Semester IV

DISCIPLINE SPECIFIC CORE COURSE -10 (DSC-10)
IV.1. Applied Probability and Statistics

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical / Practice		
Applied probability and statistics, DSC 10, IV.1.	**4**	**3**	**0**	**1**	**12th pass**	**Mathematics till XII**

Learning Objectives

Probability theory is the branch of mathematics that deals with modelling uncertainty. It is an important course as it has direct application in areas such as genetics, finance and telecommunications. It also forms the fundamental basis for many other areas in the mathematical sciences, such as modern optimization methods and risk modelling. This course introduces probability theory, random variables. This unit will concentrate on the following: Sampling distributions, hypothesis testing, interval estimation, likelihood, analysis of categorical data, joint, marginal and conditional distributions, and regression. R software will be introduced through practical classes in the beginning of the course. Its use will be supported with examples in lectures and tutorials with supplementary material on the course website.

Learning outcomes

- A good understanding of basic concepts of statistical distributions.
- A good understanding of elementary probability theory, the laws of probability and the use of Bayes and various other theorems of probability .
- Able to derive the probability density functions of transformations of random variables and use these to generate data from various distributions.
- Able to represent and statistically analyze data both graphically and numerically.
- A good understanding of exploratory data analysis by working on datasets related to human resources, image segmentation analysis, pollution levels in a city, health

diagnosis, etc. along with the ability to write a short-report describing a simple statistical data set.

- Able to translate real-world problems into probability models.

SYLLABUS

Unit I: Probability space - Conditional probability - Bayes theorem – Independence - Descriptive measures (Mean, median, mode, standard deviation, dispersion, moments) - Random variables - Joint distributions [9 hours]

Unit II: Discrete distributions (Bernoulli, Binomial, Poisson) and their properties (Expectation, variance, conditional expectation, moments) - Continuous distributions (Uniform, Normal, Exponential) with their properties (Expectation, variance, conditional expectation, moments) [12 hours]

Unit III: Joint, marginal and conditional distributions - Weak and strong law of large numbers, -Central limit theorem - Curve fitting - linear regression, Correlation [9 hours]

Unit IV: Sampling distributions - Hypothesis testing, interval estimation - Likelihood, analysis of categorical data - Test statistic and their significance [15 hours]

Practicals– [30 Hours]

Computer program R and its application to simple models

- Introduction to basic syntax of R for arithmetic operations, creating arrays and matrices
- Getting data into R and basic data analysis in R
- Statistical computations in R (evaluation of density functions and distribution functions,
  computation of descriptive measures for given data)
- Data visualization in R
- Innovation Project

Essential/recommended readings

1. Introduction to Probability and Statistics for Engineers and Scientists, S.M.Ross, AcademicPress,2009.

2. Applied Statistics and Probability for Engineers, D.C. Montgomery and G.C. Runger, John Wiley and Sons, 2014.

3. Design of Experiments: A No-Name Approach, Thomas Lorenzen and Virgil Anderson, CRC Press 1993.

4. Statistics and Experimental Design in Engineering and the Physical Sciences, Vol. I and II, N.L. Johnson and F.C. Xeen Leone, Wiley Interscience, 1977.

DISCIPLINE SPECIFIC CORE COURSE -11 (DSC-11)
IV.2. Analysis and Design of Algorithms

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Analysis and Design of Algorithms, DSC 11, IV.2.	4	3	0	1	Class XII pass	Programming Fundamentals

Learning Objectives

The objective is to teach techniques for effective problem-solving in computing. The use of different paradigms of problem-solving will be used to illustrate clever and efficient ways to solve a given problem. In each case, emphasis will be placed on rigorously proving the correctness of the algorithm. In addition, the analysis of the algorithm will be used to show the efficiency of the algorithm over the naive techniques.

Learning outcomes

After completing this course, student should be able to;

- Understand basics of algorithmic analysis and their practical understanding of the real-world examples.
- Learn mathematical design of algorithms and their algorithmic correctness through proofs.
- Understand computational complexity with asymptotic notations and their analysis.
- Have an introduction of different types of paradigm and domain of algorithms such as NP completeness.
- Have hands-on experiments on dynamic programming and greedy approaches.
- Do hands-on experiments on advanced data structures such as AVL tree, Red black, Search heuristics, Approximation algorithms, Distributed and parallel algorithms.

SYLLABUS

Unit I: Algorithmic analysis and modeling - Algorithmic proofs - Computational complexity - Asymptotic notation and analysis **[12 hours]**

Unit II: Sorting methods analysis – Randomization – NP Completeness – Advanced data structure **[12 hours]**

Unit III: Geometric algorithms – Graph algorithms – Linear Programming – Design paradigm such as Divide & conquer **[10 hours]**

Unit IV: Dynamic Programming – Greedy Approaches – Search heuristics – Approximation algorithms – Compression and streaming algorithms – Distributed and parallel algorithms. **[11 hours]**

Practicals - [30 Hours]

Write program to perform

- operation count for a given pseudo code
- Bubble sort for any given list of numbers.
- Insertion sort for any given list of numbers.
- Quick Sort for the given list of integer values.
- Merge Sort on the given two lists of integer values.
- Binary Search for a given set of integer values recursively and non-recursively.

Write program to find

- Maximum and Minimum of the given set of integer values.
- a solution for the knapsack problem using greedy methods.
- the minimum cost spanning tree using Prim's Algorithm.
- the minimum cost spanning tree using Kruskal's Algorithm.
- a solution for job sequencing with deadlines problem.

Write program

- for all pairs shortest path problems.
- to solve the N-QUEENS problem.
- to solve the Sum of subsets problem for a given set of distinct numbers.

Essential/recommended readings

- Introduction to Algorithms. Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, and Clifford Stein. MIT Press, 2009.
- Problem Solving with Algorithms and Data Structures Using Python. Bradley W. Miller, and David L. Ranum. Franklin, Beedle & Associates, 2011.
- Data Structures and Algorithms in C++, A. Drozdek, Course Technology, 2013.
- The Art of Computer Programming, Vol. 1,2,3,4. Donald E. Knuth, Pearson Education, 2013.

DISCIPLINE SPECIFIC CORE COURSE -12 (DSC-12)
IV.3. Database Management Systems

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Database Management Systems, DSC 12, IV.3.	**4**	**3**	**0**	**1**	**12th pass**	**NIL**

Learning Objectives

The objective is to present an introduction to database management systems, with an emphasis on how to organize, maintain and retrieve - efficiently, and effectively - information from a DBMS. In addition, Course also introduces the present day modern databases with implementation on real-world projects.

Learning outcomes

After completing this course, student should be able to;

- Install, configure, and interact with a relational database management system.
- Describe, define and apply the major components of the relational database model to database design.
- Learn and apply the Structured Query Language (SQL) for database definition and manipulation.
- Utilize a database modeling technique for a single entity class, a one-to-one (1:1) relationship between entity classes, a one-to-many (1:M) relationship between entity classes, a many-to-many (M:M) relationship between entity classes, and recursive relationships.
- Define, develop and process single entity, 1:1, 1:M, and M:M database tables.
- Learn and implement the principles and concepts of information integrity, security and confidentiality.
- Apply ethical computing concepts and practices to database design and implementation.

SYLLABUS

Unit I: Traditional Files & Databases – Database Management Systems **[9 hours]**

Unit II: Relational Model - ER Modeling – Constraints, Query language & features – Normalization – Indexing **[12 hours]**

Unit III: Transaction Processing & Concurrency Control – PL/SQL Basics Graph Databases - Data Modeling Techniques & UML **[12 hours]**

Unit IV: Analysis of Data using Mining Techniques – MongDB - NoSQL – Object Oriented Databases - Study of Real-World Applications **[12 hours]**

Practicals- **[30 Hours]**

- ER Diagram of Existing systems and new systems
- SQL Commands, Structures & execution of Commands on Test Database
- Creation of Databases and identifying the Constraints
- Execution of DDL, DML, TCL Queries on created database
- XML Databases • Executing Aggregate Functions and Extraction of Data elements
- Programs on Database Objects including Procedures, Functions, Exception
- Modeling of Systems and Requirements using UML
- Design of Application(s) using Mining Techniques
- Reverse Engineering & Study of a Database System Architecture
- Innovation Project

Essential/recommended readings

- Fundamental of Database Systems, R. Elmasri and S. B. Navathe, Pearson Education Asia, 7th edition, 2016.
- Database System Concepts, Abraham, H. and Sudershan, S., 5 Ed., McGraw-Hill, 2013
- Introduction to Data Mining, Pang, N. T., Pearson Education, 2013
- Database System: The Complete Book, Jeffrey Ullman, Jennifer Widom, and Héctor García-Molina, Pearson Education, 2008
- Data Modeling: A Beginners Guide, Andy Oppel, McGrew Hill, 2010