongly applies core computer science and data science knowledge to cloud-based academic and professional tasks.

- CO7:PO1-Strongly builds comprehensive understanding of digital literacy and productivity using foundational theories.

**2. Justification of PO2 to All COs:**

- CO1:PO2 -Strongly involves hands-on creation and editing of documents using professional standards.
- CO2:PO2 -Strongly applies practical knowledge to securely store and manage files on cloud platforms.
- CO3:PO2 -Moderately requires procedural use of communication and scheduling tools for professional tasks.
- CO4:PO2 -Strongly focuses on practical data collection and analysis using Google Forms and Sheets.
- CO5:PO2 -Strongly engages real-time collaboration using industry-standard Google Workspace tools.
- CO6:PO2 -Strongly applies professional cloud-based tools for academic and real-world scenarios.
- CO7:PO2 -Strongly enhances practical digital literacy and productivity for professional use.

**3. Justification of PO3 to All COs:**

- CO1:PO3 -Moderately applies data handling through structured document creation and sharing in Sheets.
- CO2:PO3 -Strongly focuses on secure cloud storage and organized file management on Google Drive.
- CO3:PO3 -Partially supports data retrieval via email attachments and scheduling information exchange.
- CO4:PO3 -Strongly involves collecting, managing, and analyzing data using Forms and Sheets.
- CO5:PO3 -Moderately supports shared data handling through real-time collaborative editing.
- CO6:PO3 -Strongly applies cloud-based tools for data storage, access, and retrieval in various tasks.
- CO7:PO3 -Moderately enhances data management skills through improved digital literacy and productivity.

**4. Justification of PO4 to All COs:**

- CO1:PO4 -Moderately develops problem-solving by organizing and presenting data in Docs, Sheets, and Slides.
- CO2:PO4 -Partially supports analytical skills through structured file storage and retrieval.
- CO3:PO4 -Partially aids problem-solving by scheduling and coordinating tasks for effective communication.
- CO4:PO4 -Strongly builds analytical ability through data collection, statistical analysis, and interpretation in Forms and Sheets.
- CO5:PO4 -Moderately enhances critical thinking via collaborative real-time problem-solving.
- CO6:PO4 -Moderately applies cloud-based tools for solving academic or professional data-related tasks.
- CO7:PO4 -Moderately improves analytical thinking by fostering digital literacy and productivity skills.

**5. Justification of PO5 to All COs:**

- CO1:PO5 -Partially related, as basic document creation develops general technical skills but not domain- specific expertise.
- CO2:PO5 -Partially supports technical competency through file management but lacks domain specialization.
- CO3:PO5 -Minimal connection; communication tools are general-purpose rather than domain-specific.
- CO4:PO5 -Moderately related, as analyzing data with Forms and Sheets introduces some technical skills relevant to analytics.
- CO5:PO5 -Partially related collaboration improves technical skills but not specialized expertise.
- CO6:PO5 -Moderately supports application of cloud tools in professional and academic contexts, enhancing technical competencies.
- CO7:PO5 -Moderately develops digital literacy and productivity, indirectly supporting technical competency.

**6. Justification of PO6 to All COs:**

- CO1:PO6- Moderately supports research documentation and reporting through Docs, Sheets, and Slides.
- CO2:PO6- Partially related; secure storage aids research indirectly but not directly developing research skills.

- CO3:PO6- Minimal relation; communication tools support collaboration but do not strongly foster research skills.
- CO4:PO6- Strongly related; collecting and analyzing data develops inquiry-based, analytical, and ethical research skills.
- CO5:PO6- Moderately enhances collaborative research and innovative problem-solving through real-time teamwork.
- CO6:PO6- Moderately supports research tasks by applying cloud-based tools for analysis and reporting.
- CO7:PO6- Moderately improves digital literacy and productivity, aiding research efficiency and innovation.

**7. Justification of PO7 to All COs:**

- CO1:PO7- Strongly supports effective written and visual communication through creating and sharing documents, spreadsheets, and presentations
- CO2:PO7- Moderately related; organizing and managing files aids collaborative workflows and information sharing
- CO3:PO7- Strongly develops communication skills via Gmail, Meet, and Calendar for professional and academic interactions
- CO4:PO7- Moderately enhances communication of data insights through analysis and reporting in Forms and Sheets
- CO5:PO7- Strongly fosters real-time collaboration and teamwork using Google Workspace tools
- CO6:PO7- Moderately supports collaborative tasks and communication through cloud-based applications
- CO7:PO7- Strongly improves overall communication and productivity skills through digital literacy

**8. Justification of PO8 to All COs:**

- CO1:PO8- Strongly enhances proficiency in ICT tools for document creation, spreadsheets, and presentations
- CO2:PO8- Strongly develops skills in secure digital storage and file management using cloud technology.
- CO3:PO8- Strongly builds technological proficiency through email, calendar, and video conferencing tools.
- CO4:PO8- Strongly supports use of data collection and analysis tools, improving

technical skills.

- CO5:PO8- Strongly fosters collaborative use of advanced ICT tools in real-time.
- CO6:PO8- Strongly applies cloud-based platforms and tools for academic, professional, and CO7:PO8- personal tasks. Strongly improves overall digital literacy and technical productivity skills.

**9. Justification of PO9 to All COs:**

- CO1:PO9- Moderately encourages self-directed learning through document creation and editing.
- CO2:PO9- Moderately supports adaptability by managing and organizing files efficiently on Google Drive.
- CO3:PO9- Moderately develops continuous learning in communication and scheduling tools.
- CO4:PO9- Strongly promotes analytical learning and adaptability through data collection and analysis.
- CO5:PO9- Strongly enhances collaborative learning and adaptability in real-time teamwork.
- CO6:PO9- Strongly supports lifelong learning by applying cloud-based tools across tasks and contexts.
- CO7:PO9- Strongly builds digital literacy and productivity, fostering continuous skill enhancement

**10. Justification of PO10 to All COs:**

- CO1:PO10- Moderately supports ethical practices by encouraging proper document management and sharing with integrity.
- CO2:PO10- Strongly related; secure file storage and responsible data handling directly reflect ethical and responsible practices.
- CO3:PO10- Moderately encourages ethical communication and professional scheduling in collaborative contexts.
- CO4:PO10- Strongly applies ethical data collection, analysis, and reporting practices.
- CO5:PO10- Moderately supports responsible collaboration and teamwork using shared digital tools.
- CO6:PO10- Strongly promotes ethical use of cloud-based tools for academic and professional purposes.
- CO7:PO10- Moderately improves digital literacy and productivity in an ethically

responsible manner

**11. Justification of PO11 to All COs:**

- CO1:PO11- Strongly develops autonomy and accountability through independent document creation and editing.
- CO2:PO11- Strongly reinforces responsibility in managing and securing files effectively.
- CO3:PO11- Moderately supports accountability and responsible communication in scheduling and professional interactions.
- CO4:PO11- Strongly builds independence and responsibility in data collection and analysis.
- CO5:PO11- Moderately encourages accountability in collaborative projects using Google Workspace tools.
- CO6:PO11- Strongly fosters autonomy and responsible application of cloud-based tools for tasks.
- CO7:PO11- Strongly enhances self-directed skill development, promoting accountability and productivity.

**12. Justification of PO12 to All COs:**

- CO1:PO12- Moderately supports community engagement by enabling preparation of documents and presentations for societal projects.
- CO2:PO12- Moderately related; secure file storage aids organized sharing of community-based project resources.
- CO3:PO12- Strongly promotes engagement through effective communication and coordination with peers and stakeholders.
- CO4:PO12- Strongly supports data collection and analysis for community-focused initiatives.
- CO5:PO12- Strongly enhances real-time collaboration for projects that serve community or societal needs.
- CO6:PO12- Moderately applies cloud-based tools for managing and executing community or academic tasks.
- CO7:PO12- Moderately improves productivity and digital skills, indirectly supporting community service activities.

**13. Justification of PO13 to All COs:**

- CO1:PO13- Strongly encourages creativity in preparing and presenting documents, spreadsheets, and slides innovatively.

- CO2:PO13- Moderately related; organizing and managing files efficiently supports systematic work for entrepreneurial tasks.
- CO3:PO13- Strongly supports innovative communication and collaboration, essential for entrepreneurial initiatives.
- CO4:PO13- Strongly enhances analytical thinking and problem-solving, fostering innovative approaches using data.
- CO5:PO13- Strongly promotes collaborative creativity in real-time teamwork and project execution.
- CO6:PO13- Strongly supports application of cloud tools for innovative academic, professional, and entrepreneurial tasks.
- CO7:PO13- Strongly builds digital literacy and productivity, enabling creative and entrepreneurial solutions.

# CBCS Syllabus as per NEP 2020 for F.Y.B. Sc. Data Science (2024 Pattern)

| | |
|---|---|
| **Name of the Programme** | **:** B.Sc. Data Science |
| **Program Code** | **:** USDS |
| **Class** | **:** F.Y.B.Sc. |
| **Semester** | **:** I |
| **Course Type** | **:** Skill Enhancement Course (SEC) |
| **Course Code** | **:** DSC- 108-SEC |
| **Course Title** | **:** Electronics and Digital Logic |
| **No. of Credits** | **:** 2 credits |
| **No. of Teaching Hours** | **:** 60 |

## Course Objectives:

1. To help students recognize, identify, and draw different electronic symbols, logic diagrams, and circuit diagrams correctly.
2. To develop hands-on skills in making proper circuit connections and assembling electronic circuits..
3. To train students to design and analyze circuits for specific practical applications.
4. To encourage students to apply their knowledge by working on small mini-projects.
5. To introduce the basic techniques and fundamental concepts used in designing digital circuits and digital systems.
6. To help students understand different number systems and learn how to convert between them.
7. To strengthen the understanding of fundamental principles involved in digital circuit design and system development.

## Course Outcomes:

By the end of the course student will be able to

**CO 1.** identify various electronic components, devices, and integrated circuits (ICs) used in data acquisition and digital systems.

**CO 2.** understand basic electrical and digital parameters that form the foundation of hardware-based data generation systems.

**CO 3.** operate laboratory instruments such as multimeters and power supplies for measuring and analyzing electrical signals as real-world data..

**CO 4.** construct electronic and digital circuits and perform performance analysis to interpret circuit outputs as structured data.

**CO 5.** develop small hardware-based hobby projects that demonstrate the integration of electronics with data-driven applications.

**CO 6.** perform number system conversions (binary, decimal, octal, hexadecimal) to understand digital data representation and computational processing.

**CO 7.** identify different types of logic gates along with their ICs, verify their truth tables, and relate Boolean logic to decision-making processes used in data science and programming.

**Topics and Learning Points:**

- ❖ The practical course consists of 12 experiments.
- ❖ Any two of the following activities with proper documentation will be considered as equivalent of 4 experiments weightage in term work.

1. Study of Basic Electronic Components and Breadboard Connections
2. Use of measuring electronic Instruments.
3. Measurement of signal parameters (amplitude, period, frequency, peak voltage, peak to peak voltage, RMS value)
4. Verification of Ohm's Law
5. Verification of network theorems: KCL / KVL.
6. Verification of network theorems: Thevenin/ Norton/ Maximum Power Transfer.
7. Verification of logic gates using IC's (7400, 7402, 7408, 7404, 7432, 7486)
8. Realization of basic gates using universal gates (NAND, NOR)
9. Study of Half & Full adder using gates.
10. Code converter : Binary to Gray and Gray to Binary
11. Verification of DE Morgan's theorem
12. To study Universal adder & subtractor
13. Study of Encoder (Priority Encoder)
14. Study of Decoder using IC 7447 (BCD to 7-Segment Decoder)

**Activity: Any One Activity (Equivalent to two Practicals)**

1. Hands on training workshop
2. Software simulation.
3. Internet Browsing
4. Industrial /field Visit
5. Do it Yourself Open ended Project

## Programme Outcomes and Course Outcomes Mapping:

| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PO13 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 2 | - | - | 3 | - | - | 2 | - | 1 | 2 | - | 2 |
| **CO2** | 3 | - | 2 | 3 | - | - | - | 2 | 2 | - | - | - | - |
| **CO3** | - | - | 2 | - | 3 | - | 2 | 3 | - | - | 2 | - | - |
| **CO4** | - | 3 | 3 | 3 | 3 | 2 | 2 | 3 | - | 1 | 2 | - | 2 |
| **CO5** | - | - | - | - | 3 | - | 2 | 3 | 2 | 2 | 2 | 2 | 3 |
| **CO6** | 3 | - | 3 | 3 | - | - | - | 2 | - | - | - | - | - |
| **CO7** | 3 | 3 | 3 | 3 | 3 | 1 | 2 | 3 | - | - | 2 | - | 2 |

Weight: 1 - Partially related 2 - Moderately Related 3 - Strongly related

**Justification of CO-PO Mapping:**

**PO1: Comprehensive Knowledge and Understanding**

- Achieved primarily through **CO1, CO2, CO6, and CO7**, where students learn to identify electronic components, understand fundamental parameters, perform number system conversions, and recognize logic gates along with their functions. These outcomes help in building a strong foundational understanding of electronics and its relevance to digital data systems.

**PO2: Practical, Professional, and Procedural Knowledge**

- Strongly supported by CO1, CO3, CO4, CO7, since practical knowledge is applied in identifying devices, handling instruments, connecting circuits, and working with logic gate ICs.
- CO5 also contributes moderately through project development.

**PO3: Data Handling, Storage, and Retrieval**

- Achieved by CO2 (parameters), CO3 (instrument operation), CO4 (circuit analysis), CO6 (number conversions), and CO7 (truth tables). These involve data collection, calculation, and interpretation.

**PO4: Analytical and Problem-Solving Skills**

- Developed through CO2, CO4, CO6, and CO7, where students analyze circuit performance, solve conversion problems, and verify truth tables.

**PO5: Specialized and Technical Competencies**

- Directly linked with CO1 (components), CO3 (instruments), CO4 (circuit analysis), CO5 (projects), and CO7 (logic gates), ensuring technical expertise.

**PO6: Research and Innovation Skills**

- Partially achieved through CO4 (circuit analysis) and CO5 (hobby projects), where students innovate, explore, and attempt new ideas beyond standard procedures.

**PO7: Communication and Collaboration Skills**

- Indirectly supported by CO3, CO4, CO5, and CO7, as students work in lab teams, explain circuit operations, and share project outcomes.

**PO8: Digital and Technological Proficiency**

- Achieved by CO1, CO2, CO3, CO4, CO5, CO6, and CO7 since most activities involve digital instruments, number systems, and logic circuits. This PO has very strong coverage.

**PO9: Lifelong Learning and Adaptability**

- Supported by CO2, CO5, where students develop adaptability through understanding parameters and project-based learning.

**PO10: Ethics, Values, and Social Responsibility**

- Weak but relevant linkage through CO5 (hobby projects), encouraging students to design socially useful circuits, and CO1/CO4 via safe lab practices.

**PO11: Autonomy, Responsibility, and Accountability**

- Achieved through CO1, CO3, CO4, CO5, and CO7, where students handle instruments, circuits, and projects responsibly, ensuring correct results.

**PO12: Community Engagement and Service**

- Weak but present through CO5, where students can design simple, community-beneficial electronics.

**PO13: Creativity and Entrepreneurial Mindset**

- Strongly linked to CO5 (projects) and moderately with CO1, CO4, CO7, encouraging students to apply creativity in real-world or entrepreneurial contexts.