# MARUDHAR KESARI JAIN COLLEGE FOR WOMEN (AUTONOMOUS)

**Vaniyambadi – 635 751**

## Department of Data Science

## For

## Undergraduate Programme

## Bachelor of Science in Data Science

## From the Academic Year 2024-25

# CONTENT

# LEARNING OUTCOMES BASED CURRICULUM FRAMEWORK FOR UNDER GRADUATE EDUCATION

## 1. Preamble

Bachelor of Data Science is a 3 – Year Undergraduate Programme spread over six semesters. The course is designed to achieve a high degree of technical skills in Problem solving and Modern application development. The course develops requisite professional skills and problem solving along with developing the analytical abilities for pursuing a successful career in software industry and forms the required basics for further higher studies in Computer Science specifically in the area of Data Science.

| LEARNING OUTCOMES-BASED CURRICULUMFRAMEWORK FOR UNDERGRADUATE EDUCATION | |
|---|---|
| **Programme** | **B.Sc., Data Science** |
| **Programme Code** | **US03** |
| **Duration** | **3 years [UG]** |
| **Programme Outcomes** | **PO1: Disciplinary knowledge:** Capable of demonstrating comprehensive knowledge and understanding of one or more disciplines that form a part of an undergraduate Programme of study.<br>**PO2: Communication Skills:** Ability to express thoughts and ideas effectively in writing and orally; Communicate with others using appropriate media; confidently share one's views and express herself/himself; demonstrate the ability to listen carefully, read and write analytically, and present complex information in a clear and concise manner to different groups.<br>**PO3: Critical thinking:** Capability to apply analytic thought to a body of knowledge; analyse and evaluate evidence, arguments, claims, beliefs on the basis of empirical evidence; identify relevant assumptions or implications; formulate coherent arguments; critically evaluate practices, policies and theories by following scientific approach to knowledge development.<br>**PO4: Problem solving: Capacity** to extrapolate from what one has learned and apply their competencies to solve different kinds of non-familiar problems, rather than replicate curriculum content knowledge; and apply one's learning to real life situations.<br>**PO5: Analytical reasoning**: Ability to evaluate the reliability and relevance of evidence; identify logical flaws and holes in the arguments of others; analyze and synthesize data from a variety of sources; draw valid conclusions and support them with evidence and examples and addressing opposing viewpoints.<br>**PO6: Research-related skills**: A sense of inquiry and capability for asking relevant/appropriate questions, problem arising, synthesising and articulating; Ability to recognise cause-and-effect relationships, define problems, formulate hypotheses, test hypotheses, analyse, interpret and draw conclusions from data, establish hypotheses, predict cause-and-effect relationships; ability to plan, execute and report the results of an experiment or investigation.<br>**PO7: Cooperation / Teamwork:** Ability to work effectively and respectfully with diverse teams; facilitate cooperative or coordinated effort on the part of a group, and act together as a group or a team in the interests of a common cause and work efficiently as a member of a team.<br>**PO8: Scientific reasoning**: Ability to analyse, interpret and draw conclusions from quantitative/qualitative data; and critically evaluate ideas, evidence, and experiences from an open-minded and reasoned perspective. |

| | |
|---|---|
| **Programme Specific Outcomes:** | **PSO1.** Able to apply data analytical skills that rely on mathematical and statistical methods to solve problems in a data-driven world.<br>**PSO2**. Able to analyze and interpret complex data to produce actionable insights.<br>**PSO3**. Able to understand the nuances of data analytical skills to evolve innovative ideas and communicate the social relevance and impact of their analytical findings. |

**Eligibility for Admission:**

Candidate for admission to the first year of (B.Sc., Data Science) Department of Data Science shall be required to have passed the Higher Secondary Examination with atleast any one of the subject as Maths and Computer Science

## Methods of Evaluation and Assessment

| **Methods of Evaluation** | | |
|---|---|---|
| Internal Evaluation | | 25 Marks |
| External Evaluation | End Semester Examination | 75 Marks |
| | **Total** | **100 Marks** |
| **Methods of Assessment** | | |
| Recall (K1) | Simple definitions, MCQ, Recall steps, Concept definitions | |
| Understand / Comprehend (K2) | MCQ, True/False, Short essays, Concept explanations, short summary or overview | |
| Application (K3) | Suggest idea/concept with examples, suggest formulae, solve problems, Observe, Explain | |
| Analyze (K4) | Problem-solving questions, finish a procedure in many steps, Differentiate Between various ideas, Map knowledge | |
| Evaluate (K5) | Longer essay/Evaluation essay, Critique or justify with pros and cons | |
| Create (K6) | Check knowledge in specific or offbeat situations, Discussion, Debating or Presentations | |

| Semester – III | | | | | | |
|---|---|---|---|---|---|---|
| 24UFTA31 | Tamil – 3 | 4 | 1 | 0 | 0 | 3 |
| 24UFEN31 | English – 3 | 4 | 1 | 0 | 0 | 3 |
| 24UDSC31 | CC – 5 Fundamental of Data Science with Python | 3 | 1 | 2 | 0. | 5 |
| 24UDSC32P | CC - 6 –Practical V- Fundamental of Data Science with Python Lab | 0 | 0 | 4 | 0 | 2 |
| 24UMAA32 | EC – 4 AL Statistical Methods and its Applications- I | 3 | 1 | 0 | 0 | 4 |
| 24UDSA31 24UDSA32 | EC - 5 (Generic) Operating System / RDBMS | 0 | 0 | 2 | 0 | 2 |
| 24UDSS31P | SEC -4 – Practical VI- RDBMS | 1 | 0 | 1 | 0 | 2 |
| 24UAEC31 | AEC – 2 Human Values and Indian Knowledge System | 1 | 1 | 0 | 0 | 2 |
| | | | | | 30 | 23 |

| Semester - IV | | | | | | |
|---|---|---|---|---|---|---|
| 24UFTA41 | Tamil – 4 | 4 | 1 | 0 | 0 | 3 |
| 24UFEN41 | English – 4 | 4 | 1 | 0 | 0 | 3 |
| 24UDSC41 | CC – 7 Machine Learning | 3 | 1 | 2 | 0 | 5 |
| 24UDSC42P | CC - 8 (Practical) Machine Learning Lab | 0 | 0 | 4 | 0 | 2 |
| 24UMAA42/ 24UPHA43 | EC - 6 AL Statistical Methods and its Application- I & II/Digital Electronic and Microcontroller | 3 | 1 | 0 | 0 | 4 |
| 24UMAA42P/ 24UPHA43P | EC - 7 AL (Practical) Statistical Methods and its Application Lab/ Microprocessor and Microcontroller Lab | 0 | 0 | 2 | 0 | 2 |
| 24UDSS41 | SEC – 5 UI/ UX Designing | 1 | 0 | 1 | 0 | 2 |
| 24UAEC41 | AEC – 3 Environmental Studies | 1 | 1 | 0 | 0 | 2 |
| | | | | | 30 | 23 |

| Semester – V | | | | | | |
|---|---|---|---|---|---|---|

| Semester – VI | | | | | | |
|---|---|---|---|---|---|---|

**L-Learning T-Tutorial P-Practical S-Seminar C-Credit**

## 2nd YEAR: THIRD SEMESTER

| Course Code | Course Name | Category | L | T | P | S | Credits | Hours | Marks | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | CIA | External | Total |
| **24UDSC31** | **FUNDAMENTAL OF DATA SCIENCE WITH PYTHON** | **Core** | **3** | **1** | **2** | **0** | **5** | **6** | **25** | **75** | **100** |

| **Learning Objectives** | |
|---|---|
| LO1 | To understand the data science fundamentals and process. |
| LO2 | To learn to describe the data for the data science process. |
| LO3 | To learn to describe the relationship between data. |
| LO4 | To utilize the Python libraries for Data Wrangling.. |
| LO5 | To present and interpret data using visualization libraries in Python |

| Unit | Content | Hours |
|---|---|---|
| 1 | Data Science: Benefits and uses – facets of data – Data Science Process: Overview – Defining research goals – Retrieving data – Data preparation – Exploratory Data analysis – build the model– presenting findings and building applications – Data Mining – Data Warehousing – Basic Statistical descriptions of Data | 14 |
| 2 | Types of Data – Types of Variables -Describing Data with Tables and Graphs –Describing Data with Averages – Describing Variability – Normal Distributions and Standard (z) Scores | 14 |
| 3 | Correlation –Scatter plots –correlation coefficient for quantitative data –computational formula for correlation coefficient – Regression – regression line –least squares regression line – Standard error of estimate – interpretation of r2 –multiple regression equations – regression towards the mean | 14 |
| 4 | Basics of Numpy arrays –aggregations –computations on arrays – comparisons, masks, boolean logic – fancy indexing – structured arrays – Data manipulation with Pandas – data indexing and selection – operating on data – missing data – Hierarchical indexing – combining datasets – aggregation and grouping – pivot tables | 14 |
| 5 | Importing Matplotlib – Line plots – Scatter plots – visualizing errors – density and contour plots – Histograms – legends – colors – subplots – text and annotation – customization – three dimensional plotting – Geographic Data with Basemap – Visualization with Seaborn. | 14 |

| CO | Course Outcomes- The students will be able to |
|---|---|
| CO1 | Understand data science fundamental and follow the correct process for applying data science. |
| CO2 | Represent and understand data in different formats and analyse it. |
| CO3 | Infer new information from the data using different analysis techniques. |
| CO4 | Gather, collect, and transform raw data into useful formats with Python libraries. |
| CO5 | Apply Python libraries to visualize and study data. |

| **Text books:** | |
|---|---|
| 1 | David Cielen, Arno D. B. Meysman, and Mohamed Ali, "Introducing Data Science", Manning Publications, 2016. (Unit I) |
| 2 | Robert S. Witte and John S. Witte, "Statistics", Eleventh Edition, Wiley Publications, 2017. (Units II and III) |
| 3 | Jake VanderPlas, "Python Data Science Handbook", O'Reilly, 2016. (Units IV and V) |
| 4 | Avrim Blum, John Hopcroft, Ravindran Kannan, "Foundations of Data Science", Cambridge Press, 2020 |
| **Reference Books:** | |
| 1 | Allen B. Downey, "Think Stats: Exploratory Data Analysis in Python", Green Tea Press,2014. |
| 2 | Robert S. Witte and John S. Witte, "Statistics", Eleventh Edition, Wiley Publications, 2017. (Units II and III) |
| 3 | Jake VanderPlas, "Python Data Science Handbook", O'Reilly, 2016. (Units IV and V) |
| **Web resources:** | |
| 1 | https://rkabacoff.github.io/datavis/IntroGGPLOT.html |

## Mapping with Programme Outcomes:

| CO's | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 2 | 3 | 2 | 2 | 1 | 1 | 2 | 2 | 2 | 2 |
| CO2 | 2 | 2 | 2 | 3 | 2 | - | - | 2 | 2 | 3 | 2 |
| CO3 | 2 | 2 | 2 | 3 | 1 | - | - | 2 | 2 | 3 | 3 |
| CO4 | 3 | 3 | 3 | 3 | 1 | - | - | 2 | 3 | 3 | 2 |
| CO5 | 2 | 3 | 3 | 3 | 2 | 1 | 1 | 3 | 3 | 3 | 3 |
| Total | 12 | 12 | 10 | 14 | 8 | 2 | 2 | 11 | 12 | 14 | 12 |
| Average | 2 | 2 | 2 | 3 | 2 | 0.5 | 0.5 | 2 | 2 | 3 | 2 |

**S-Strong-3 M-Medium-2 L-Low-1**

## 2nd YEAR: THIRD SEMESTER

| Course Code | Course Name | Category | L | T | P | S | Credits | Hours | Marks | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | CIA | External | Total |
| **24UDSC32P** | **FUNDAMENTAL OF DATA SCIENCE WITH PYTHON LAB** | **Practical - V** | **0** | **0** | **4** | **0** | **2** | **4** | **25** | **75** | **100** |

| **Learning Objectives** | |
|---|---|
| LO1 | Students will be able to demonstrate the installation and setup of the R Programming Environment. |
| LO2 | Students will acquire the ability to work with R Data types effectively in program development |
| LO3 | Students will develop proficiency in utilizing various R Data Structures for problem-solving. |
| LO4 | Students will enhance their programming logic by effectively applying R Packages in real-world scenarios |
| LO5 | Students will gain skills in analyzing datasets using the extensive capabilities of R programming. |

| Program | Content | Hours |
|---|---|---|
| 1 | Working with Numpy arrays | 6 |
| 2 | Working with Pandas data frames | 6 |
| 3 | Develop python program for Basic plots using Matplotlib | 6 |
| 4 | Develop python program for Frequency distributions | 6 |
| 5 | Develop python program for Variability | 6 |
| 6 | Develop python program for Averages | 6 |
| 7 | Develop python program for Normal Curves | 6 |
| 8 | Develop python program for Correlation and scatter plots | 6 |
| 9 | Develop python program for Correlation coefficient | 6 |
| 10 | Develop python program for Simple Linear Regression | 6 |
| | **Total** | 60 |

| CO | Course Outcomes-On Completion of Course the Students will able to |
|---|---|
| CO1 | The show the installation of R Programming Environment. |
| CO2 | Utilize and R Data types for developing programs |
| CO3 | Make use of different R Data Structures. |
| CO4 | Develop programming logic using R Packages. |
| CO5 | Analyze the data sets using R programming capabilities |

| **Text books:** | |
|---|---|
| 1 | JaredP. Lander ,R for Everyone: Advanced Analytics and Graphics, 2nd Edition**,** Pearson Education, 2018. |
| 2 | S.R.ManiSekharandT.V.SureshKumar,ProgrammingwithR,1st |
| **Reference Books:** | |
| 1 | The Comprehensive R Archive Network-https://cran.r-project.org. |
| 2 | R for Data Science by Hadley Wickham and Garrett Grolemund , 2017 , Published by O Reilly Media, Inc. |
| **Web resources:** | |
| 1 | https://rkabacoff.github.io/datavis/IntroGGPLOT.html |

## Mapping with Programme Outcomes:

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 2 | 2 | 3 | 2 | 1 | 1 | 2 | 3 | 2 | 2 |
| **CO2** | 2 | 2 | 2 | 3 | 2 | - | - | 2 | 3 | 3 | 2 |
| **CO3** | 2 | 2 | 2 | 3 | 2 | - | - | 2 | 2 | 3 | 3 |
| **CO4** | 3 | 3 | 3 | 3 | 1 | - | - | 2 | 3 | 3 | 2 |
| **CO5** | 3 | 3 | 3 | 3 | 2 | 1 | 1 | 3 | 3 | 3 | 3 |
| **Total** | 10 | 12 | 12 | 15 | 9 | 2 | 2 | 11 | 14 | 14 | 12 |
| **Average** | 2 | 2 | 2 | 3 | 2 | 0.5 | 0.5 | 2 | 3 | 3 | 2 |

**S-Strong-3 M-Medium-2 L-Low-1**

## 2nd YEAR: THIRD SEMESTER

| Course Code | Course Name | Category | L | T | P | S | Credits | Hours | Marks | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | CIA | External | Total |
| **24UMAA32** | **STATISTICAL METHODS AND ITS APPLICATIONS -I** | **Elective-IV** | **3** | **1** | **0** | **0** | **4** | **4** | **25** | **75** | **100** |

| **Learning Objectives** | |
|---|---|
| LO1 | Scope and diagrammatic representation of data |
| LO2 | To know about Measures of Location |
| LO3 | To gain knowledge on Measures of Dispersion |
| LO4 | To understand the concept of Skewness |
| LO5 | To understand the relationship between variables and forecasting the future values |

| Unit | Content | Hours |
|---|---|---|
| 1 | Introduction - Scope and Limitations of Statistical Methods – Classification of Data –Tabulation of Data- Diagrammatic and Graphical Representation of Data. | 12 |
| 2 | Measures of Location: Arithmetic Mean, Median, Mode, and Their Properties. | 12 |
| 3 | Measures of Dispersion: Range, Quartile Deviation, Mean Deviation, Standard Deviation. | 12 |
| 4 | Measures of Skewness : Karl Pearson's, Bowley's, and Kelly's and Coefficient of Skewness . | 12 |
| 5 | Correlation: Karl Pearson – Spearman's Rank Correlation | 12 |

| CO | Course Outcomes |
|---|---|
| CO1 | Understand the statistical methods measures of location |
| CO2 | Understand the statistical methods measures of dispersion |
| CO3 | Apply the statistical methods of dispersion and location |
| CO4 | Understand the concept of Skewness. |
| CO5 | Understand the relationship between variables and fore casting the future values |

| **Text books:** | |
|---|---|
| 1 | Fundamental of Mathematical Statistics - S. C. Gupta & V. K. Kapoor - Sultan Chand |
| 2 | Fundamental of Applied Statistics - S. C. Gupta & V. K. Kapoor - Sultan Chand |
| 3 | Statistical Methods - Snedecor G.W.& Cochran W. G. oxford & +DII |
| 4 | Elements of Statistics - Mode. E. B. - Prentice Hall |
| 5 | Statistical Methods- Dr. S. P. Gupta -Sultan Chand & Sons |
| **Reference Books:** | |
| 1 | Gupta S.P. (2001), Statistical Methods, Sultan Chand & Sons, New Delhi. |
| 2 | Gupta. S. C. and Kapoor. V. K. Fundamentals of Applied Statistics, Sultan Chand & Sons, New Delhi |
| 3 | Pillai R. S. N. And Bagavathi. V. (2005), Statistics, S. Chand & Company Ltd., New Delhi. |
| 4 | Sancheti D. C. And Kapoor. V. K (2005), Statistics (7th Edition), Sultan Chand & Sons, New Delhi. |
| 5 | Arora P. N, Comprehensive Statistical Methods, Sultan Chand & Sons, New Delhi |
| **Web resources:** | |
| 1 | https://nptel.ac.in/courses/111107105 |

## Mapping with Programme Outcomes and Programme Specific Outcomes

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 2 | 3 | 3 | 2 | - | - | 2 | 3 | 3 | 2 |
| **CO2** | 3 | 3 | 3 | 3 | 3 | - | - | 2 | 3 | 3 | 3 |
| **CO3** | 3 | 3 | 2 | 3 | 2 | 1 | 2 | 2 | 2 | 3 | 2 |
| **CO4** | 2 | 3 | 3 | 3 | 3 | 2 | 2 | 3 | 3 | 3 | 3 |
| **CO5** | 2 | 2 | 3 | 3 | 3 | 1 | 1 | 3 | 3 | 3 | 2 |
| **Total** | 13 | 13 | 14 | 15 | 13 | 4 | 5 | 12 | 14 | 15 | 12 |
| **Average** | 2.6 | 2.6 | 2.8 | 3 | 2.6 | 0.8 | 1 | 2.4 | 2.8 | 3 | 2.4 |

**3 – Strong, 2- Medium, 1- Low**

## 2nd YEAR: THIRD SEMESTER

| Course Code | Course Name | Category | L | T | P | S | Credits | Hours | Marks | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | CIA | External | Total |
| **24UDSE31** | **OPERATING SYSTEM** | **Elective-V** | **1** | **0** | **1** | **0** | **2** | **2** | **25** | **75** | **100** |

| **Learning Objectives** | |
|---|---|
| LO1 | To understand the fundamental concepts and role of Operating System. |
| LO2 | To learn the Process Management and Scheduling Algorithms. |
| LO3 | To understand the Memory Management policies. |
| LO4 | To gain insight on I/O and File management techniques. |
| LO5 | Analyze resource management techniques |

| Unit | Content | Hours |
|---|---|---|
| 1 | Introduction- views and goals – Operating System Services – User and Operating System interface - System Call- Types of System Calls– Operating System Design and Implementation - Operating System Structure. Process Management: Process concept-Process Scheduling-Operations on Processes-Interprocess Communication. **Threads**: Types of threads | **6** |
| 2 | Process Scheduling: Basic Concepts-Scheduling Criteria Scheduling Algorithm Multiple Processor Scheduling CPU Scheduling. Synchronization: The Critical-Section Problem Synchronization Hardware–Semaphores-Classic Problem of Synchronization. | **6** |
| 3 | Deadlocks: Deadlock Characterization- Methods for Handling Deadlocks- Deadlock Prevention-Deadlock Avoidance-Deadlock Detection-Recovery from Deadlock. | **6** |
| 4 | Memory-Management Strategies: Swapping - Contiguous Memory Allocation Segmentation- Paging - Structure of the Page Table. Virtual-Memory Management: Demand Paging- Page Replacement-Allocation of Frames-Thrashing. | **6** |
| 5 | Storage Management: File System- File Concept - Access Methods-Directory and Disk Structure -File Sharing- Protection. Allocation Methods-Free-Space Management-Efficiency and Performance–Recovery. | **6** |

| CO | Course Outcomes |
|---|---|
| CO1 | Define OS with its view and goals and services rented by it Design of Operating System with its structure. Message through Inter process communication. |
| CO2 | Describe the allocation of process through scheduling algorithms. Define critical section problems and its usage. Prevention of multiple process executing through the concept of semaphores. |
| CO3 | Describe the concept of Mutual exclusion, Deadlock detection and agreement protocols for deadlock prevention and its avoidance. |
| CO4 | Analyze the strategies of Memory management schemes and the usage of Virtual memory. Apply Replacement algorithms to avoid thrashing. |
| CO5 | Brief study of storage management. Categorize the methods to allocate files for proper protection. |

| **Text books:** | |
|---|---|
| 1 | A.Silberschatz P .B. Galvin, Gange. "Operating System Concepts", Ninth Edition, 2013, Addison Wesley Publishing Co. |
| 2 | P.Rizwan Ahmed, Operating System, Margham Publications, Chennai.2018 |
| **Reference Books:** | |
| 1 | Anderw S Tanenbaum, Albert S. Woodhull," Operating System Design and Implementation", prentice - Hall |
| 2 | William Stallings, " Operating Systems Internals and Design Principles", Pearson, 2018,9th Edition. |
| 3 | Operating Systems: A Spiral Approach– Elmasri, Carrick, Levine, TMH Edition |
| 4 | Operating System Concepts (2nd Ed) by James L. Peterson, Abraham Silberschatz, Addison –Wesley. |
| 5 | Operating Systems Design & implementation Andrew S. Tanenbam, Albert S. Woodhull Pearson. |
| **Web resources:** | |
| 1 | https://www.guru99.com/operating-system-tutorial.html |
| 2 | https://www.mygreatlearning.com/blog/what |
| 3 | https://en.wikipedia.org/wiki/Operating_system |
| 4 | https://www.geeksforgeeks.org/what-is-an-operating-system/ |
| 5 | http://www.cs.kent.edu/~farrell/osf03/oldnotes/2.th-edition.pdf |

## Mapping with Programme Outcomes and Programme Specific Outcomes

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 2 | 1 | 2 | 2 | 2 | - | 2 | 3 | 2 | 2 |
| **CO2** | 3 | 3 | 2 | 2 | 2 | - | 2 | 2 | 3 | 3 | 2 |
| **CO3** | 3 | 3 | 3 | 2 | 2 | 1 | 1 | 3 | 3 | 3 | 2 |
| **CO4** | 3 | 3 | 2 | 3 | 3 | 2 | 1 | 3 | 3 | 3 | 3 |
| **CO5** | 2 | 2 | 2 | 2 | 2 | 1 | 1 | 3 | 3 | 3 | 2 |
| **Total** | 14 | 13 | 10 | 11 | 11 | 6 | 5 | 13 | 15 | 14 | 11 |
| **Average** | 3 | 3 | 2 | 2 | 2 | 1 | 1 | 3 | 3 | 3 | 2 |

**3 – Strong, 2- Medium, 1- Low**

## 2nd YEAR: THIRD SEMESTER

| Course Code | Course Name | Category | L | T | P | S | Credits | Hours | Marks | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | CIA | External | Total |
| **24UDSE32** | **RDBMS** | **Elective-V** | **1** | **0** | **1** | **0** | **2** | **2** | **25** | **75** | **100** |

| **Learning Objectives** | |
|---|---|
| LO1 | Purpose and advantages of database systems. |
| LO2 | Introduce the fundamental concepts of relational models. |
| LO3 | Develop proficiency in Structured Query Language (SQL) for data definition and manipulation. |
| LO4 | Teach the principles of database design, including normalization techniques. |
| LO5 | To learn and understand to write queries using SQL, PL/SQL. |

| Unit | Content | Hours |
|---|---|---|
| 1 | **Introduction to Databases:** Purpose and advantages of database systems. Three-level architecture: internal, conceptual, and external views. Data models: hierarchical, network, and relational. Database languages: DDL, DML, and DCL. Database users and administrators. | **6** |
| 2 | **Relational Model:** Structure of relational databases. Relational algebra: selection, projection, union, set difference, Cartesian product, and join operations. Relational calculus: tuple and domain calculus. Integrity constraints: domain, entity, referential, and key constraints. | **6** |
| 3 | **SQL:** Basic SQL queries: SELECT, INSERT, UPDATE, DELETE. Advanced SQL features: nested queries, joins, views, and indexes. Data control commands: GRANT and REVOKE. Transaction control commands: COMMIT, ROLLBACK, and SAVEPOINT. | **6** |
| 4 | Database Design: Entity-Relationship (E-R) model: entities, attributes, relationships, and E-R diagrams. Mapping E-R diagrams to relational schemas. Normalization: 1NF, 2NF, 3NF, and Boyce-Codd Normal Form (BCNF). Functional dependencies and their role in normalization. | **6** |

| | | |
|---|---|---|
| 5 | PL/SQL: A Programming Language: Fundamentals - Comments – Data Types – Variable Declaration – Assignment operation –Arithmetic operators. Control Structures: Control Structures – Nested Blocks – SQL in PL/SQL – Data Manipulation – Transaction Control statements. | **6** |

| **CO** | **Course Outcomes –On completion of this course, the student will be** |
|---|---|
| CO1 | Understand the fundamental concepts and architecture of database systems. |
| CO2 | Apply relational algebra and calculus for query formulation. |
| CO3 | Design and implement relational databases using SQL. |
| CO4 | Develop normalized database schemas to eliminate data redundancy. |
| CO5 | Learn to design Data base operations and implement using PL/SQL programs. Learn basics of PL/SQL and develop programs using Cursors, Exceptions |

| **Text books:** | |
|---|---|
| 1 | Coronel, Morris, Rob, "Database Systems, Design, Implementation and Management", Ninth Edition |
| 2 | Nilesh Shah, "Database Systems Using Oracle", 2nd edition, Pearson Education India, 2016 |
| **Reference Books:** | |
| 1 | Abraham Silberschatz, Henry F.Korth and S.Sudarshan,"Database System Concepts", McGraw Hill International Publication ,VI Edition |
| 2 | Shio Kumar Singh , "Database Systems ",Pearson publications ,II Edition |
| 3 | P.Rizwan Ahmed, RDBMS, Margham Publications, 2016 |
| **Web resources:** | |
| 1 | Web resources from NDL Library, E-content from open-source libraries |

## Mapping with Programme Outcomes and Programme Specific Outcomes

| | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PSO1** | **PSO2** | **PSO3** |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 2 | 3 | 2 | 3 | 2 | 1 | 2 | 3 | 2 | 2 |
| **CO2** | 3 | 3 | 3 | 2 | 2 | 2 | 1 | 2 | 3 | 3 | 2 |
| **CO3** | 3 | 2 | 3 | 2 | 2 | 1 | 1 | 3 | 3 | 3 | 2 |
| **CO4** | 3 | 3 | 2 | 2 | 2 | 1 | - | 2 | 3 | 2 | 3 |
| **CO5** | 3 | 2 | 2 | 3 | 3 | 1 | 2 | 3 | 3 | 2 | 3 |
| **Total** | 15 | 12 | 13 | 11 | 12 | 7 | 4 | 12 | 15 | 12 | 12 |
| **Average** | 3 | 2 | 3 | 2 | 2 | 1 | 1 | 2 | 3 | 2 | 2 |

**3 – Strong, 2- Medium, 1- Low**

## 2nd YEAR: THIRD SEMESTER

| Course Code | Course Name | Category | L | T | P | S | Credits | Hours | Marks | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | CIA | External | Total |
| **24UDSS31P** | **RDBMS LAB** | **SEC - IV** | **0** | **0** | **2** | **0** | **2** | **2** | **25** | **75** | **100** |

| **Learning Objectives** | |
|---|---|
| LO1 | To learn the basics of Blockchain and apply cryptographic algorithms. |
| LO2 | To design, build, and deploy smart contracts and distributed applications. |
| LO3 | To deploy Private Blockchain and smart contracts on Ethereum. |
| LO4 | To understand and deploy cryptocurrencies and their functions in applications. |
| LO5 | To implement Blockchain for various use cases. |

| Program | Content | Hours |
|---|---|---|
| 1 | Create a database table, add constraints (primary key, unique, check, not null), insert rows, update, and delete rows using SQL DDL and DML commands. | 2 |
| 2 | Create a set of tables, add foreign key constraints, and incorporate referential integrity. | 2 |
| 3 | Query the database tables using different 'WHERE' clause conditions and implement aggregate functions. | 2 |
| 4 | Query the database tables using sub queries and simple join operations. | 2 |
| 5 | Query the database tables using natural, equi, and outer joins. | 2 |
| 6 | Write user-defined functions and stored procedures in SQL. | 2 |
| 7 | Write SQL triggers for insert, delete, and update operations in a database table. | 2 |
| 8 | Trigger | 2 |
| 9 | **Cursor**<br>Student Mark Analysis Using Cursor | 2 |
| 10 | **Application**<br>Library Management system | 2 |
| | | 20 |

| CO | Course Outcomes-On Completion of Course the Students will able to |
|---|---|
| CO1 | Understand the various basic concepts of Data Base System. Difference between file system and DBMS and compare various data models.. |
| CO2 | Define the integrity constraints. Understand the basic concepts of Relational Data Model, Entity-Relationship Model. |
| CO3 | Design database schema considering normalization and relationships within database. Understand and construct database using Structured Query Language. Attain a good practical skill of managing and retrieving of data using Data Manipulation Language (DML). |
| CO4 | Classify the different functions and various join operations and enhance the knowledge of handling multiple tables. |
| CO5 | Learn to design Data base operations and implement using PL/SQL programs. Learn basics of PL/SQL and develop programs using Cursors, Exceptions. |

| **Text books:** | |
|---|---|
| 1 | Coronel, Morris, Rob, "Database Systems, Design, Implementation and Management", Ninth Edition. |
| 2 | Nilesh Shah, "Database Systems Using Oracle", 2nd edition, Pearson Education India, 2016 |
| **Reference Books:** | |
| 1 | Abraham Silberschatz, Henry F.Korth and S.Sudarshan,"Database System Concepts", McGraw Hill International Publication ,VI Edition |
| 2 | Shio Kumar Singh , "Database Systems ",Pearson publications ,II Edition |
| **Web resources:** | |
| 1 | Web resources from NDL Library, E-content from open-source libraries |

## Mapping with Programme Outcomes:

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 2 | 3 | 2 | 1 | 2 | 1 | 2 | 3 | 2 | 2 |
| **CO2** | 3 | 3 | 3 | 3 | 1 | 2 | 1 | 2 | 3 | 3 | 2 |
| **CO3** | 3 | 3 | 3 | 3 | 2 | 1 | 1 | 3 | 3 | 3 | 2 |
| **CO4** | 3 | 2 | 3 | 3 | 2 | 1 | - | 2 | 3 | 3 | 3 |
| **CO5** | 3 | 3 | 2 | 3 | 2 | 1 | 2 | 3 | 3 | 2 | 3 |
| **Total** | 15 | 13 | 14 | 14 | 8 | 7 | 4 | 12 | 15 | 13 | 12 |
| **Average** | 3 | 3 | 3 | 3 | 2 | 1 | 1 | 2 | 3 | 3 | 2 |

**S-Strong-3 M-Medium-2 L-Low-1**

## 2nd YEAR: FOURTH SEMESTER

| Course Code | Course Name | Category | L | T | P | S | Credits | Hours | Marks | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | CIA | External | Total |
| **24UDSC41** | **MACHINE LEARNING** | **Core** | **3** | **1** | **2** | **0** | **5** | **6** | **25** | **75** | **100** |

| **Learning Objectives** | |
|---|---|
| LO1 | To define the concept of Machine Learning and explain how it differs from traditional programming. |
| LO2 | To compute and interpret error metrics such as Mean Squared Error (MSE) and Root Mean Squared Error (RMSE) to evaluate regression model performance. |
| LO3 | To compute the principle of the k-Nearest Neighbors (kNN) algorithm and its role in classification tasks. |
| LO4 | To define the concept of Dimensionality Reduction and understand the Principal Component Analysis (PCA) technique for feature reduction. |
| LO5 | Illustrate the learning process in reinforcement learning, including exploration and exploitation strategies. |

| Unit | Content | Hours |
|---|---|---|
| 1 | **Introduction to Machine Learning**<br>What is Machine Learning?-Applications of ML in Real Life-Types of Learning – Supervised, Unsupervised, Semi-supervised, Reinforcement-Machine Learning Workflow-Data Collection and Preparation-Handling Missing Data and Outliers-Feature Scaling and Normalization-Model Evaluation Metrics (Accuracy, Confusion Matrix, Precision, Recall) | 14 |
| 2 | **Supervised Learning (Regression)**<br>Concept of Supervised Learning- Linear Regression – Simple and Multiple-Polynomial Regression-Error Metrics – MSE, RMSE-Logistic Regression (Binary Classification)-Decision Boundary Concept- Case Study: Predicting Student Performance. | 14 |
| 3 | **Supervised Learning (Classification)**<br>Concept of Classification -k-Nearest Neighbors (kNN) - Decision Trees-Random Forest (Concept only) - Naïve Bayes Classifier -Overfitting and Model Generalization. | 14 |
| 4 | **Unsupervised Learning**<br>Introduction to Clustering -K-Means Clustering Algorithm - Hierarchical Clustering (Basics)- Distance Measures (Euclidean, Manhattan)-Dimensionality Reduction – Introduction to PCA- Applications of Clustering-Association Rule Learning – Apriori Algorithm (Concept) | 14 |
| 5 | **Introduction to Reinforcement Learning**<br>Introduction- Difference between supervised, unsupervised, and reinforcement learning- Agent and Environment - States, Actions, and Rewards- How an agent learns through feedback- The Learning Process- **Q-Learning Basics:** Introduction to Q-learning -Understanding the Q-table- RL in marketing and recommendation systems | 14 |

| CO | Course Outcomes- The students will be able to |
|---|---|
| CO1 | Understand the ML process and dataset preparation. |
| CO2 | Learn to build and evaluate regression models. |
| CO3 | Understand and apply classification algorithms |
| CO4 | Learn unsupervised methods for data grouping and pattern finding. |
| CO5 | Understand the basic concepts and components of reinforcement learning, |

| | |
|---|---|
| **Text books:** | |
| 1 | **"Introduction to Machine Learning with Python"** – Andreas C. Müller & Sarah Guido, O'Reilly Media. |
| 2 | **"Machine Learning"** – Tom M. Mitchell, McGraw Hill. |
| 3 | **"Python Machine Learning By Example"** – Yuxi (Hayden) Liu, Packt Publishing. |
| 4 | Shai Shalev-Shwartz and Shai Ben-David, "Understanding Machine Learning: From Theory to Algorithms", Cambridge University Press, 2015 |
| 5 | Hal Daumé III, "A Course in Machine Learning", 2017 (freely available online) |
| **Reference Books:** | |
| 1 | **"Hands-On Machine Learning with Scikit-Learn & TensorFlow"** – Aurélien Géron, O'Reilly |
| 2 | **"Fundamentals of Machine Learning for Predictive Data Analytics"** – John D. Kelleher et al., MIT Press. |
| 3 | Peter Flach, "Machine Learning: The Art and Science of Algorithms that Make Sense of Data", First |
| 4 | Kevin Murphy, "Machine Learning: A Probabilistic Perspective", MIT Press, 2012 |
| 5 | Trevor Hastie, Robert Tibshirani, Jerome Friedman, "The Elements of Statistical Learning", Springer, |
| **Web resources:** | |
| 1 | https://www.ibm.com/think/topics/machine-learning |
| 2 | https://www.coursera.org/learn/machine-learning |
| 3 | https://www.datacamp.com/blog/introduction-to-unsupervised-learning |
| 4 | https://www.slideshare.net/slideshow/4mlunitivbayesian-learningpptx/259270077 |
| 5 | https://www.sciencedirect.com/science/article/pii/S2405844018332067 |

## Mapping with Programme Outcomes:

| CO's | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 2 |
| **CO2** | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 3 | 3 | 3 | 2 |
| **CO3** | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 3 | 3 | 2 | 3 |
| **CO4** | 3 | 3 | 2 | 3 | 3 | 3 | 2 | 3 | 3 | 3 | 3 |
| **CO5** | 3 | 3 | 2 | 3 | 3 | 2 | 2 | 3 | 3 | 3 | 3 |
| **Total** | 15 | 15 | 13 | 15 | 15 | 14 | 11 | 15 | 15 | 14 | 13 |
| **Avera ge** | **3** | **3** | **2.6** | **3** | **3** | **2.8** | **2.2** | **3** | **3** | **2.8** | **2.6** |

**S-Strong-3 M-Medium-2 L-Low-1**

## 2nd YEAR: FOURTH SEMESTER

| Course Code | Course Name | Category | L | T | P | S | Credits | Hours | Marks | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | CIA | External | Total |
| **24UDSC42P** | **MACHINE LEARNING LAB** | **Practical** | **0** | **0** | **4** | **0** | **2** | **4** | **25** | **75** | **100** |

| **Learning Objectives** | |
|---|---|
| LO1 | Understand the step-by-step process of implementing machine learning models using Python. |
| LO2 | Apply data preprocessing techniques such as cleaning, encoding, and normalization on real-world datasets |
| LO3 | Implement basic supervised and unsupervised learning algorithms using Python libraries |
| LO4 | Evaluate model performance using suitable metrics and visualize the results effectively. |
| LO5 | Develop confidence in building simple, end-to-end machine learning projects and presenting findings |

| Program | Content | Hours |
|---|---|---|
| 1 | Loading and Exploring Datasets (CSV, Excel) | 4 |
| 2 | Data Cleaning – Handling Missing & Categorical Data | 4 |
| 3 | Simple Linear Regression Model | 4 |
| 4 | Multiple Linear Regression | 4 |
| 5 | Logistic Regression for Binary Classification | 4 |
| 6 | Decision Tree Classifier on Iris Dataset | 4 |
| 7 | k-Nearest Neighbors Classifier | 4 |
| 8 | K-Means Clustering on Customer Data | 4 |
| 9 | Principal Component Analysis (PCA) Visualization | 4 |
| 10 | Mini Project – End-to-End ML Model (Regression or Classification) | 4 |
| | **Total** | 40 |

| CO | Course Outcomes-On Completion of Course the Students will able to |
|---|---|
| CO1 | Load, explore, and preprocess datasets using Python for machine learning tasks. |
| CO2 | Implement and test regression and classification models using scikit-learn. |
| CO3 | Apply unsupervised learning techniques like K-Means and PCA to analyze patterns in data. |
| CO4 | Assess model accuracy and visualize model outputs using Python plotting libraries. |
| CO5 | Design and execute a mini project demonstrating the complete machine learning workflow — from data preparation to model evaluation. |

| **Text books:** | |
|---|---|
| 1 | Andreas C. Müller and Sarah Guido, Introduction to Machine Learning with Python, O'Reilly Media |
| 2 | Kevin P. Murphy, Machine Learning: A Probabilistic Perspective, MIT Press |
| 3 | Christopher M. Bishop, Pattern Recognition and Machine Learning, Springer |
| 4 | Sebastian Raschka, Vahid Mirjalili, Python Machine Learning, Packt Publishing, 3rd Edition |
| 5 | Aurélien Géron, Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow, O'Reilly Media, 3rd Edition |
| **Reference Books:** | |
| 1 | Ethem Alpaydin, ―Introduction to Machine Learning (Adaptive Computation and Machine Learning), The MIT Press 2004. |
| 2 | Stephen Marsland, ―Machine Learning: An Algorithmic Perspective, CRC Press, 2009. |
| 3 | Peter Flach, "Machine Learning: The Art and Science of Algorithms that Make Sense of Data", First Edition, Cambridge University Press, 2012. |
| 4 | Kevin Murphy, "Machine Learning: A Probabilistic Perspective", MIT Press, 2012 |
| 5 | Trevor Hastie, Robert Tibshirani, Jerome Friedman, "The Elements of Statistical Learning", Springer, 2009 (freely available online) |
| **Web resources:** | |
| 1 | https://www.ibm.com/think/topics/machine-learning |
| 2 | https://www.coursera.org/learn/machine-learning |
| 3 | https://www.datacamp.com/blog/introduction-to-unsupervised-learning |
| 4 | https://www.slideshare.net/slideshow/4mlunitivbayesian-learningpptx/259270077 |
| 5 | https://www.sciencedirect.com/science/article/pii/S2405844018332067 |

## Mapping with Programme Outcomes:

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 2 |
| **CO2** | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 3 | 3 | 3 | 2 |
| **CO3** | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 3 | 3 | 2 | 3 |
| **CO4** | 3 | 3 | 2 | 3 | 3 | 3 | 2 | 3 | 3 | 3 | 3 |
| **CO5** | 3 | 3 | 2 | 3 | 3 | 2 | 2 | 3 | 3 | 3 | 3 |
| **Total** | 15 | 15 | 13 | 15 | 15 | 14 | 11 | 15 | 15 | 14 | 13 |
| **Average** | **3** | **3** | **2.6** | **3** | **3** | **2.8** | **2.2** | **3** | **3** | **2.8** | **2.6** |

**S-Strong-3 M-Medium-2 L-Low-1**

## 2nd YEAR: FOURTH SEMESTER

| Course Code | Course Name | Category | L | T | P | S | Credits | Hours | Marks | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | CIA | | Total |
| **24UDSS41** | **UI/UX Designing** | **Elective-V** | **1** | **0** | **1** | **0** | **2** | **2** | **25** | | **100** |

| Learning Objectives | |
|---|---|
| LO1 | Understand and describe the **5 stages of design thinking**: Empathize, Define, Ideate, Prototype, and Test. |
| LO2 | Identify and use basic research and analysis tools such as **FigJam** |
| LO3 | Understand the principles of **visual communication** in designing graphical interfaces. |
| LO4 | Explore and utilize **UX design tools** like Figma and understand features like navigation, interactions, buttons, and component libraries. |
| LO5 | Identify and utilize various **UI elements** in high-fidelity wireframes (visual design, buttons, text fields, etc.). |

| Unit | Content | Hours |
|---|---|---|
| 1 | **Design Thinking Fundamentals**<br>Introduction to Design thinking – Concept, Purpose, 5 stages of design thinking – Empathize, Define, Ideate, Prototype, Test, Introduction to User Interface / User Experience (UI/UX) – Definition of Design with respect to digital media, User Interface, User experience, Difference between UI and UX. History of UX. Need of UI and UX | **6** |
| 2 | **User Requirements and its Analysis**<br>Introduction to research and analysis tool (freeware) such as FigJam- User requirements – Definition, Types of user research - Qualitative research, Quantitative research. Tools to collect user requirements – personal observation, interviews, questionnaire, User/ Expert reviews. | **6** |
| 3 | **User Interface Design**<br>Storyboarding, User journey mapping - Gestalt principles of design - Aesthetics in UI design - Using Light, Color and Contrast Effectively in UI Design - Introduction to any freeware design tool such as Figma - Visual Communication Design - effective visual communication for graphical user interface | **6** |
| 4 | **User Experience Design Tool**<br>Introduction to User Experience design - UX design open source tool such as - Figma features – Navigations, interactions, Buttons Creating library- Gamification, micro-animation - Creating visual identity of the project – design system, design theme | **6** |

| | | |
|---|---|---|
| 5 | **Prototyping and Testing**<br>Introduction to Wireframing - Purpose of wireframing, Types – low fidelity, medium fidelity, high fidelity- Basics of sketching, Creating low fidelity wireframes, medium fidelity and high fidelity in Figma. | **6** |

| **CO** | **Course Outcomes- The Students are able to** |
|---|---|
| CO1 | Explain the concept and purpose of **Design Thinking**. |
| CO2 | Apply different tools for collecting user data: **observations, interviews, questionnaires, and expert/user reviews**. |
| CO3 | Apply principles of **visual communication design** to build effective graphical interfaces. |
| CO4 | Use Figma (or other open-source tools) for UX design, including features like **navigation, interaction design, button creation, and component libraries**. |
| CO5 | Apply basic **sketching techniques** and create various levels of wireframes using **Figma**. |

| **Text books:** | |
|---|---|
| 1 | Jesse James Garrett The Elements of User Experience: User-Centered Design for the Web and Beyond New Riders Publishing. |
| 2 | Falk Uebernickel, Li Jiang,Walter Brenner, Britta Pukall,Therese Naef Design Thinking: The Handbook World Scientific Publishing Co Pte Ltd |
| 3 | Fabio Staiano Designing and Prototyping Interfaces with Figma Packt Publishing Ltd |
| 4 | The Elements of User Experience: User-Centered Design for the Web and Beyond — Jesse James GarrettDesign Thinking for Beginners. |
| 5 | Interaction Design: Beyond Human-Computer Interaction (5th Ed.) — Helen Sharp, Yvonne Rogers & Jenny Preece |
| **Reference Books:** | |
| 1 | The Design of Everyday Things — Don Norman |
| 2 | Don't Make Me Think, Revisited: A Common-Sense Approach to Web Usability<br>Steve Krug |
| **Web resources:** | |
| 1 | https://aim.gov.in/pdf/Design_Thinking.pdf |
| 2 | https://www.ideou.com/pages/design-thinking-resources |
| 3 | https://www.figma.com/resource-library/what-is-design-thinki |
| 4 | https://youtu.be/XT152i5asdQ?si=jPdLFFExnaZO8NRs |

**Mapping with Programme Outcomes and Programme Specific Outcomes**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 3 | 2 | 2 | 2 | 1 | 1 | 2 | 3 | 2 | 2 |
| **CO2** | 2 | 3 | 3 | 3 | 2 | 2 | 1 | 3 | 3 | 3 | 2 |
| **CO3** | 3 | 3 | 3 | 3 | 3 | 2 | 1 | 3 | 3 | 3 | 3 |
| **CO4** | 3 | 3 | 3 | 3 | 3 | 2 | 1 | 3 | 3 | 3 | 3 |
| **CO5** | 3 | 3 | 3 | 3 | 3 | 2 | 1 | 3 | 3 | 3 | 3 |
| **Total** | 14 | 15 | 14 | 14 | 13 | 9 | 5 | 14 | 15 | 14 | 13 |
| **Average** | **2.8** | **3.0** | **2.8** | **2.8** | **2.6** | **1.8** | **1.0** | **2.8** | **3.0** | **2.8** | **2.6** |

**3 – Strong, 2- Medium, 1- Low**