# The Curriculum Book

## Master of Science

## in

## Computer Science (Artificial Intelligence and Data Science)

### 2 YEAR-PROGRAMME

**Under Multiple Entry and Exit, Internship and**

**CBCS-LOCF as per NEP-2020**

**w.e.f. Session 2025-26**


**DEPARTMENT OF ARTIFICIAL INTELLIGENCE AND DATA SCIENCE**

**GURU JAMBHESHWAR UNIVERSITY OF SCIENCE &**

**TECHNOLOGY, HISAR-125001, HARYANA**

**(A+ NAAC Accredited State Govt. University)**

# SEMESTER I

| Type of Course | Course Code | Nomenclature of Paper/Course | Credit(s) | Contact Hours | Internal Marks | External Marks | Total | Duration of Exam (Hrs.) |
|---|---|---|---|---|---|---|---|---|
| **Discipline Specific Courses** | U25MDS101T | Fundamentals of Data Science | 4 | 4 | 30 | 70 | 100 | 3 |
| | U25MDS102T | Probability and Statistics | 4 | 4 | 30 | 70 | 100 | 3 |
| | U25MDS103T | Data Structures & Algorithms | 3 | 3 | 20 | 50 | 70 | 2.5 |
| | U25MDS103P | Data Structures & Algorithms Lab. | 1 | 2 | 10 | 20 | 30 | 3 |
| **Discipline Elective Course** | U25MDS104T(i) | Operating Systems | 3 | 3 | 20 | 50 | 70 | 2.5 |
| | U25MDS104P(i) | Operating Systems Lab. | 1 | 2 | 10 | 20 | 30 | 3 |
| | | **OR** | | | | | | |
| | U25MDS104T(ii) | Database Management System | 3 | 3 | 20 | 50 | 70 | 2.5 |
| | U25MDS104P(ii) | Database Management System Lab. | 1 | 2 | 10 | 20 | 30 | 3 |
| **Practicum/ Dissertation/ Project work/** | U25MDS105P | Python and R Programming Lab. | 4 | 8 | 30 | 70 | 100 | 3 |
| **Seminar/Open Elective Course/SEC/EEC/ VAC** | | To be opted from pool | 2 | 2 | 15 | 35 | 50 | 2 |
| | | **TOTAL** | **22** | **28** | **165** | **385** | **550** | |

## SEMESTER II

| Type of Course | Course Code | Nomenclature of Paper/Course | Credit(s) | Contact Hours | Internal Marks | External Marks | Total | Duration of Exam (Hrs.) |
|---|---|---|---|---|---|---|---|---|
| **Discipline Specific Courses** | U25MDS201T | Artificial Intelligence | 4 | 4 | 30 | 70 | 100 | 3 |
| | U25MDS202T | Data Analytics | 3 | 3 | 20 | 50 | 70 | 2.5 |
| | U25MDS202P | Data Analytics Lab. | 1 | 2 | 10 | 20 | 30 | 3 |
| | U25MDS203T | Data Mining | 3 | 3 | 20 | 50 | 70 | 2.5 |
| | U25MDS203P | Data Mining Lab. | 1 | 2 | 10 | 20 | 30 | 3 |
| **Discipline Elective Course** | U25MDS204T(i) | Pattern Recognition | 4 | 4 | 30 | 70 | 100 | 3 |
| | | **OR** | | | | | | |
| | U25MDS204T(ii) | Information Retrieval Systems | 4 | 4 | 30 | 70 | 100 | 3 |
| **Practicum/ Dissertation/Project work/** | U25MDS205P | Python Tools for Data Science Lab. | 4 | 8 | 30 | 70 | 100 | 3 |
| **Seminar/Open Elective Course/SEC/EEC /VAC** | U25MDS206S | Seminar | 2 | 2 | 50 | 00 | 50 | - |
| | | **TOTAL** | **22** | **28** | **200** | **350** | **550** | |

**Note:** Internship of 4 credits of 4 weeks (120 Hrs.) duration after 2nd semester is mandatory for each student either for enhancing the employability or for developing research aptitude

Notes

1. The internship to be carried after second semester will be of 4 credits (120 Hrs). The marks of internship will be credited in second semester.

2. The minimum credit requirement for 2-year PG programme will be 84 including 4 credits of internship. Range of credits will be 84-100. In any case total credits in 2 years cannot exceed 100. Each semester should not be of less than 20 credits.

3. The first semester will include a 2 credits Value Added Course from other department (including from Indian Knowledge System, Constitutional and moral values, etc.); the second semester will include a 2 credits Seminar; the third semester will include a 2 credits Open Elective Course offered by the other department of the university and the fourth semester will include a 2 credits Skill Enhancement Course/Employability and Entrepreneurship Skills Course/Vocational Course. All these courses of 2 credits of first, third and fourth semesters will be opted by the students from the relevant Pools. DSC/DEC/PC may be of 4 or 3 or 2 credits.

4.OEC/SEC/EEC/VOC/VAC can be carried out through SWAYAM/MOOC also of minimum 2 credits. In case of more than 2 credits then only 2 credits will be counted.

# DEPARTMENT OF ARTIFICIAL INTELLIGENCE AND DATA SCIENCE

| Type of Course | Course Code | Nomenclature of Paper/Course | Credit(s) | Contact Hours | Internal Marks | External Marks | Total | Duration of Exam (Hrs.) |
|---|---|---|---|---|---|---|---|---|
| Value-Added Courses (VAC) | U25VAC103T(i) | Fundamentals of Cyber Security | 2 | 2 | 15 | 35 | 50 | 2 |
| | U25VAC103T(ii) | Ethical AI and Data Privacy | 2 | 2 | 15 | 35 | 50 | 2 |
| Open Elective Courses (OEC) | U25OEC303T(i) | Introduction to Artificial Intelligence | 2 | 2 | 15 | 35 | 50 | 2 |
| | U25OEC303T(ii) | Introduction to Data Science | 2 | 2 | 15 | 35 | 50 | 2 |
| Skill Enhancement Courses (SEC) | U25SEC403P(i) | Web Technologies Lab. | 2 | 4 | 15 | 35 | 50 | 2 |
| | U25SEC403P(ii) | Python Programming Lab. | 2 | 4 | 15 | 35 | 50 | 2 |
| Employability and Entrepreneurship Skills Courses (EEC) | U25EEC403T(i) | Data Science for Business and Decision Making | 2 | 2 | 15 | 35 | 50 | 2 |
| | U25EEC403T(ii) | Ethical Hacking | 2 | 2 | 15 | 35 | 50 | 2 |
| Vocational Course (VOC) | U25VOC403P(i) | Python Tools Lab. | 2 | 4 | 15 | 35 | 50 | 2 |
| | U25VOC403P(ii) | Data Visualizations Lab. | 2 | 4 | 15 | 35 | 50 | 2 |

Details of the courses offered by the department to students from other departments as per NEP-2020 are categorized as shown in the table below.

**Chairman**

# Fundamentals of Data Science

**General Course Information**

| | |
|---|---|
| Course Code: U25MDS101T<br>Course Credits: 4<br>Type: **Discipline Specific Courses**<br>Contact Hours:4 hours/week<br>Mode: Lectures (L)<br>Examination Duration: 3 hours | **Course Assessment Methods:**<br>**Max. Marks: 100 (Internal: 30; External: 70)**<br>The department will conduct one minor test worth 15 marks. The Course Coordinator will decide whether to hold a second minor test at their level, and there will be no date sheet for it. Class performance includes attendance (5 marks) and 10 marks for assignments, seminars, presentations, or quizzes. Internal marks will be the total of the minor test score and the class performance marks earned by the student.<br><br>**Note:** The end semester examination will be of 70 marks. The examiner is required to set nine questions in all. The first question will be compulsory consisting of consisting of seven short questions covering the entire syllabus consisting of 2 marks each. In addition to that eight more questions will be set, two question from each unit. The students shall be required to attempt five questions in all selecting one question from each unit in addition to compulsory Question No. 01. All question shall carry equal marks i.e. 14 marks. |

**About the Course:**

This course is designed to introduce students to data science and its practice: how it works and how it can produce insights from social, political, business and economic data.

## Program Outcomes:

Upon completion of this course, students will be able to:

**CO1** *(Remember)*: Define key concepts and terminology in data science including data types, processes, and algorithms.
**CO2** *(Understand)*: Explain the data science lifecycle, methodologies, and visualization techniques.
**CO3** *(Apply)*: Use appropriate data science tools and techniques to prepare, analyze, and visualize datasets.
**CO4** *(Analyze)*: Examine feature selection methods and anomaly detection techniques in various datasets.
**CO5** *(Evaluate)*: Assess data models and forecasting methods for suitability in real-world applications.
**CO6** *(Create)*: Design and implement end-to-end data science solutions using tools like Tableau, Excel, and Python libraries.

## Course Content

### Unit I

Data Science: Definition, Basic Terminology, Data science Venn diagram, Types of Data, Structured versus Unstructured data, Quantitative versus Qualitative data, The Four Levels of Data, Five steps of Data Science, Data Science Process Overview, Data science classification, Data Science Algorithms, Business Intelligence and Data Science, Components of Data Science, Introduction, Prior Knowledge, Data Preparation, Modeling, Applications, Objectives of Data Exploration, Datasets, Descriptive statistics

### Unit II

Data Visualization: Introduction, Types of Data visualization, Technologies for visualization, Various visualization techniques, The Five Cs of Data Visualization, Data Science Methodology, Analytics for Data Science, Data Analytics

Examples, Data Analytics Life Cycle, Data Discovery, Data preparation, Model Planning, Model Building, Operationalization.

**Unit III**

Feature Selection: Classifying feature selection methods, Anomaly Detection: Introduction, Distance and Density based outlier detection, Local Outlier Factor, Time series Forecasting, Decomposition, smoothing based methods, Regression based methods, Machine Learning methods.

**Unit IV**

Introduction to Data Science Tools: SAS, APACHE FLINK, BigML, Excel, Tableau, Matplotlib, TensorFlow, Weka

Applications: Hands on with Solving Data Problems, Collecting and Analyzing Twitter Data, Collecting and Analyzing YouTube Data.

**Text and Reference Books:**


1. Sanjeev J. Wagh, Manisha S. Bhende, Anuradha D. Thakare, *Fundamentals of Data Science*, 1st Edition, 2022
2. Daimi, Kevin, Ed. Hamid R. Arabnia, *Principles of Data Science*, Springer, 2020.
3. Vijay Kotu, Bala Deshpande, *Data Science: Concepts and Practices*, Morgan Kaufmann Publishers, Second edition, 2019
4. D J Patil, Hilary Mason, Mike Loukides, *Ethics and Data Science*, O' Reilly, 1st edition, 2018
5. Sinan Ozdemir, *Principles of Data Science*, Packt Publishing, December 2016.
6. Jure Leskovek, Anand Rajaraman and Jeffrey *Ullman, Mining of Massive Datasets* v2.1, Cambridge University Press, 2014.
7. Cielen, Davy, Arno DB Meysman, Mohamed Ali, *Introducing Data Science: Big Data, Machine Learning, and more, using Python Tools*, Manning Publications Co., 2016

# Probability and Statistics

**General Course Information**

| | |
|---|---|
| Course Code: U25MDS102T<br>Course Credits: 4<br>Type: **Discipline Specific Courses**<br>Contact Hours: 4 hours/week<br>Mode: Lectures (L)<br>Examination Duration: 3 hours | **Course Assessment Methods:**<br>**Max. Marks: 100 (Internal: 30; External: 70)**<br>The department will conduct one minor test worth 15 marks. The Course Coordinator will decide whether to hold a second minor test at their level, and there will be no date sheet for it. Class performance includes attendance (5 marks) and 10 marks for assignments, seminars, presentations, or quizzes. Internal marks will be the total of the minor test score and the class performance marks earned by the student.<br><br>**Note:** The end semester examination will be of 70 marks. The examiner is required to set nine questions in all. The first question will be compulsory consisting of consisting of seven short questions covering the entire syllabus consisting of 2 marks each. In addition to that eight more questions will be set, two question from each unit. The students shall be required to attempt five questions in all selecting one question from each unit in addition to compulsory Question No. 01. All question shall carry equal marks i.e. 14 marks. |

**About the Course:**

Probability and statistics both are the most important concepts for Data Science and Machine Learning. Probability is about predicting the likelihood of future events, while statistics involves the analysis of the frequency of past events. This course will give an additional space for widening the applications of the knowledge in Data Science domain to the various fields of real life.

## Program Outcomes:

Upon completion of this course, students will be able to:

**CO1** *(Remember)*: Recall and describe fundamental concepts in statistics and probability, including distributions, correlation, and regression.
**CO2** *(Understand)*: Interpret and explain graphical and numerical methods used in descriptive statistics and probability theory.
**CO3** *(Apply)*: Use probability distributions and sampling techniques to solve real-world statistical problems.
**CO4** *(Analyze)*: Differentiate between types of estimators and evaluate the properties of sampling distributions.
**CO5** *(Evaluate)*: Conduct statistical inference using confidence intervals and hypothesis testing methods.
**CO6** *(Create)*: Design and carry out appropriate statistical tests, including t-tests, chi-square tests, and ANOVA, for given data scenarios.

## Course Content

### Unit I

Raw Data, Graphical Plots - Frequency Distribution, Relative and Cumulative Frequency Distributions, Measures of Central Tendency: Mean, Median, Mode, Measures of Dispersion: Range, Standard Deviation, Quartile Deviation, Mean and Median Absolute Deviation, Moments - Measures of Skewness and Kurtosis, Notion of Linear Correlation and Linear Regression, Concept of Probability, Axioms of Probability- Conditional Probability, Simple Problems - Independent Events - Bayes' Rule (without proof) and Simple Applications.

**Unit II**

Discrete and Continuous Random Variables, Probability Distributions for Discrete and Continuous Random Variables, Distribution Functions - Joint Distributions - Independent Random Variables - Probability Distributions of Functions of Random Variables, Marginal and Conditional Distributions, Mathematical Expectation, Notions of Binomial, Poisson, Normal, Uniform, Exponential Distributions.

**Unit III**

Population, Parameter, Statistic, Sampling Techniques: Simple Random Sampling (SRS), Sampling with and without Replacement, Sampling distribution of mean, Sampling Distribution of Difference of Means: Student's t, F and Chi-square distribution, and their properties. Point and Interval Estimation, Properties of a Good Estimator:Unbiasdness, Consistency, Efficiency. Confidence interval for population mean (variance known and unknown case), Confidence interval for population variance (mean known and unknown), Confidence interval for difference between means.

**Unit IV**

Testing of Hypothesis: Parameter and statistic, Simple and composite hypotheses, Null and alternative hypotheses, Critical Region, Level of significance, One tailed and two tailed tests, size of test, types of errors. One Sample Tests for Mean, Two Sample Tests for Means, paired t-test, significance of correlation coefficient, Chi-square Test and its Applications: - Test for Goodness of Fit, F- Test One-way and Two-way Analysis of Variance.

**Text and Reference Books:**


1. Montgomery, D. C., and Runger, G. C. *Applied Statistics and Probability for Engineers*, Seventh Edition, John Wiley & Sons, 2018.
2. Bruce, P., Bruce, A., and Gedeck, P. *Practical Statistics for Data Scientists*, Second Edition, O'Reilly Media, 2020.
3. Spiegel, M. R., Schiller, J. J., and Alu Srinivasan, R. *Probability and Statistics*, Fourth Edition, Schaum's Outline Series, McGraw Hill Companies, 2013.
4. S.C. Gupta, V. K. Kapoor, *Fundamentals of Mathematical Statistics,* Sultan Chand & Sons, 2020.
5. S.C. Gupta, V. K. Kapoor, *Fundamentals of Applied Statistics,* Sultan Chand & Sons, 2014.

# Data Structures and Algorithms

**General Course Information**

| | |
|---|---|
| Course Code: U25MDS103T<br>Course Credits: 3<br>Type: **Discipline Specific Courses**<br>Contact Hours: 3 hours/week<br>Mode: Lectures (L)<br>Examination Duration: 2.5 hours | **Course Assessment Methods:**<br>**Max. Marks: 70 (Internal: 20; External: 50)**<br>The department will conduct one minor test worth 10 marks. The Course Coordinator will decide whether to hold a second minor test at their level, and there will be no date sheet for it. Class performance includes attendance (5 marks) and 5 marks for assignments, seminars, presentations, or quizzes. Internal marks will be the total of the minor test score and the class performance marks earned by the student.<br><br>**Note:** The end semester examination will be of 50 marks. The examiner is required to set seven questions in all. The first question will be compulsory consisting of consisting of five short questions covering the entire syllabus consisting of 2.5 marks each. In addition to that six more questions will be set, two questions from each unit. The students shall be required to attempt four questions in all selecting one question from each unit in addition to compulsory Question No. 01. All question shall carry equal marks i.e. 12.5 marks. |

Data Structures and Algorithms is a core and an essential course for every graduate in Computer Science. This course introduces data structures like arrays, linked lists, trees and graphs etc. and various operations to be implemented on these data structures for solving real world problems. It includes various sorting and searching algorithms as well.

**Course Outcomes:**

Upon completion of this course, students will be able to:

**CO1** *(Remember)*: Define and describe fundamental data structures including arrays, linked lists, stacks, queues, trees, and graphs.
**CO2** *(Understand)*: Explain memory representation and operations of linear and non-linear data structures.
**CO3** *(Apply)*: Implement various data structures and perform operations like insertion, deletion, traversal, and searching.
**CO4** *(Analyze)*: Analyze the efficiency of algorithms using asymptotic notations and evaluate performance trade-offs.
**CO5** *(Evaluate)*: Compare different searching, sorting, and hashing techniques in terms of time and space complexity.
**CO6** *(Create)*: Design and develop efficient data structure-based solutions for real-world problems involving trees, graphs, and hashing.

## Course Content

### Unit I

Introduction to data structures and their types, Abstract data types, Linear lists: Arrays and linked lists: memory representations, implementing operations like traversing, searching, inserting and deleting etc. Applications of arrays and linked lists. Representing sets and polynomials using linked lists.

**Unit II**

Stack and Queue: Static and linked implementations, Operations and Applications. Circular queues, Tress, Binary trees and related terminology, Tree traversals (Recursive), Threaded Binary Trees, Binary Search Trees implementation and operations, Priority queues.

**Unit III**

Height Balanced or AVL trees and B trees. Graph definitions and related terminology, memory representations and related operations (traversal, insertion, deletion, search), Hashing, Hash tables, hash function and collision resolution, Sequential and binary search, Sorting algorithms: Bubble sort, Selection sort, Insertion sort, Time and space complexity of algorithms: Asymptotic analysis, Big O, Omega, Theta notations.

T**ext and Reference Books:**


1. Aho, A. V., Ullman, J. D., and Hopcroft, J. E., *Data Structures and Algorithms*, Addison-Wesley, 1983.
2. LangsamYedidyah, Augenstein J Moshe, Tenenbaum M Aaron, *Data Structures using C and C++*, 3rd edition, PHI, 2009.
3. Cormen, T. H., Leiserson, C. E., Rivest, R. L. and Stein, C., *Introduction to Algorithms*, MIT Press, 2009.
4. Robert L. Kruse, *Data Structure and Program Design in C*, Pearson Education India, 2007.
5. Weiss, M. A., *Data Structures and Algorithm Analysis in C++*, Addison-Wesley, 2007.
6. Sahni, S., *Data Structures, Algorithms, and Applications in C++*, WCB/McGraw-Hill, 2001.

## Data Structures and Algorithms Lab.

**General Course Information**

| | |
|---|---|
| Course Code: U25MDS103P<br>Course Credits: 1<br>Type: **Discipline Specific Courses**<br>Contact Hours: 2 hours/week<br>Mode: Lab practice and assignments | **Course Assessment Methods:**<br>**Total Marks: 30 (internal: 10; external: 20)**<br>The internal and external assessment is based on the level of participation in lab. sessions and the timely submission of lab experiments/assignments, the quality of solutions designed for the assignments, the performance in VIVA VOCE, the quality of lab. file and ethical practices followed. The internal examination is conducted by the course coordinator. The external examination is conducted by external examiner appointed by the Controller of Examination in association with the internal examiner appointed by the Chairperson of the Department. |

**Pre-requisites:** Programming in C language.

**About the Course:**

This lab course involves implementation of basic and advance data structures and various operations on these data structures. The objective of the lab course is to train the students to solve the problems related to data structures and choose the appropriate data structure for solving computational problem efficiently.

**Course Outcomes:**

Upon completion of this course, students will be able to:

**CO1** *(Remember)*: Recall and identify appropriate data structures required for different computational problems.
**CO2** *(Understand)*: Demonstrate understanding of the working principles of data structures through hands-on implementation.
**CO3** *(Apply)*: Implement and execute operations like insertion, deletion, traversal, and searching on arrays, linked lists, stacks, and queues.
**CO4** *(Analyze)*: Test and analyze recursive and non-recursive programs for tree and graph traversals.
**CO5** *(Evaluate)*: Evaluate and compare the performance of searching and sorting algorithms based on time and space complexity.
**CO6** *(Create)*: Develop complete programs integrating appropriate data structures to solve real-world problems.

### Practical Lab based on theory course U25MDS103T

**Note:**

The actual experiments/assignments will be designed by the course coordinator. One assignment should be designed to be done in groups of two or three students. The assignments must meet the objective of the course. The list of assignments and schedule of submission will be prepared by the course coordinator at the beginning of the semester.

# Operating Systems

**General Course Information**

| | |
|---|---|
| Course Code: U25MDS104T(i)<br>Course Credits: 3<br>Type: **Discipline Elective Course**<br>Contact Hours: 3 hours/week<br>Mode: Lectures (L)<br>Examination Duration: 2.5 hours | **Course Assessment Methods:**<br>**Max. Marks: 70 (Internal: 20; External: 50)**<br>The department will conduct one minor test worth 10 marks. The Course Coordinator will decide whether to hold a second minor test at their level, and there will be no date sheet for it. Class performance includes attendance (5 marks) and 5 marks for assignments, seminars, presentations, or quizzes. Internal marks will be the total of the minor test score and the class performance marks earned by the student.<br><br>**Note:** The end semester examination will be of 50 marks. The examiner is required to set seven questions in all. The first question will be compulsory consisting of consisting of five short questions covering the entire syllabus consisting of 2.5 marks each. In addition to that six more questions will be set, two questions from each unit. The students shall be required to attempt four questions in all selecting one question from each unit in addition to compulsory Question No. 01. All question shall carry equal marks i.e. 12.5 marks. |

**About the Course:**

The objective of this course is to help students become familiar with the fundamental concepts of operating systems and provide them with enough understanding of operating system design.

## Course Outcomes:

Upon completion of this course, students will be able to:

**CO1** *(Remember)*: Describe the fundamental concepts, services, and types of operating systems including batch, real-time, and cloud-based OS.
**CO2** *(Understand)*: Explain process management concepts such as process states, scheduling, multithreading, and inter-process communication.
**CO3** *(Apply)*: Apply scheduling algorithms and memory management techniques to solve basic OS-related problems.
**CO4** *(Analyze)*: Analyze the structure and functioning of file systems, including file access methods and allocation strategies.
**CO5** *(Evaluate)*: Evaluate issues and solutions related to deadlock, distributed OS, and network communication protocols.
**CO6** *(Create)*: Compare and assess modern operating systems (e.g., Windows, UNIX, Linux) based on architecture, memory management, and system services.

## Course Content

### Unit I

Introductory Concepts: Operating systems functions and characteristics, Computer system organization, Computer system architecture, Operating system structure, Virtual machines, Protection & Security, Operating system services and system calls, Types of Operating systems: Batch operating system, Time-sharing OS, Distributed operating system, Real time systems.NOS, Multiprocessor OS, Mobile OS, RTOS, Cloud OS. Processes: Process in memory, Process states, PCB, Process scheduling, Inter-process communication

### Unit II

CPU scheduling: Levels of Scheduling, Scheduling criteria, Scheduling algorithms, Multithreading models. Thrashing. File Systems: Types of Files and their access methods, File allocation methods, Directory structure. Distributed OS-types of distributed operating systems, Network topology, Communication protocols. Issues in Distributed operating systems

**Unit III**

Deadlocks- Deadlock characterization, Methods for handling deadlocks, Deadlock prevention, Deadlock avoidance, Recovery from deadlock. Memory: Basic hardware, Address binding, swapping, logical and physical address space, Contiguous memory allocation, Fragmentation, Paging, TLB, Segmentation, Virtual memory Demand paging, Page replacement algorithms. Case Studies: Comparative study of WINDOW, UNIX & LINUX system.

**Text and Reference Books:**


1. Silberschatz, Peter B. Galvin and Greg Gagne, *Operating System Concepts, 8th Edition*, Wiley Indian Edition, 2010.
2. Andrew S Tanenbaum, *Modern Operating Systems, Third Edition*, Prentice Hall India, 2008.
3. Naresh Chauhan, *Principles of Operating Systems*, Oxford Press, 2014.
4. D.M. Dhamdhere, *Operating Systems, 2nd edition*, Tata McGraw Hill, 2010.
5. William Stallings, *Operating Systems– Internals and Design Principles, 5th Edition*, Prentice Hall India, 2000.

## Operating Systems Lab.

**General Course Information**

| | |
|---|---|
| Course Code: U25MDS104P (i)<br>Course Credits: 1<br>Type: **Discipline Specific Courses**<br>Contact Hours: 2 hours/week<br>Mode: Lab practice and assignments | **Course Assessment Methods:**<br>**Total Marks: 30 (internal: 10; external: 20)**<br>The internal and external assessment is based on the level of participation in lab. sessions and the timely submission of lab experiments/assignments, the quality of solutions designed for the assignments, the performance in VIVA VOCE, the quality of lab. file and ethical practices followed. The internal examination is conducted by the course coordinator. The external examination is conducted by external examiner appointed by the Controller of Examination in association with the internal examiner appointed by the Chairperson of the Department. |

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**About the Course:**

The objective of this course is to help students become familiar with the fundamental concepts of operating systems and provide them with enough understanding of operating system design.

### Course Outcomes:

Upon completion of this course, students will be able to:

**CO1** *(Remember)*: Recall and describe basic operating system concepts and commands related to file and process management.
**CO2** *(Understand)*: Demonstrate understanding of system-level programming concepts using commands and shell scripting in UNIX/Linux.
**CO3** *(Apply)*: Implement programs for CPU scheduling, memory management, and inter-process communication using C/C++ or shell scripts.
**CO4** *(Analyze)*: Analyze system behavior through simulations of scheduling algorithms, paging techniques, and file operations.
**CO5** *(Evaluate)*: Test and validate the efficiency of OS algorithms (e.g., page replacement, deadlock detection) through case-based experiments.
**CO6** *(Create)*: Design shell scripts and programs that demonstrate process synchronization, resource allocation, and system calls.

### Practical Lab based on theory course U25MDS104T (i)

**Note:**

The actual experiments/assignments will be designed by the course coordinator. One assignment should be designed to be done in groups of two or three students. The assignments must meet the objective of the course. The list of assignments and schedule of submission will be prepared by the course coordinator at the beginning of the semester.

# Database Management System

**General Course Information**

| | |
|---|---|
| Course Code: U25MDS104T (ii)<br>Course Credits: 3<br>Type: **Discipline Elective Course**<br>Contact Hours: 3 hours/week<br>Mode: Lectures (L)<br>Exam Duration:2.5 hours | **Course Assessment Methods:**<br>**Max. Marks: 70 (Internal: 20; External: 50)**<br>The department will conduct one minor test worth 10 marks. The Course Coordinator will decide whether to hold a second minor test at their level, and there will be no date sheet for it. Class performance includes attendance (5 marks) and 5 marks for assignments, seminars, presentations, or quizzes. Internal marks will be the total of the minor test score and the class performance marks earned by the student.<br>**Note:** The end semester examination will be of 50 marks. The examiner is required to set seven questions in all. The first question will be compulsory consisting of consisting of five short questions covering the entire syllabus consisting of 2.5 marks each. In addition to that six more questions will be set, two questions from each unit. The students shall be required to attempt four questions in all selecting one question from each unit in addition to compulsory Question No. 01. All question shall carry equal marks i.e. 12.5 marks. |

**About the Course:**

This course includes a detailed coverage of principles of database design and models. Students learn querying a database using SQL, normalization techniques, transaction processing etc.

## Course Outcomes:

Upon completion of this course, students will be able to:

**CO1** *(Remember)*: Define fundamental database concepts, architectures, data models, and various database languages.
**CO2** *(Understand)*: Interpret Entity-Relationship (E-R) models and convert E-R diagrams into relational schemas.
**CO3** *(Apply)*: Apply relational algebra and calculus to formulate database queries and manipulate data.
**CO4** *(Analyze)*: Analyze database design using normalization techniques to eliminate anomalies and ensure data integrity.
**CO5** *(Evaluate)*: Evaluate concurrency control mechanisms and transaction management techniques for consistency and recovery.
**CO6** *(Create)*: Design distributed databases using fragmentation and replication strategies ensuring scalability and reliability.

**Course Content**

**Unit I**

Data Base Systems Concepts and Architecture: DBMS architecture and various views of Data, Data Independence, Database languages, Data Models: Relational Database Model, Hierarchical Data Model, Network Data Model, Schemas and Instances. E-R Model: Entity Types, Attributes & Keys, Relationships, Roles and Structural Constraints, E-R Diagrams, Reduction of an E-R Diagram to Tables

**Unit II**

.Relational Model and Query Language: Overview of Relational Database, Key Integrity Constraints, Relational Algebra, Relational Calculus, Relational Database Design: Overview of normalization, Database Anomalies,

Candidate and Super Key, Functional Dependencies, Integrity Constraints, Decomposition, Normal forms: First, Second, Third Normal, Boyce Codd, Normal Form, Multi-valued Functional Dependencies and Fourth Normal Form, Join Dependencies and Fifth Normal Form, Denormalization

**Unit III**

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Concurrency Control Techniques: Overview of database Transactions, Transaction states, ACID properties of a Transaction, Transaction Recovery, Concurrency Control, Locking Techniques, Time-stamp ordering, Multi-version Techniques, Deadlock, Recovery Techniques in centralized DBMS,DDBMS Design: Replication and Fragmentation Techniques.

**Text and Reference Books:**


1. Elmasri, R., and Navathe, S. B., *Fundamentals of Database Systems*, 3rd Edition, Addison Wesley, 2002.
2. Silberschatz, A., Korth, H. F., and Sudarshan, S., Database *System Concepts,* McGraw Hill, 2011.
3. Pannerselvam R., *Database Management Systems*, 2nd Edition, PHI Learning, 2011.
4. Desai, B. C., *An Introduction to Database System*, Galgotia Publication, 2010.
5. Leon, A., and Leon, M., *Database Management Systems*, Ist Edition, Vikas Publishing, 2009.
6. Mata-Toledo, R., Cushman, P., Sahoo, D., *Database Management Systems*, Schaums' Outline series, TMH, 2007.

## Database Management System Lab.

**General Course Information**

| | |
|---|---|
| Course Code: U25MDS104P(ii)<br>Course Credits: 1<br>Type: **Discipline Elective Course**<br>Contact Hours: 2 hours/week<br>Mode: Lab practice and assignments | **Course Assessment Methods:**<br>**Total Marks: 30 (internal: 10; external: 20)**<br>The internal and external assessment is based on the level of participation in lab. sessions and the timely submission of lab experiments/assignments, the quality of solutions designed for the assignments, the performance in VIVA VOCE, the quality of lab. file and ethical practices followed. The internal examination is conducted by the course coordinator. The external examination is conducted by external examiner appointed by the Controller of Examination in association with the internal examiner appointed by the Chairperson of the Department. |

**About the Course:**

This lab. course on DBMS involves a rigorous training on Oracle programming. It provides a strong formal foundation in database concepts, technology and practice to the students to groom them into well-informed database application developers. The objective of the lab course is to develop proficiency in the execution of commands of the database design and query using Oracle.

**Course Outcomes:**

Upon completion of this course, students will be able to:

**CO1** *(Remember)*: Recall and understand basic SQL syntax and commands used for data definition and data manipulation.
**CO2** *(Understand)*: Interpret and explain database schemas, relationships, and query logic using SQL and ER diagrams.
**CO3** *(Apply)*: Apply SQL commands to create, modify, and query relational databases effectively.
**CO4** *(Analyze)*: Analyze and implement normalization techniques on sample datasets to improve database design.
**CO5** *(Evaluate)*: Evaluate and handle database transactions, integrity constraints, and query optimization scenarios.
**CO6** *(Create)*: Design and develop mini database applications using SQL and front-end tools for real-world use cases.

### Practical Lab based on theory course U25MDS104T (ii)

**Note:**

The actual experiments/assignments will be designed by the course coordinator. One assignment should be designed to be done in groups of two or three students. The assignments must meet the objective of the course. The list of assignments and schedule of submission will be prepared by the course coordinator at the beginning of the semester.

## Python and R Programming Lab.

**General Course Information**

| | |
|---|---|
| Course Code: U25MDS105P<br>Course Credits: 4<br>Type: **Practicum/ Dissertation/Project work/**<br>Contact Hours: 8 hours/week<br>Mode: Lab practice and assignments. | **Course Assessment Methods:**<br>**Total Marks: 100 (internal: 30; external: 70)**<br>The internal and external assessment is based on the level of participation in lab. sessions and the timely submission of lab experiments/assignments, the quality of solutions designed for the assignments, the performance in VIVA VOCE, the quality of lab. file and ethical practices followed. The internal examination is conducted by the course coordinator. The external examination is conducted by external examiner appointed by the Controller of Examination in association with the internal examiner appointed by the Chairperson of the Department. |

**About the Course:**

The major objective of Python programming is to make the students solve real word problem including data science problems efficiently using python library. The understanding and knowledge of R programming helps the students to read the data and its manipulation using R.

**Course Outcomes:**

Upon completion of this course, students will be able to:

**CO1** *(Remember)*: Recall basic syntax, data types, and control structures in Python and R programming languages.
**CO2** *(Understand)*: Explain programming concepts including functions, loops, and data manipulation in Python and R.
**CO3** *(Apply)*: Write and execute Python and R programs to perform data analysis and visualization tasks.
**CO4** *(Analyze)*: Debug and troubleshoot code to identify and fix logical and runtime errors in Python and R scripts.
**CO5** *(Evaluate)*: Assess and optimize code performance for data processing and statistical analysis.
**CO6** *(Create)*: Develop mini-projects integrating Python and R for real-world data science applications.

**Note:**

The actual experiments/assignments will be designed by the course coordinator. One assignment should be designed to be done in groups of two or three students. The assignments must meet the objective of the course. The list of assignments and schedule of submission will be prepared by the course coordinator at the beginning of the semester.

# Artificial Intelligence

**General Course Information**

| | |
|---|---|
| Course Code: U25MDS201T<br>Course Credits: 4<br>Type: **Discipline Specific Courses**<br>Contact Hours: 4 hours/week<br>Mode: Lectures (L)<br>Examination Duration: 3 hours | **Course Assessment Methods:**<br>**Max. Marks: 100 (Internal: 30; External: 70)**<br>The department will conduct one minor test worth 15 marks. The Course Coordinator will decide whether to hold a second minor test at their level, and there will be no date sheet for it. Class performance includes attendance (5 marks) and 10 marks for assignments, seminars, presentations, or quizzes. Internal marks will be the total of the minor test score and the class performance marks earned by the student.<br><br>**Note:** The end semester examination will be of 70 marks. The examiner is required to set nine questions in all. The first question will be compulsory consisting of consisting of seven short questions covering the entire syllabus consisting of 2 marks each. In addition to that eight more questions will be set, two question from each unit. The students shall be required to attempt five questions in all selecting one question from each unit in addition to compulsory Question No. 01. All question shall carry equal marks i.e. 14 marks. |

**About the Course:**

Artificial Intelligence is a core and an essential course for every graduate in Computer Science and Engineering. This course introduces the concepts of Artificial Intelligence and challenges inherent in building intelligent systems. It includes the role of knowledge representation in problem solving and how these are used in making intelligent machine. Further it incorporates the concepts of expert system and its applications.

### Course Outcomes:

Upon completion of this course, students will be able to:

**CO1** *(Remember)*: Define fundamental AI concepts, search algorithms, and problem-solving techniques.
**CO2** *(Understand)*: Explain various knowledge representation methods including propositional and predicate logic.
**CO3** *(Apply)*: Apply heuristic search techniques and logic programming to solve AI problems.
**CO4** *(Analyze)*: Analyze reasoning methods under uncertainty using Bayesian networks and fuzzy logic.
**CO5** *(Evaluate)*: Evaluate planning strategies and expert system architectures for problem-solving in AI.
**CO6** *(Create)*: Design rule-based expert systems and develop AI solutions for real-world applications.

## Course Content

### Unit I

Introduction to AI: Introduction, Turing Test, AI problems, State Space Search, production system

Problem Solving Using Search: Blind search techniques - Breadth first search, Depth first search. Heuristic search techniques - Generate and test, Hill Climbing, Best first search, A* Algorithm, AO* Algorithm, The Minimax Search Procedure, Adding Alpha-Beta Cut-offs.

### Unit II

Knowledge Representation: Introduction, Knowledge Representation- Representation and Mappings, Symbolic Logic - Propositional logic, Predicate logic- Representing simple facts in logic, Representing Instances and ISA Relationship, Computable functions and Predicates, Unification, Resolution.

Representing Knowledge Using Rules: Procedural versus Declarative Knowledge, Logic Programming, Forward versus Backward Reasoning, Matching, Control Knowledge.

**Unit III**

Reasoning Under Uncertainty: Introduction to Nonmonotonic Reasoning, Probability and Baye's Theorem, Certainty Factors and Rule-based Systems, Bayesian Networks.

Fuzzy logic system: Introduction, Crisp Set, Fuzzy Sets, Fuzzy Membership Functions, Operations on Fuzzy Sets, Fuzzy Relations.

**Unit IV**

Planning: Introduction, Components of Planning System, Goal Stack Planning, Nonlinear Planning using Constraint Posting, Hierarchical Planning.

Expert System and Applications: Introduction, Architecture, Rule based Expert Systems, Applications of Expert Systems.

**Text and Reference Books:**


1. Elaine Rich, Kevin Knight and Shivashankar B Nair, *Artificial intelligence*, McGraw Hill Education. 3rd edition, 2009.
2. Stuart Russel and Peter Norvig, *Artificial intelligence: A modern Approach*, Pearson Education, 3rd edition, 2015.
3. Dan W. Patterson, *Introduction to Artificial Intelligence and Expert System*, Pearson Education.1st edition, 2007.
4. Deepak Khemani, *A first course in Artificial Intelligence*, McGraw Hill Education. 3rd edition, 1st edition, 2013.
5. George F. Luger, *Artificial Intelligence: Structures and Strategies for Complex Problem Solving*, Pearson Education, 5th edition, 2009.

# Data Analytics

**General Course Information**

| | |
|---|---|
| Course Code: U25MDS202T<br>**Course Credits: 3**<br>Type: Discipline Specific Courses<br>Contact Hours: 3 hours/week<br>Mode: Lectures (L)<br>Examination Duration: 2.5 hours | **Course Assessment Methods:**<br>**Max. Marks: 70 (Internal: 20; External: 50)**<br>The department will conduct one minor test worth 10 marks. The Course Coordinator will decide whether to hold a second minor test at their level, and there will be no date sheet for it. Class performance includes attendance (5 marks) and 5 marks for assignments, seminars, presentations, or quizzes. Internal marks will be the total of the minor test score and the class performance marks earned by the student.<br>**Note:** The end semester examination will be of 50 marks. The examiner is required to set seven questions in all. The first question will be compulsory consisting of consisting of five short questions covering the entire syllabus consisting of 2.5 marks each. In addition to that six more questions will be set, two questions from each unit. The students shall be required to attempt four questions in all selecting one question from each unit in addition to compulsory Question No. 01. All question shall carry equal marks i.e. 12.5 marks. |

**About the Course:**

In this course, the learners will be able to develop expertise in R programming for manipulating, exploring, visualizing, applying descriptive and inferential statistics. In addition, they will learn to implement predictive modelling.

**Course Outcomes:**

Upon completion of this course, students will be able to:

**CO1** *(Remember)*: Recall basic concepts of data types, data structures, and data manipulation techniques in analytics.
**CO2** *(Understand)*: Explain exploratory data analysis techniques and data visualization methods to summarize data insights.
**CO3** *(Apply)*: Apply data cleaning methods to detect outliers and handle missing values in datasets.
**CO4** *(Analyze)*: Analyze regression and classification models to assess their accuracy and interpretability.
**CO5** *(Evaluate)*: Evaluate classification model performance using confusion matrix and related metrics such as ROC curve and F-measure.
**CO6** *(Create)*: Develop predictive models using linear regression and machine learning classification techniques for real-world data analytics problems.

## Course Content

### Unit I

Data analytics preliminaries: Introduction to data analytics, scales of measurements (Data types). Working with vectors, matrices and tabular data (data frames), reading and writing tabular data from and to files (text and CSV). Discriminating between sample and population, Quantile-Quantile plot. Manipulating tabular data: Sorting, filtering cases, selecting variables, deriving new variables, grouping and summarizing data. working with packages for data manipulations and transformations.

**Unit II**

Exploratory data analysis: random and normally distributed variables, skewed normal distribution, z-score, detecting outliers in data, handling missing values. Visualizing data through various plots and charts: bar charts, histogram, frequency polygon, density plots, scatter plots, box & whisker plots, heat and contour plots

Predictive modelling: what is predictive modelling, estimating a function, the trade-off between model accuracy and prediction accuracy and model interpretability, regression versus classification, measuring the quality of fit, The bias and variance trade- off.

**Unit III**

Simple and multiple linear regression modelling: estimating the coefficients, assessing the accuracy of the coefficient estimates, assessing the accuracy of the model.

Classification Modeling: The process of classification, decision tree, Bayesian, k-nearest neighbor, support vector machine classification models. evaluating a classification model: confusion matrix, accuracy, sensitivity, specificity, f-measure, kappa statistics, ROC and area under curve. accuracy and interpretability of classification models.

Evaluating the accuracy of a classifier: holdout or random sampling methods, cross-validation, bootstrap methods.

**Text and Reference Books:**


1. W. N. Venables, D. M. Smith and the R core Team, *An introduction to R, Notes on R: A Programming Environment for Data Analysis and Graphics*, version 3.3.2, 2016.
2. Saroj Dahiya Ratnoo and Himmat Singh Ratnoo, *Essentials of R for Data Analytics*, Wiley, 2021.
3. Hadley Wickham and Garrett Grolemund, *R for Data Science Import, Tidy, Transform and model Data*, O'Reilly, 2017.
4. Paul Teeter, *R Cookbook*, O'Reilly, 2011.
5. Gareth James, Daniela Witten, Trevor Hastie, Robert Tibshirani, *An Introduction to Statistical Learning with Applications in R*, Springer, 2013.
6. Han, J., Kamber, M, Pei, J., *Data Mining Concepts and Techniques*, Third edition, Morgan Kaufmann, 2012.

## Data Analytics Lab.

### General Course Information

| | |
|---|---|
| Course Code: U25MDS202P<br>Course Credits: 1<br>Type: Discipline Specific Courses<br>Course Contact Hours: 2 hours/week<br>Mode: Lab practice and assignments | **Course Assessment Methods:**<br>**Total Marks: 30 (internal: 10; external: 20)**<br>The internal and external assessment is based on the level of participation in lab. sessions and the timely submission of lab experiments/assignments, the quality of solutions designed for the assignments, the performance in VIVA VOCE, the quality of lab. file and ethical practices followed. The internal examination is conducted by the course coordinator. The external examination is conducted by external examiner appointed by the Controller of Examination in association with the internal examiner appointed by the Chairperson of the Department. |

### About the Course:

The objective of this lab is to enable students to apply advanced data analytics tools for manipulating data, applying statistics, regression and classification.

### Course Outcomes:

Upon completion of this course, students will be able to:

**CO1** *(Remember)*: Recall basic commands and functions for data manipulation and visualization in tools like Python or R.
**CO2** *(Understand)*: Demonstrate understanding of data cleaning techniques including handling missing values and outlier detection.
**CO3** *(Apply)*: Apply exploratory data analysis methods to visualize and summarize datasets using various plots and charts.
**CO4** *(Analyze)*: Analyze and interpret the results of regression and classification models built on sample datasets.
**CO5** *(Evaluate)*: Evaluate model performance using metrics such as accuracy, sensitivity, specificity, and ROC curves.
**CO6** *(Create)*: Develop and present predictive models addressing real-world datasets through hands-on projects.

### Practical Lab based on theory course U25MDS202T

### Note:

The actual experiments/assignments will be designed by the course coordinator. One assignment should be designed to be done in groups of two or three students. The assignments must meet the objective of the course. The list of assignments and schedule of submission will be prepared by the course coordinator at the beginning of the semester.

# Data Mining

**General Course Information**

| | |
|---|---|
| Course Code: U25MDS203T<br>Course Credits: 3<br>Type: **Discipline Specific Courses**<br>Contact Hours: 3 hours/week<br>Mode: Lectures (L)<br>Examination Duration: 2.5 hours | **Course Assessment Methods:**<br>**Max. Marks: 70 (Internal: 20; External: 50)**<br>The department will conduct one minor test worth 10 marks. The Course Coordinator will decide whether to hold a second minor test at their level, and there will be no date sheet for it. Class performance includes attendance (5 marks) and 5 marks for assignments, seminars, presentations, or quizzes. Internal marks will be the total of the minor test score and the class performance marks earned by the student.<br>**Note:** The end semester examination will be of 50 marks. The examiner is required to set seven questions in all. The first question will be compulsory consisting of consisting of five short questions covering the entire syllabus consisting of 2.5 marks each. In addition to that six more questions will be set, two questions from each unit. The students shall be required to attempt four questions in all selecting one question from each unit in addition to compulsory Question No. 01. All question shall carry equal marks i.e. 12.5 marks. |

**Pre-requisites:** Knowledge of database systems, elementary knowledge of statistics and probability.

## About the Course:

This course covers the basics of data mining, including data preprocessing, data warehousing, and key algorithms for discovering patterns and associations in large datasets. Students will learn to apply data mining techniques to extract meaningful insights and handle complex, multidimensional data.

## Course Outcomes:

Upon completion of this course, students will be able to:

**CO1** *(Remember)*: Define key concepts, functionalities, and challenges in data mining and data preprocessing.
**CO2** *(Understand)*: Explain data warehouse architecture, multidimensional models, and OLAP operations.
**CO3** *(Apply)*: Apply data preprocessing techniques such as cleaning, integration, reduction, and transformation on datasets.
**CO4** *(Analyze)*: Analyze frequent patterns and association rules using algorithms like Apriori and pattern growth.
**CO5** *(Evaluate)*: Evaluate the efficiency and effectiveness of data mining algorithms and pattern evaluation methods.
**CO6** *(Create)*: Design and implement constraint-based frequent pattern mining in complex, multidimensional datasets.

## Course Content

### Unit I

Introduction to Data Mining: Kind of data to be mined, Data Mining Functionalities, Technologies used in Data Mining, Applications of data Mining, Major Issues in Data Mining. Data Pre-Processing: Need for preprocessing, Data Objects and Attribute types, Statistical description of data, Data Visualization, Measuring similarity and dissimilarity of data, Data Cleaning, Data Integration, Data Reduction, Data Transformation and Data Discretization.

### Unit II

Data Warehouse: Introduction, Data Warehouse and Database Systems, Data Warehouse Architecture, Data Warehouse Models, Data Cube and OLAP, Multidimensional data Model, Concept Hierarchies, OLAP operations, Data Warehouse Implementation

**Unit III**

Mining Associations and Correlations: Mining Frequent Patterns, Associations and Correlations, Frequent Itemset Mining using Apriori Algorithm, Generating Association Rules from Frequent Itemsets. Improving efficiency of Apriori, Pattern Growth Approach for Mining Frequent Itemsets, Pattern evaluation Methods.Advanced Pattern Mining: Pattern Mining in Multilevel and Multidimensional Space, Constraint-Based Frequent Pattern Mining.

## Text and Reference Books:


1. Jiawei Han, Micheline Kamber and Jian Pei, *Data Mining Concepts and Techniques*, Morgan Kaufmann Publishers, Third Edition, July 2011.
2. Alex Berson, Stephen J. Smith, *Data Warehousing, Data Mining & OLAP*, Tata McGraw Hill, 2004.
3. Pang-Ning Tan, Michael Steinbach and Vipin Kumar, *Introduction to Data Mining*, Pearson Education, 2014.
4. K. P. Soman, Shyam Diwakar and V. Ajay*, Insight into Data Mining Theory and Practice*, Easter
5. Economy Edition, Prentice Hall of India, 2009.
6. G. K. Gupta, *Introduction to Data Mining with Case Studies*, Prentice Hall of India, 2006.
7. Daniel T. Larose, *Data Mining Methods and Models*, Wiley, 2006.
8. W. H. Inman, *Building the Data Warehouse*, Wiley India, 2005.

## Data Mining Lab.

### General Course Information

| | |
|---|---|
| Course Code: U25MDS203P<br>Course Credits: 1<br>Type: **Discipline Specific Courses**<br><br>Course Contact Hours: 2 hours/week<br>Mode: Lab practice and assignments | **Course Assessment Methods:**<br>**Total Marks: 30 (internal: 10; external: 20)**<br>The internal and external assessment is based on the level of participation in lab. sessions and the timely submission of lab experiments/assignments, the quality of solutions designed for the assignments, the performance in VIVA VOCE, the quality of lab. file and ethical practices followed. The internal examination is conducted by the course coordinator. The external examination is conducted by external examiner appointed by the Controller of Examination in association with the internal examiner appointed by the Chairperson of the Department. |

### About the Course:

The course helps the students to learn how to perform data mining tasks using a data mining toolkit (such as open-source WEKA), understand the data sets and data pre-processing, demonstrate the working of algorithms for data mining tasks such as association rule mining, classification, clustering and regression, and exercise the data mining techniques with varied input values for different parameters.

### Course Outcomes:

Upon completion of this course, students will be able to:

**CO1** *(Remember)*: Recall basic data mining concepts and preprocessing techniques.
**CO2** *(Understand)*: Explain the steps involved in data cleaning, transformation, and integration.
**CO3** *(Apply)*: Implement data mining algorithms like Apriori for association rule mining.
**CO4** *(Analyze)*: Analyze frequent patterns and evaluate their significance in datasets.
**CO5** *(Evaluate)*: Assess the performance and efficiency of different data mining techniques.
**CO6** *(Create)*: Develop and execute data mining projects to discover meaningful patterns from real datasets.

### Practical Lab based on theory course U25MDS203T

### Note:

The actual experiments/assignments will be designed by the course coordinator. One assignment should be designed to be done in groups of two or three students. The assignments must meet the objective of the course. The list of assignments and schedule of submission will be prepared by the course coordinator at the beginning of the semester.

# Pattern Recognition

**General Course Information**

| | |
|---|---|
| Course Code: U25MDS204T(i)<br>Course Credits: 4<br>Type: **Discipline Elective Course**<br>Contact Hours: 4hours/week<br>Mode: Lectures (L)<br>Examination Duration: 3 hours | **Course Assessment Methods:**<br>**Max. Marks: 100 (Internal: 30; External: 70)**<br>The department will conduct one minor test worth 15 marks. The Course Coordinator will decide whether to hold a second minor test at their level, and there will be no date sheet for it. Class performance includes attendance (5 marks) and 10 marks for assignments, seminars, presentations, or quizzes. Internal marks will be the total of the minor test score and the class performance marks earned by the student.<br><br>**Note:** The end semester examination will be of 70 marks. The examiner is required to set nine questions in all. The first question will be compulsory consisting of consisting of seven short questions covering the entire syllabus consisting of 2 marks each. In addition to that eight more questions will be set, two question from each unit. The students shall be required to attempt five questions in all selecting one question from each unit in addition to compulsory Question No. 01. All question shall carry equal marks i.e. 14 marks. |

**About the Course:**
The aim of this course to summarize various techniques involved in pattern recognition. It includes supervised, unsupervised and ANN based pattern recognition techniques and their applications.

## Course Outcomes:

Upon completion of this course, students will be able to:

**CO1** *(Remember)*: Recall fundamental concepts and design methodologies of pattern recognition systems.
**CO2** *(Understand)*: Explain Bayes decision theory, parameter estimation, and non-parametric techniques.
**CO3** *(Apply)*: Apply linear and generalized decision functions for pattern classification tasks.
**CO4** *(Analyze)*: Analyze discriminant functions and machine learning algorithms like SVM and boosting methods.
**CO5** *(Evaluate)*: Evaluate syntactic pattern recognition models and their applications in biometrics.
**CO6** *(Create)*: Design and implement pattern recognition solutions for real-world problems such as facial and fingerprint recognition.

## Course Content

### Unit I

Introduction - Basic concepts, Applications, Fundamental problems in pattern Recognition system design, Design concepts and methodologies, The Design Cycle, Learning and Adaptation., Examples of Automatic Pattern recognition systems, Simple pattern recognition model, Decision and Distance Functions - Linear and generalized decision functions, Pattern space and weight space, Geometrical properties, implementations of decision functions, Minimum-distance pattern classifications. Bayes Decision Theory: Bayes Decision Theory, Minimum Error rate Classification.

### Unit II

Maximum Likelihood and Bayesian Parameter Estimation: Maximum Likelihood Estimation, Bayesian Estimation, Bayesian Parameter Estimation, Gaussian Case and General Theory. Hidden Markov models; Non Parametric

Techniques: Density Estimation, Parzen Windows, K- Nearest Neighbor Estimation, Nearest Neighbour rule, Metrics and Nearest Neighbour Classification, Fuzzy Classification, k-Means Clustering, Self-Organizing Maps.
Non Parametric Decision Making - Introduction, histogram, kernel and window estimation,. Adaptive decision boundaries, adaptive discriminate functions, Minimum squared error Discriminate functions.

**Unit III**

Linear Discriminant Functions: Linear Discriminant Functions and Decision Surfaces, Generalized Discriminant Functions, The two-category linearly separable case, Minimizing the perceptron criterion function, relaxation procedures, non- separable behaviour, Minimum Squared- Error procedures. Support vector machines, Algorithm-independent machine learning-Bias and Variance, Bootstrapping-Adaboost Algorithm, Boosting, Bagging

**Unit IV**

Syntactic Pattern Recognition & Application of Pattern Recognition: Introduction, concepts from formal language theory, formulation of syntactic pattern recognition problem, syntactic pattern description, recognition grammars, automata as pattern recognizers, Application of pattern recognition techniques in bio-metric, facial recognition, IRIS scan, Finger prints, etc..

## Text and Reference Books:


1. R. O. Duda, P. E. Hart and D. G. Stork, *Pattern classification*, John Wiley & Sons, 2002.
2. C. M. Bishop, *Neural Networks for Pattern Recognition*, Oxford University Press, 1995.
3. V. N. Vapnik, *The Nature of Statistical Learning Theory*, Springer, 2000.
4. N. Cristianini and J. Shawe-Taylor*, An Introduction to Support Vector Machines*, Cambridge University Press, 2000.

# Information Retrieval Systems

**General Course Information:**

| | |
|---|---|
| Course Code: U25MDS204T(ii)<br>Course Credits: 4<br>Type: Discipline Elective Course<br>Contact Hours: 4 hours/week<br>Mode: Lectures (L)<br>Examination Duration: 3 hours | **Course Assessment Methods:**<br>**Max. Marks: 100 (Internal: 30; External: 70)**<br>The department will conduct one minor test worth 15 marks. The Course Coordinator will decide whether to hold a second minor test at their level, and there will be no date sheet for it. Class performance includes attendance (5 marks) and 10 marks for assignments, seminars, presentations, or quizzes. Internal marks will be the total of the minor test score and the class performance marks earned by the student.<br><br>**Note:** The end semester examination will be of 70 marks. The examiner is required to set nine questions in all. The first question will be compulsory consisting of consisting of seven short questions covering the entire syllabus consisting of 2 marks each. In addition to that eight more questions will be set, two question from each unit. The students shall be required to attempt five questions in all selecting one question from each unit in addition to compulsory Question No. 01. All question shall carry equal marks i.e. 14 marks. |

**About the Course:**

This course would enable the students to understand the various aspects of an information retrieval system and its evaluation and to be able to design. The main aim of this course is to give students an understanding about data/file structures that are necessary to design, and implement information retrieval (IR) systems, IR principles to locate relevant information large collections of data, different document clustering algorithms, information retrieval systems for web search tasks etc.

**Course Outcomes:**

Upon completion of this course, students will be able to:

**CO1** *(Remember)*: Recall the basic concepts, objectives, and capabilities of information retrieval systems.
**CO2** *(Understand)*: Explain cataloging, indexing processes, and data structures used in information retrieval.
**CO3** *(Apply)*: Apply automatic indexing and clustering techniques to organize and retrieve information.
**CO4** *(Analyze)*: Analyze user search techniques and similarity measures to improve search effectiveness.
**CO5** *(Evaluate)*: Evaluate information visualization technologies and text search algorithms.
**CO6** *(Create)*: Design multimedia information retrieval solutions for audio, image, and video data.

## Course content

### Unit I

Introduction to Information Retrieval Systems: Definition of Information Retrieval System, Objectives of Information Retrieval Systems, Functional Overview, Relationship to Database Management Systems, Digital Libraries and Data Warehouses. Information Retrieval System Capabilities: Search Capabilities, Browse Capabilities, Miscellaneous Capabilities.

### Unit II

Cataloging and Indexing: History and Objectives of Indexing, Indexing Process, Automatic Indexing, Information Extraction. Data Structure: Introduction to Data Structure, Stemming Algorithms, Inverted File Structure, N-Gram

Data Structures, PAT Data Structure, Signature File Structure, Hypertext and XML Data Structures, Hidden Markov Models.

**Unit III**

Automatic Indexing: Classes of Automatic Indexing, Statistical Indexing, Natural Language, Concept Indexing, Hypertext Linkages. Document and Term Clustering: Introduction to Clustering, Thesaurus Generation, Item Clustering, Hierarchy of Clusters.

User Search Techniques: Search Statements and Binding, Similarity Measures and Ranking, Relevance Feedback, Selective Dissemination of Information Search, Weighted Searches of Boolean Systems, Searching the INTERNET and Hypertext.

**Unit IV**

Information Visualization: Introduction to Information Visualization, Cognition and Perception, Information Visualization Technologies.

Text Search Algorithms: Introduction to Text Search Techniques, Software Text Search Algorithms, Hardware Text Search Systems. Multimedia Information Retrieval: Spoken Language Audio Retrieval, Non-Speech Audio Retrieval, Graph Retrieval, Imagery Retrieval, Video Retrieval.

**Text and References Books:**


1. Kowalski & Maybury, *Information storage and retrieval systems: theory and implementation* (Vol. 8). Springer Science & Business Media, 2002.
2. Frakes & Baeza-Yates (Eds)., Information *retrieval: data structures and algorithms*. Prentice-Hall, Inc., 1992.
3. Korfhage, *Information Retrieval and Storage*, John Wiley & Sons, 1997
4. Baeza-Yates & Ribeiro-Neto (1999), *Modern information retrieval* (Vol. 463), New York: ACM press, 1999.

## Python Tools for Data Science Lab.

### General Course Information

| | |
|---|---|
| Course Code: U25MDS205P<br>Course Credits: 4<br>Type: **Practicum/ Dissertation/Project work/**<br>Contact Hours: 8 hours/week<br>Mode: Lab practice and assignments | **Course Assessment Methods:**<br>**Total Marks: 100 (internal: 30; external: 70)**<br>The internal and external assessment is based on the level of participation in lab. sessions and the timely submission of lab experiments/assignments, the quality of solutions designed for the assignments, the performance in VIVA VOCE, the quality of lab. file and ethical practices followed. The internal examination is conducted by the course coordinator. The external examination is conducted by external examiner appointed by the Controller of Examination in association with the internal examiner appointed by the Chairperson of the Department. |

**About the Course:**

This course focus on study of python tools for data scientists. In this course, powerful python tools -NumPy, Pandas and Matplotlib are to be studied. After studying this course, a student is expected to apply python tool for solving data science problems efficiently.

**Course Outcomes:**

Upon completion of this course, students will be able to:

**CO1** *(Remember)*: Recall basic Python programming concepts and libraries for data science.
**CO2** *(Understand)*: Explain functionalities of popular Python tools like Pandas, NumPy, and Matplotlib.
**CO3** *(Apply)*: Use Python libraries to manipulate, analyze, and visualize datasets.
**CO4** *(Analyze)*: Analyze data using statistical and plotting functions in Python.
**CO5** *(Evaluate)*: Evaluate the effectiveness of different Python tools for solving data science problems.
**CO6** *(Create)*: Develop Python scripts to solve real-world data science tasks and projects.

**Note:**

The actual experiments/assignments will be designed by the course coordinator. One assignment should be designed to be done in groups of two or three students. The assignments must meet the objective of the course. The list of assignments and schedule of submission will be prepared by the course coordinator at the beginning of the semester.

## Seminar

### General Course Information

| | |
|---|---|
| Course Code: U25MDS206S<br>Course Credits: 2<br>Type: **Seminar**<br><br>Contact Hours: 2 hours/week<br>Mode: Seminar | **Course Assessment Methods:**<br>**Total Marks: 50 (internal: 50; external: 00)**<br><br>The course assessment is based on active participation in seminar sessions, timely submission of seminar reports, quality of content and presentation design, preparation of a well-structured seminar file/report, effective presentation delivery, and the student's performance during questioning at the time of presentation. The internal evaluation is conducted by the course coordinator, with no external examination component. |

**About the Course:**

The Seminar course is designed to expose students to emerging trends and innovations across various technological domains such as Artificial Intelligence, Data Science, Internet of Things, Cybersecurity, Cloud Computing, and more. It encourages students to explore recent advancements, conduct independent research, and present their findings effectively. Through interactive sessions, presentations, and peer discussions, students enhance their research, analytical, and communication skills. The course promotes critical thinking, academic integrity, and awareness of real-world technological applications.

**Course Outcomes:**

Upon completion of this course, students will be able to:

**CO1** *(Remember)*: Identify and describe recent trends and emerging technologies in various domains.
**CO2** *(Understand)*: Explain the significance and impact of latest technological advancements.
**CO3** *(Apply)*: Apply research skills to gather and synthesize information from credible sources.
**CO4** *(Analyze)*: Analyze and evaluate current innovations and their real-world applications.
**CO5** *(Evaluate)*: Assess the relevance and credibility of technological content and presentations.
**CO6** *(Create)*: Develop and deliver effective presentations demonstrating critical thinking and communication skills.

# DEPARTMENT OF ARTIFICIAL INTELLIGENCE AND DATA SCIENCE

Details of the courses offered by the department to students from other departments as per NEP-2020 are categorized as shown in the table below.

| Type of Course | Course Code | Nomenclature of Paper/Course | Credit(s) | Contact Hours | Internal Marks | External Marks | Total | Duration of Exam (Hrs.) |
|---|---|---|---|---|---|---|---|---|
| Value-Added Courses (VAC) | U25VAC103T(i) | Fundamentals of Cyber Security | 2 | 2 | 15 | 35 | 50 | 2 |
| | U25VAC103T(ii) | Ethical AI and Data Privacy | 2 | 2 | 15 | 35 | 50 | 2 |
| Open Elective Courses (OEC) | U25OEC303T(i) | Introduction to Artificial Intelligence | 2 | 2 | 15 | 35 | 50 | 2 |
| | U25OEC303T(ii) | Introduction to Data Science | 2 | 2 | 15 | 35 | 50 | 2 |
| Skill Enhancement Courses (SEC) | U25SEC403P(i) | Web Technologies Lab. | 2 | 4 | 15 | 35 | 50 | 2 |
| | U25SEC403P(ii) | Python Programming Lab. | 2 | 4 | 15 | 35 | 50 | 2 |
| Employability and Entrepreneurship Skills Courses (EEC) | U25EEC403T(i) | Data Science for Business and Decision Making | 2 | 2 | 15 | 35 | 50 | 2 |
| | U25EEC403T(ii) | Network Security and Ethical Hacking Fundamentals | 2 | 2 | 15 | 35 | 50 | 2 |
| Vocational Course (VOC) | U25VOC403P(i) | Python Tools Lab. | 2 | 4 | 15 | 35 | 50 | 2 |
| | U25VOC403P(ii) | Data Visualizations Lab. | 2 | 4 | 15 | 35 | 50 | 2 |

**Chairman**

## Fundamental of Cyber Security

**General Course Information**

| | |
|---|---|
| **Course Code:** U25VAC103T(i)<br>**Credits:** 2<br>**Hours /Week:** 2<br>**Course Type**: Value Added Course<br>**Category:** Theory<br>**Mode:** Lectures (L)<br>**Examination Duration:** 2 Hours | **Course Assessment Methods:**<br>**Max. Marks: 50 (Internal: 15; External: 35)**<br><br>The department will conduct one minor test worth 10 marks. The Course Coordinator will decide whether to hold a second minor test at their level, and there will be no date sheet for it. Class performance includes attendance (5 marks). Internal marks will be the total of the minor test score and the class performance marks earned by the student.<br><br>**Note:** The end semester examination will be of 35 marks. The examiner is required to set five questions in all. The first question will be compulsory consisting of five short questions covering the entire syllabus consisting of 3 marks each. In addition to that four more questions will be set with two questions from each unit. The students shall be required to attempt three questions in all selecting one question from each unit consisting of 10 marks each in addition to compulsory Question No. 1 consisting of marks 15. |

### About the Course:

This course provides foundational knowledge of cyberspace, cyber security, and digital safety. It aims to raise awareness of the risks and challenges posed by the digital world, including cyber crimes, social media vulnerabilities, and digital payment frauds. Students will learn about secure practices, legal frameworks like the IT Act 2000, and effective mitigation strategies. The course also focuses on personal cyber hygiene, mobile device security, and responsible use of social platforms and digital financial services..

### Course Outcomes:

Upon completion of this course, students will be able to:

**CO1** *(Remember)*: Define cyberspace, web technologies, and key concepts of cyber security and cyber crime.
**CO2** *(Understand)*: Explain the architecture of cyberspace and classification of cyber threats and crimes.
**CO3** *(Apply)*: Apply legal knowledge from IT Act 2000 and follow procedures for reporting cyber crimes.
**CO4** *(Analyze)*: Analyze security and privacy issues related to social media and digital payment systems.
**CO5** *(Evaluate)*: Evaluate risks and frauds in digital transactions and assess preventive measures.
**CO6** *(Create)*: Configure and implement cyber safety best practices and basic device-level security policies.

### Course Content

### Unit I

Defining Cyberspace and Web-technology, Architecture of cyberspace, Communication and web technology, Internet, World wide web, Internet infrastructure for data transfer and governance, Internet society, Concept of cyber security, Issues and challenges of cyber security, Classification of cyber crimes, Common cyber crimes- cyber crime targeting computers and mobiles, cyber crime against women and children, financial frauds, social engineering attacks, malware and ransomware attacks, zero day and zero click attacks, Reporting of cyber crimes, Remedial and mitigation measures, Legal

perspective of cyber crime, IT Act 2000 and its amendments, Cyber crime and offences, Organisations dealing with Cyber crime and Cyber security in India.

## Unit II

Introduction to Social networks and media, Social media platforms, Social media monitoring, Hashtag, Viral content, Social media privacy, Challenges, opportunities and pitfalls in online social network, Security issues related to social media, Best practices for the use of Social media. Introduction to digital payments, Components of digital payment and stake holders, Modes of digital payments- Banking Cards, Unified Payment Interface (UPI), e-Wallets, Aadhar enabled payments, Digital payments related common frauds and preventive measures. RBI guidelines on digital payments and customer protection in unauthorised banking transactions. End Point device and Mobile phone security, Password policy, Security patch management, Data backup, Downloading and management of third party software, Device security policy, Cyber Security best practices, Significance of host firewall and Ant-virus, Wi-Fi security, Configuration of basic security policy and permissions.

**Text and Reference Books:**


1. R. C. Mishra, *Cyber Crime Impact in the New Millennium*, Author Press, 2010.
2. S. Belapure and N. Godbole, *Cyber Security: Understanding Cyber Crimes, Computer Forensics and Legal Perspectives*, Wiley India Pvt. Ltd., 1st Edition, 2011.
3. H. A. Oliver, *Security in the Digital Age: Social Media Security Threats and Vulnerabilities*, Create Space Independent Publishing Platform, Pearson, 13th November, 2001.
4. E. M. Awad, *Electronic Commerce*, Prentice Hall of India Pvt. Ltd.
5. K. Kumar, *Cyber Laws: Intellectual Property & E-Commerce Security*, Dominant Publishers.
6. E. Cole, R. Krutz, and J. W. Conley, *Network Security Bible*, 2nd Edition, Wiley India Pvt. Ltd.
7. E. Maiwald, *Fundamentals of Network Security*, McGraw-Hill.

## Ethical AI and Data Privacy

**General Course Information**

| | |
|---|---|
| **Course Code:** U25VAC103T(ii)<br>**Credits:** 2<br>**Hours /Week:** 2<br>**Course Type**:<br>**Category:** Theory<br>**Mode:** Lectures (L)<br>**Examination Duration:** 2 Hours | **Course Assessment Methods:**<br>**Max. Marks: 50 (Internal: 15; External: 35)**<br><br>The department will conduct one minor test worth 10 marks. The Course Coordinator will decide whether to hold a second minor test at their level, and there will be no date sheet for it. Class performance includes attendance (5 marks). Internal marks will be the total of the minor test score and the class performance marks earned by the student.<br><br>**Note:** The end semester examination will be of 35 marks. The examiner is required to set five questions in all. The first question will be compulsory consisting of five short questions covering the entire syllabus consisting of 3 marks each. In addition to that four more questions will be set with two questions from each unit. The students shall be required to attempt three questions in all selecting one question from each unit consisting of 10 marks each in addition to compulsory Question No. 1 consisting of marks 15. |

### About the Course:

This course explores the intersection of Artificial Intelligence (AI), data management, and cybersecurity. It addresses the evolving data landscape shaped by AI technologies and highlights ethical, legal, and privacy-related challenges. Through real-world case studies, it examines the risks associated with AI biases, automation, and personalization. The course also introduces AI-driven data classification, modern security frameworks like Zero Trust Architecture, and global privacy regulations such as GDPR and CCPA. Students will gain critical insights into building secure, ethical, and AI-resilient data ecosystems.

### Course Outcomes:

Upon completion of this course, students will be able to:

CO1 *(Remember)*: Define AI-driven data management concepts, ethical dilemmas, and key challenges in modern data governance.
CO2 *(Understand)*: Explain the AI threat landscape including biases, deepfakes, and real-world AI data breach cases.
CO3 *(Apply)*: Apply AI-based data classification techniques and privacy-preserving methods in data management.
CO4 *(Analyze)*: Analyze security frameworks like Zero-Trust Architecture and behavioral analytics for AI-powered threat detection.
CO5 *(Evaluate)*: Evaluate global privacy regulations (GDPR, CCPA) and their impact on AI data privacy and ethical data handling.
CO6 *(Create)*: Design data protection strategies addressing AI biases and ethical challenges while ensuring compliance with privacy laws.

### Course Content

#### Unit I

The New Data Landscape: The Role of AI in Modern Data Management, The Illusion of Anonymity in Big Data, AI-driven Data Governance, The Ethical Dilemmas of Predictive Analytics, The Double-edged Sword of Personalization, Data Sovereignty in a Borderless Digital World, The Imperative of Data Protection.
Understanding the AI Threat Landscape: The Rise of Rogue AI, Biases: The Unseen Puppeteers, Deepfakes: The

Erosion of Trust.Case Study: The Impact of AI Bias in Healthcare Diagnostics
Real-World AI Data Breaches: Lessons Learned: Autonomous Vehicles: When AI Meets the Real World, The Notorious Chatbot Incident, The Health Data Exposure.
Double-Edged Sword of Automation and Citizen Development Tools: RPA: Efficiency versus Security Trade-offs, Low-Code/No-Code Platforms: Democratization versus Compliance, Challenges of Automation in Smart Cities.

**Unit II**

Data Classification and Management: AI-Driven Data Classification Techniques, Ethical Considerations in AI-Driven Data Classification, Adaptive Data Classification, Role of Privacy-Preserving AI in Data Management, Data Classification Tools.
Foundations of AI-Proof Security: The Importance of Zero-Trust Architecture, Behavioral Analytics and AI-Powered Threat Detection, AI-Powered Penetration Testing, Data Masking and Anonymization, Power of Sandboxing in AI-Powered Security, Security Information and Event Management (SIEM) in the AI Era.
Privacy Considerations in the Age of AI: Privacy Regulations in the AI Context, GDPR: A Global Benchmark, CCPA: Pioneering U.S. Privacy Measures, Emerging Global Regulations and the AI Challenge, Data Privacy in Healthcare: Handling Sensitive Health Information, Ethical Data Collection and Handling, Protecting the Vulnerable: Children and AI, Understanding and Addressing Bias in AI Data.

**Text and Reference Books:**

1. Ryan, J., & Lazo, M. (2024). *AI data privacy and protection: The complete guide to ethical AI, data privacy, and security*. Technics Publications.

## Introduction to Artificial Intelligence

**General Course Information**

| | |
|---|---|
| **Course Code:** U25OEC303T(i)<br>**Credits:** 3<br>**Hours /Week:** 3<br>**Course Type**: Open Elective Courses<br>**Category:** Theory<br>**Mode:** Lectures (L)<br>**Examination Duration:** 2.5 Hours | **Course Assessment Methods:**<br>**Max. Marks: 50 (Internal: 15; External: 35)**<br><br>The department will conduct one minor test worth 10 marks. The Course Coordinator will decide whether to hold a second minor test at their level, and there will be no date sheet for it. Class performance includes attendance (5 marks). Internal marks will be the total of the minor test score and the class performance marks earned by the student.<br><br>**Note:** The end semester examination will be of 35 marks. The examiner is required to set five questions in all. The first question will be compulsory consisting of five short questions covering the entire syllabus consisting of 3 marks each. In addition to that four more questions will be set with two questions from each unit. The students shall be required to attempt three questions in all selecting one question from each unit consisting of 10 marks each in addition to compulsory Question No. 1 consisting of marks 15. |

**About the Course:**

This subject deals with the basic concepts of Artificial Intelligence.

**Course Outcomes:**

Upon completion of this course, students will be able to:

CO1 (Remember): Recall the basics of Artificial Intelligence, its importance, and key AI techniques.
CO2 (Understand): Explain problem spaces, state space search, and production system characteristics in AI.
CO3 (Apply): Apply search algorithms like depth-first, breadth-first, and heuristic searches to solve AI problems.
CO4 (Analyze): Analyze the efficiency and suitability of various search techniques including A* and AO* algorithms.
CO5 (Evaluate): Evaluate game-playing strategies using minimax and alpha-beta pruning algorithms.
CO6 (Create): Design AI-based solutions for problem-solving and game-playing using appropriate search methods.

### Course Content

### Unit I

Overview of Artificial Intelligence: Introduction to AI, Importance of AI, AI and its related field, AI techniques, Problems, Problem Space and search: Defining the problem as a state space search, Production system and its characteristics, Issue in the design of search problem.

### Unit II

Search Techniques: Depth first search, Breadth First Search, Heuristic Search Technique: Hill climbing, best first search technique, A* algorithm, Searching of AND/ OR graph using AO* algorithm, Game

Playing: AI and game playing, min-max algorithm, and Modified minimax with alpha-beta pruning.

**Text and Reference Books:**


1. E. Rich, K. Knight, and S. B. Nair, *Artificial Intelligence*, McGraw Hill Education, 2009.
2. R. Chopra, *Artificial Intelligence (A Practical Approach)*, S Chand Publishing, 2012.
3. S. Russel and P. Norvig, *Artificial Intelligence: A Modern Approach*, Pearson Education, 2015.
4. D. W. Patterson, *Introduction to Artificial Intelligence and Expert System*, Pearson Education, 1st edition, 2007.
5. D. Khemani, *A First Course in Artificial Intelligence*, McGraw Hill Education, 3rd edition, 1st edition, 2013.
6. G. F. Luger, *Artificial Intelligence: Structures and Strategies for Complex Problem Solving*, Pearson Education, 5th edition, 2009.

## Introduction to Data Science

**General Course Information**

| | |
|---|---|
| **Course Code:** U25OEC303T(ii)<br>**Credits:** 2<br>**Hours /Week:** 2<br>**Course Type**: Open Elective Courses<br>**Category:** Theory<br>**Mode:** Lectures (L)<br>**Examination Duration:** 2 Hours | **Course Assessment Methods:**<br>**Max. Marks: 50 (Internal: 15; External: 35)**<br><br>The department will conduct one minor test worth 10 marks. The Course Coordinator will decide whether to hold a second minor test at their level, and there will be no date sheet for it. Class performance includes attendance (5 marks). Internal marks will be the total of the minor test score and the class performance marks earned by the student.<br><br>**Note:** The end semester examination will be of 35 marks. The examiner is required to set five questions in all. The first question will be compulsory consisting of five short questions covering the entire syllabus consisting of 3 marks each. In addition to that four more questions will be set with two questions from each unit. The students shall be required to attempt three questions in all selecting one question from each unit consisting of 10 marks each in addition to compulsory Question No. 1 consisting of marks 15. |

**About the Course:**

This subject deals with the basic concepts of Data Science.

**Course Outcomes:**

Upon completion of this course, students will be able to:

**CO1 (Remember):** Define key concepts in data science, including data types, growth challenges, and the data science process.
**CO2 (Understand):** Explain data acquisition, preprocessing techniques, and the difference between structured and unstructured data.
**CO3 (Apply):** Apply data cleaning and transformation techniques to prepare datasets for analysis.
**CO4 (Analyze):** Analyze different types of data such as acoustic, image, sensor, and network data and their handling techniques.
**CO5 (Evaluate):** Evaluate data wrangling methods including merging, reshaping, and aggregation for efficient data manipulation.
**CO6 (Create):** Create workflows to transform, aggregate, and manipulate large datasets using techniques like pivoting, group operations, and string manipulations..

### Course Content

#### Unit I

Data Science-a Discipline, Landscape-Data to Data science, Data Growth-issues and challenges, data science process. foundations of data science. Messy data, Anomalies and artifacts in datasets. Cleaning data, Data Acquisition and Processing: introduction, Structured Vs. Unstructured data, data preprocessing techniques including data cleaning, selection, integration, transformation and reduction, data mining, interpretation.

## Unit II

Representation of Data: Special types-acoustic, image, sensor and network data. General techniques for handling large data

Data Wrangling Combining and Merging Data Sets – Reshaping and Pivoting – Data Transformation – String manipulations – Regular Expressions , Data Aggregation and Group Operations Group By Mechanics – Data Aggregation – GroupWise Operations – Transformations – Pivot Tables – Cross Tabulations – Date and Time data types.

**Text and Reference Books:**


1. S. Ozdemir, *Principles of Data Science*, Packt Publishing, 2016.
2. J. Grus, *Data Science from Scratch*, O'Reilly, 2016.
3. F. Provost and T. Fawcett, *Data Science for Business*, O'Reilly, 2013.
4. R. D. Peng and E. Matsui, *The Art of Data Science*, Lean Publishing, 2015.
5. P. Bruce, A. Bruce, and P. Gedeck, *Practical Statistics for Data Scientists, 2e: 50+ Essential Concepts Using R and Python*, O′Reilly.

## Web Technologies Lab.

**General Course Information**

| | |
|---|---|
| **Course Code:** U25SEC403T(i)<br><br>**Credit:** 2<br>**Hours/Week:** 4<br><br>**Course Type:** Skill Enhancement Course<br><br>**Category:** Practical<br>**Mode:** Lab Practice and Assignments | **Course Assessment Methods:**<br>**Total Marks: 50 (Internal: 35; External: 15)**<br>The internal and external assessment is based on the level of participation in lab sessions and the timely submission of lab experiments/assignments, the quality of solutions designed for the assignments, the performance in VIVA VOCE, the quality of lab file and ethical practices followed. The external examination is conducted by external examiner appointed by the Controller of Examination in association with the internal examiner appointed bythe Chairperson of the Department. |

**About the Course:**

The Web Technologies Lab course provides hands-on practical experience in designing, developing, and deploying modern web applications. It covers fundamental and advanced web technologies including HTML5, CSS3, JavaScript, client-server architecture, and popular frameworks and tools. Students learn to create responsive and interactive websites, work with web servers, and integrate backend services. The lab emphasizes practical skills through assignments, projects, and experiments that reflect real-world web development scenarios, preparing students for careers in web design and development.

**Course Outcomes:**

Upon completion of this course, students will be able to:

CO1 (Remember): Recall basic web technologies including HTML, CSS, and JavaScript.
CO2 (Understand): Explain the structure and functionality of web pages and client-server communication.
CO3 (Apply): Develop interactive web pages using HTML, CSS, and JavaScript.
CO4 (Analyze): Debug and troubleshoot common web development issues and errors.
CO5 (Evaluate): Assess web page performance and responsiveness across different devices and browsers.
CO6 (Create): Build dynamic web applications incorporating front-end and back-end technologies.

**Note:**

The actual experiments/assignments will be designed by the course coordinator. One assignment should be designed to be done in groups of two or three students. The assignments must meet the levels of the given course outcomes. The list of assignments and schedule of submission will be prepared by the course coordinator at the beginning of the semester.

## Python Programming Lab.

**General Course Information**

| | |
|---|---|
| **Course Code:** U25SEC403T(i)<br><br>**Credit:** 2<br><br>**Hours/Week:** 4<br><br>**Course Type:** Skill Enhancement Course<br><br>**Category:** Practical<br><br>**Mode:** Lab Practice and Assignments | **Course Assessment Methods:**<br>**Total Marks: 50 (Internal: 35; External: 15)**<br>The internal and external assessment is based on the level of participation in lab sessions and the timely submission of lab experiments/assignments, the quality of solutions designed for the assignments, the performance in VIVA VOCE, the quality of lab file and ethical practices followed. The external examination is conducted by external examiner appointed by the Controller of Examination in association with the internal examiner appointed bythe Chairperson of the Department. |

**About the Course:**

Python is a scripting programming language known for both its simplicity and wide breadth of applications. For this reason, it is considered one of the best languages for beginners. Used for everything from web development to scientific computing Python is referred to as a general-purpose language by the greater programming community. The major objective of Python language is to make the students solve real word problem efficiently using python.

**Course Outcomes:**

Upon completion of this course, students will be able to:

CO1 (Remember): Recall Python syntax, data types, and basic programming constructs.
CO2 (Understand): Explain the use of control structures, functions, and modules in Python programs.
CO3 (Apply): Write Python programs to solve simple computational problems using loops and conditionals.
CO4 (Analyze): Debug and test Python code to identify and fix logical and runtime errors.
CO5 (Evaluate): Evaluate different approaches to problem-solving using Python programming constructs.
CO6 (Create): Develop Python applications using functions, file handling, and object-oriented programming concepts.

**Note:**

The actual experiments/assignments will be designed by the course coordinator. One assignment should be designed to be done in groups of two or three students. The assignments must meet the levels of the given course outcomes. The list of assignments and schedule of submission will be prepared by the course coordinator at the beginning of the semester.

## Data Science for Business and Decision Making

**General Course Information**

| | |
|---|---|
| **Course Code:** U25EEC403T(i)<br>**Credits:** 2<br>**Hours /Week:** 2<br>**Course Type**: Employability and Entrepreneurship Skills Courses<br>**Category:** Theory<br>**Mode:** Lectures (L)<br>**Examination Duration:** 2 Hours | **Course Assessment Methods:**<br>**Max. Marks: 50 (Internal: 15; External: 35)**<br><br>The department will conduct one minor test worth 10 marks. The Course Coordinator will decide whether to hold a second minor test at their level, and there will be no date sheet for it. Class performance includes attendance (5 marks). Internal marks will be the total of the minor test score and the class performance marks earned by the student.<br><br>**Note:** The end semester examination will be of 35 marks. The examiner is required to set five questions in all. The first question will be compulsory consisting of five short questions covering the entire syllabus consisting of 3 marks each. In addition to that four more questions will be set with two questions from each unit. The students shall be required to attempt three questions in all selecting one question from each unit consisting of 10 marks each in addition to compulsory Question No. 1 consisting of marks 15. |

### About the Course:

This course introduces core concepts and applications of Data Science, including data mining, machine learning, and predictive analytics. It covers key tools, ethical issues, and the role of data in supporting objective decision-making in business and public sectors. Students gain practical skills to analyze data effectively and use it as a competitive advantage.

### Course Outcomes:

Upon completion of this course, students will be able to:
CO1 (Remember): Recall fundamental concepts, processes, and applications of data science.
CO2 (Understand): Explain the role of data science in business analytics and decision-making.
CO3 (Apply): Use software tools like Excel and Python for data analysis and processing.
CO4 (Analyze): Analyze ethical, privacy, and data quality issues in data science projects.
CO5 (Evaluate): Assess the transparency and reproducibility of data-driven research and decisions.
CO6 (Create): Develop data-driven solutions supporting objective and well-documented business decisions...

### Course Content

#### Unit I

Introduction to Data Science, The Scientific Method and Processes, Knowledge Extraction Using Algorithms, Insights into Structured and Unstructured Data, Data Mining and Big Data, Use of Hardware and Software Systems, Peripatetic and Amalgamated Uses of Methodologies, Statistical Components in Data Science, Analytical Pathways for Business Data, Machine Learning (ML) as a New Pathway, The Use of Data-Driven Science, Distributed and Parallel Systems, Business Analytics (BA), Intelligence, and Predictive Modeling, Statistical Applications of Data Science, Public Sector Uses of Data Science, Data as a Competitive Advantage, Data Engineering Practices, Applied Data

Science, Predictive and Explanatory Theories of Data Science, The Future of Data Science.

**Unit II**

Increased Usage of Open Science, Co-Production and Co-Consumption of Data Science, Better Reproducibility of Data Science, Transparency in the Production and Use of Data Science, Changing Research Paradigms in Academia, Software Packages such as Microsoft Excel and Python, Computational Competence for Business Leaders, The Language of Data Science, Ethical Considerations in Data Science, Data Protection and Privacy, Informed Consent and Primary Usage, Data Storage and Security, Data Quality Controls, Business Secrets and Political Interference, How Data Science Supports Business Decision-Making, Opening Up the Perspective of the Decision Maker, Properly Evaluating Feasible Options, Justification of Decisions, Maintaining Records of Decision Rationale, Less Subjectivity and More Objectivity in Decision-Making.

**Text and Reference Books:**

1. Seyed Ali Fallahchay, *Data Science for Business and Decision Making: An Introductory Text for Students and Practitioners*, Arcler Press.

## Ethical Hacking

**General Course Information**

| | |
|---|---|
| **Course Code:** U25EEC403T(ii)<br>**Credits:** 2<br>**Hours /Week:** 2<br>**Course Type**: Employability and Entrepreneurship Skills Courses<br>**Category:** Theory<br>**Mode:** Lectures (L)<br>**Examination Duration:** 2 Hours | **Course Assessment Methods:**<br>**Max. Marks: 50 (Internal: 15; External: 35)**<br><br>The department will conduct one minor test worth 10 marks. The Course Coordinator will decide whether to hold a second minor test at their level, and there will be no date sheet for it. Class performance includes attendance (5 marks). Internal marks will be the total of the minor test score and the class performance marks earned by the student.<br><br>**Note:** The end semester examination will be of 35 marks. The examiner is required to set five questions in all. The first question will be compulsory consisting of five short questions covering the entire syllabus consisting of 3 marks each. In addition to that four more questions will be set with two questions from each unit. The students shall be required to attempt three questions in all selecting one question from each unit consisting of 10 marks each in addition to compulsory Question No. 1 consisting of marks 15. |

**About the Course:**

This course covers the fundamentals of ethical hacking and cybersecurity, including security testing, vulnerability assessment, and penetration testing. It explores common threats like malware, web and database attacks, wireless and mobile security issues, and defensive tools such as firewalls and intrusion detection systems. Students learn practical skills to identify and protect against security breaches ethically and legally.

**Course Outcomes:**

Upon completion of this course, students will be able to:
CO1 (Remember): Define fundamental concepts of ethical hacking and security testing.
CO2 (Understand): Explain the processes used by attackers and ethical hackers.
CO3 (Apply): Perform footprinting, scanning, and vulnerability assessment techniques.
CO4 (Analyze): Analyze malware threats, network attacks, and system vulnerabilities.
CO5 (Evaluate): Evaluate security tools like IDS, firewalls, and honeypots for defense.
CO6 (Create): Develop basic test plans and implement penetration testing strategies ethically.

### Course Content

#### Unit I

An Introduction to Ethical Hacking : Security Fundamentals, Security Testing, Hacker and Cracker, Test Plans - Keeping It Legal, Ethical and Legality, The Technical Foundations of Hacking : The Attacker's Process, The Ethical Hacker's Process, Security and the Stack, Footprinting and Scanning : Information Gathering, Determining the Network Range, Identifying Active Machines, Finding Open Ports and Access Points, OS Fingerprinting Services, Mapping the Network Attack Surface, Vulnerability Assessment and Penetration Testing : Need of Vulnerability Assessment, Risk Prevention, Compliance Requirement, Enumeration and System Hacking :Enumeration, System Hacking, Denial of Service and Distributed Denial of Service, Sniffers.

## Unit II

Malware Threats : Viruses and Worms, Trojans, Covert Communication, Keystroke Logging and Spyware, Malware Countermeasures, Sniffers, Session Hijacking, and Denial of Service : Sniffers, Session Hijacking, Denial of Service and Distributed Denial of Service, Web Server Hacking, Web Applications, Database Attacks : Web Server Hacking, Web Application Hacking, Database Hacking, Session Hijacking, Wireless Technologies, Mobile Security and Attacks : Wireless Technologies, Mobile Device Operation and Security, Wireless LANs, Vulnerability Assessment and Penetration Testing, IDS, Firewalls and Honeypots : Intrusion Detection Systems, Firewalls, Honeypots.

**Text and Reference Books:**


1. Rafay Baloch, *Ethical Hacking and Penetration Testing Guide*, CRC Press.
2. S. Hartman, *Hands-On Ethical Hacking Tactics: Strategies, Tools, and Techniques for Effective Cyber Defense,* Packt Publishing Ltd

## Python Tools Lab.

### General Course Information

| | |
|---|---|
| **Course Code**: U25VOC403P(i)<br>**Course Credits**: 2<br>**Type**: Vocational Course<br>**Contact Hours**: 4 hours/week<br>**Category:** Practical<br>**Mode**: Lab practice and assignments | **Course Assessment Methods:**<br>**Total Marks: 50 (Internal: 15; External: 35)**<br>The internal and external assessment is based on the level of participation in lab sessions and the timely submission of lab experiments/assignments, the quality of solutions designed for the assignments, theperformance in VIVA VOCE, the quality of lab file and ethical practices followed. The external examination is conducted by external examiner appointed by the Controller of Examination in association with the internal examiner appointed bythe Chairperson of the Department. |

### About the Course:

The Python Tools Lab is a practical course designed to develop hands-on skills in using Python programming language and its powerful libraries and tools for data analysis, automation, and scientific computing. Students gain experience with key Python packages such as NumPy, Pandas, Matplotlib, and Jupyter Notebooks, learning to write efficient code, handle data sets, visualize information, and solve real-world problems. The lab focuses on practical exercises, projects, and assignments that build proficiency in Python programming and its applications in data science and related fields.

### Course Outcomes:

Upon completion of this course, students will be able to:

CO1 (Remember): Identify essential Python libraries and tools used for data analysis and visualization.
CO2 (Understand): Explain the functionalities of libraries like NumPy, Pandas, and Matplotlib.
CO3 (Apply): Use Python tools to perform data manipulation and basic visualization tasks.
CO4 (Analyze): Analyze datasets by applying filtering, grouping, and aggregation using Pandas.
CO5 (Evaluate): Assess the suitability of different Python tools for specific data science tasks.
CO6 (Create): Build comprehensive Python scripts combining multiple libraries for data processing and visualization.

### Note:

The actual experiments/assignments will be designed by the course coordinator. One assignment should be designed to be done in groups of two or three students. The assignments must meet the objective of the course. The list of assignments and schedule of submission will be prepared by the course coordinator at the beginning of the semester.

## Data Visualizations Lab.

**General Course Information**

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| **Course Code**: U25VOC403P(i)<br>**Credit**: 2<br>**Hours/Week:** 4<br>**Course Type:** Vocational Course<br>**Category:** Practical<br>**Mode:** Lab Practice and Assignments | **Course Assessment Methods:**<br>**Total Marks: 50 (Internal: 15; External: 35)**<br>The internal and external assessment is based on the level of participation in lab sessions and the timely submission of lab experiments/assignments, the quality of solutions designed for the assignments, theperformance in VIVA VOCE, the quality of lab file and ethical practices followed. The external examination is conducted by external examiner appointed by the Controller of Examination in association with the internal examiner appointed bythe Chairperson of the Department. |

**About the Course:**

The Data Visualization Lab is designed to provide students with practical experience in transforming complex datasets into meaningful visual representations. This lab complements theoretical concepts with hands-on sessions that develop the skills needed to interpret, analyze, and communicate data insights effectively. Through this lab, students will explore a range of visualization tools and libraries such as Tableau, Microsoft Power BI, Python (Matplotlib, Seaborn, Plotly), and R (ggplot2). Emphasis will be placed on storytelling with data, creating dashboards, and applying principles of design and perception to build interactive and insightful visualizations.

**Course Outcomes:**

Upon completion of this course, students will be able to:

CO1 (Remember): Recall basic concepts and types of data visualizations.
CO2 (Understand): Explain the purpose and interpretation of common charts like bar, line, pie, and scatter plots.
CO3 (Apply): Create various data visualizations using tools such as Matplotlib, Seaborn, or Tableau.
CO4 (Analyze): Analyze datasets to choose the most effective visualization techniques for different data types.
CO5 (Evaluate): Critically evaluate the clarity and impact of different visual representations.
CO6 (Create): Design and implement interactive and insightful dashboards for real-world datasets.

**Note:**

The actual experiments/assignments will be designed by the course coordinator. One assignment should be designed to be done in groups of two or three students. The assignments must meet the levels of the given course outcomes. The list of assignments and schedule of submission will be prepared by the course coordinator at the beginning of the semester.